ENVIRONMENTAL IMPACT ASSESSMENT

(SPECIAL INVESTIGATION)

ON

HYDROPOWER DEVELOPMENT OF

AYEYAWADY RIVER BASIN ABOVE MYITKYINA,

KACHIN STATE, MYANMAR

Biodiversity And Nature Conservation Association (BANCA)

October, 2009

Yangon

MYANMAR

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Part - I

ACRONYMS AND ABBREVIATIONS

BANCA	Biodiversity And Nature Conservation Association
BIA	Biological Impact Assessment
BOT	Build, operate, and transfer
CAS	California Academy of Science
CBD	Convention on Biological Diversity
CISPDR	Changjiang Institute of Survey, Planning, Design & Research
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMS	Convention on Migratory Species
CPD	Center of Plant Diversity
CPI	China Power Investment Corporation
CR	Critically Endangered
DBH	Diameter at Breast Height of a plant
DD	Data Deficient
DHPI	Department of Hydroelectric Power Implementation
EIA	Environmental Impact Assessment
EN	Endangered
EIS	Environmental Impact Statement
EW	Extinct in the Wild
EX	Extinct
FD	Forest Department
GPS	Global Positioning System
IUCN	The World Conservation Union (International Union for Conservation of Nature and Natural Resources)
IVI	Important Value Index; a quantitative analysis of dominant species and their relative values of frequency, density and basal area were calculated and summed up to get important value index.
KIA	Kachin Independent Army
kW	Kilowatt
kWh	Kilowatt hour
LC	Least Concerned
MDG	Millennium Development Goals
MOGE	Myanmar Oil and Gas Enterprise
MW	Megawatts
mg/l	Milligram per liter
NCNPP	Nature Conservation and National Park's Project

NCEA	The National Commission for Environmental Affairs
NDAK	New Democratic Army of Kachin
NP	National Park
NT	Near Threatened
NTFP	Non Timber Forest Product
NTU	Nephelometric Turbidity Unit
NWCD	Nature and Wildlife Conservation Division
PAS	Protected Areas System
ppm	Parts per Million
SI	Smithsonian Institution
TCM	Traditional Chinese Medicine
TKM	Traditional Korean Medicine
TRAFFIC	Wildlife trade monitoring network
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
USNM	Naatural Museum of atural History, Smithsonian Institution
uS/cm	Micro siemens Per Centimeter
VU	Vulnerable
WCD	World Commission on Dams
WCS	Wildlife Conservation Society
WS	Wildlife Sanctuary
WWF	World Wide Fund For Nature

GLOSSARY OF MAJOR TERMS USED IN PART I, PART II AND PART III OF THIS REPORT

Abatement	Reducing the degree or intensity of, or eliminating pollution.

Absorption	The passage of one substance into or through another; an operation in which one or more soluble components of a gas mixture are dissolved in a liquid.
Accident site	The location of and unexpected occurrence, failure, or loss, either at a plant or along a transportation route, resulting in a release of hazardous materials.
Acid deposition	A complex chemical and atmospheric phenomenon that occurs when emissions of sulfur and nitrogen compounds and other substances are transformed by chemical processes in the atmosphere, often far from the original sources, and then deposited on earth in either a wet or a dry form.
Acute toxicity	The ability of a substance to cause poisonous effects resulting in severe biological harm or death soon after a single exposure or dose; also any severe poisonous effect resulting from a single short-term exposure to a toxic substance.
Adit	A tunnel used, made for geological investigations.
Aerobic	Life or processes that require, or are not destroyed by the presence of oxygen.
Agricultural Pollution	A liquid and solid wastes from farming, including runoff and leaching of pesticides and fertilizers; erosion and dust from plowing; animal manure and eareassess; and crop residues and debris.
Air Pollution	The presence of contaminant or pollutant substances in the air that do not disperse properly and interfere with human health or welfare or produce other harmful environmental effects.
Algae	A major division of the plant kingdom consisting of simple non-vascular photosynthetic plants which a unicellular, colonial, filamentous, or thalloid body, and being aquatic in marine or freshwater or found in damp habitats on land. Algae are a large and diverse group of simple, typically autotrophic organisms, ranging from unicellular to multicellular forms. The largest and most complex marine forms are called seaweeds. They are photosynthetic, like plants, and "simple" because they lack the many distinct organs found in land plants. For that reason they are currently excluded from being considered plants.
Ambient Air	Any unconfined protion of the atmosphere; open air, surrounding air.
Amphidromous	Amphidromous fish move between fresh and saltwater during their life cycle, but not to breed.

Anadromous	Anadromous fish live in the ocean mostly, and breed in freshwater.
Aquaculture	Aquaculture is the farming of freshwater and saltwater organisms including fish, molluscs, crustaceans and aquatic plants. Unlike fishing, aquaculture, also known as aquafarming, implies the cultivation of aquatic populations under controlled conditions.
Aquatic	Aquatic means relating to water; living in or near water or taking place in water.
Aquifer	An underground geological formation or group of formations, containing usable amounts of groundwater that can supply wells and springs.
Atmosphere (as a measurement)	A standard unit of pressure representing the pressure exerted by a 29.92 inch column of mercury at sea level at 45 degree latitude and equal to 1000 grams per square centimeter.
Bacteria (singular bacterium)	Microscopic living organism that can aid in pollution control by consuming or breaking down organic matter in sewage or by similarly acting on oil spills or other water pollutants.
Benthos	Benthos are the organisms which live on, in, or near the sea or inland water bed, also known as the benthic zone.
Biochemical Oxygen Demand (BOD)	A measure of the amount of oxygen consumed in the biological processes that break down organic matter in water. The greater the BOD, the greater the degree of pollution.
Biodiversity	All living things on Earth (plants, animals and micro-organisms), and the differences that make each species unique.
Biological Oxidation	The way bacteria and microorganism feed on and decompose complex organic materials; used in self-purification of water bodies and in activated sludge wastewater treatment.
Biological Treatment	A treatment technology that uses bacteria to consume waste and thus break down organic materials.
Cadmium (Cd)	A heavy metal element that accumulates in the environment.
Carbon dioxide (CO2)	A colourless, odorless, nonpoisonous gas that results from fossil fuel combustion and is normally apart of the ambient air.

Carbon monoxide (CO)	A colourless, odorless, poisonous gas produces by incomplete fossil fuel combustion.
Carcinogen	Any substance that can cause or contribute to the production of cancer.
Carnivores	A carnivore is an animal that is adapted to eat meat and not plant.
Catadromous	Catadromous fish live in the freshwater, and breed in the ocean.
Catchment	The action of collecting water, especially the collection of rainfall over a natural drainage area.
Catchment Area	The area of land, in square kilometers (km^2) or hectares (ha), that drains to a specific point on a river.
Chemical oxygen demand (COD)	A measue of the oxygen require to oxidize all compounds in water, both organic and inorganic.
Chinese EIA Law	Law of the People's Republic of China on Appraising of Environment Impacts
Chloroflurocarbons (CFCs)	A family of inert, nontoxic and easily liquefied chemicals used in refrigeration air conditioning, packaging, and insulation or as solvents and aerosol propellants.
Chromium	A heavy metal.
Chronic toxicity	The capacity of a substance to cause long term poisonous human healh effects.
CITES Appendix I	It includes just over 800 species threatened with extinction, and trade in specimens of these species is permitted only in exceptional circumstances (e.g., scientific study).
CITES Appendix II	It includes some 29,000 species that are not necessarily threatened with extinction, but in which trade must be controlled in order to avoid levels of utilization that would be incompatible with their survival.
CITES Appendix III	It contains 200-odd species that are protected in at least one country which has then asked other CITIES Parties for assistance in controlling the trade.
Coagulation	A clumping of particles in waste water to settle out imputities; often induced by chemicals such as lime, alum and iron salts.
Confluence	The junction of two or more rivers flowing together

Contaminant — Any physical, chemical, biological, radiological substance or matter that has an adverse affect on air, water, or soil.

Corrosion — The dissolving and wearing away of metal caused by a chemical reaction the occurs between water and the pipes that the water contracts, or when chemicals touching a metal surface, or when two metals are in contact.

Critically Endangered (CR) — Organisms with a conservation status of critically endangered have an extremely high risk of becoming extinct in the wild or completely extinct in the immediate future.

Critically Endangered Species — A species considered to be facing an extremely high risk of extinction in the wild, assessed using the IUCN Red List Categories and Criteria.

Cumulative — Increasing or growing by an accumulation or successive addition of parts or elements.

Dam — A concrete or earthen barrier constructed across a river and designed to control water flow or create a reservoir

Data Deficient (DD) — Data Deficient **(**DD**)** is a category applied by the IUCN to a species when the available information is not sufficient for a proper assessment of conservation status to be made. This does not necessarily indicate that the species has not been extensively studied; but it does indicate that little or no information is available on the abundance and distribution of the species.

Data Deficient Species — A species for which there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. Data deficient species are research priorities, but not necessarily conservation priorities.

Decomposition — The breakdown of matter by bacteria and fungi; canges the chemical makeup and physical appearance of materials.

Degradation — The process by which a chemical reduced to a less complex form.

Diadromous — Diadromous fish travel between salt and freshwater

Discharge — A concrete or earthen barrier constructed across a river and designed to control water flow or create a reservoir.

Dissolved oxygen — Oxygen saturation or dissolved oxygen (DO) is a relative measure of the amount of oxygen that is dissolved or carried in a given medium. It can be measured with a dissolved oxygen probe such as an oxygen sensor or an optode in liquid media, usually water.

Dissolved solids	Disintegrated organic and inorganic material contained in water.
Diversion	The transfer of water from a stream, lake, aquifer, or other source of water by a canal, pipe, well, or other conduit to another watercourse or to the land, as in the case of an irrigation system
Downstream	Situated or moving in the direction in which a stream or river flows
Drawdown	The release of water from a reservoir for power generation, flood control, irrigation or other water management activity
Ecology	The study of interrelationships of organisms to their environment (or surroundings). Ecology considers individual organisms, populations, and communities, as well as large units of landscape such as forests, estuaries and river basins. For an EIA, the ecosystem can be considered to be an appropriate unit of analysis concerned with a community and its environment, both living and non-living.
Ecoregion	According to WWF (2002), ecoregion means, a large area of land or water that contains a geographically distinct assemblage of natural communities that share a large majority of their species and ecological dynamics, share similar environmental conditions, and interact ecologically in ways that are critical for their long-term persistence.
Ecosystem	A community and its environment (living and nonliving considered collectively) (may range in extent from very small to very large units). An ecosystem is a natural unit consisting of all plants, animals and micro-organisms (biotic factors) in an area functioning together with all of the physical (abiotic) factors of the environment.
Ecotourism	Tourism directed towards threatened natural environments, especially to support conservation efforts and observe wildlife.
Effluent	Wastewater treated or untreated that flows out of a treatment plant, sewer, or industrial outfall; generally refers to wastes discharged into surfact water.

Electrical conductivity	Electrical conductivity or specific conductance is a measure of a material's ability to conduct an electric current. The conductivity of a solution of water is highly dependent on its concentration of dissolved salts and sometimes other chemical species which tend to ionize in the solution. Electrical conductivity of water samples is sued as an indicator of how salt-free, ion-free, or impurity-free the sample is; the purer the water, the lower the conductivity (the higher the resistivity). Conductivity measurements in water are often reported as "Specific Conductance", which is the conductivity of the water were it measured at 25C.
Emission	Pollution discharged into the atmosphere from smokestacks, other vents, and surface areas of commercial or industrial facilities, from residential chimneys; and from motor vehicle, locomotive, or aircraft exhausts.
Emission factor	The relationship between the amount of pollution produced and the amount of raw material processed.
Emission standard	The maximum amount of air polluting discharge legally allowed from a single soure, mobile or stationary.
Endangered (EN)	A species is Endangered when the best available evidence indicates that meets any of the criteria A to E for Endangered, and it is therefore considered to be facing a very high risk of extinction in the wild.
Endangered Species	A species considered to be facing a very high risk of extinction in the wild, assessed using the IUCN Red List Categories and Criteria.
Endemic Bird Area - EBA	One of 218 discrete biogeographic regions holding at least two restricted-range birds, as assessed by Birdlife International.
Endemic species	A species that is restricted to a particular geographic area and thus are found nowhere else on earth.Species that are endemic to small geographic ranges are known as restricted-range species. A species of animal or plant native to, or limited to, a specific geographical area
Environmental awareness and education	Activities designed to inform, disseminate ideas, promote debates, and inspire changes to generate a lasting change of behavior in favor of conservation.
Environment	The total of all those physical, chemical, biological and social economic factors that impinge on an individual, a community or a population

Environmental audit	An analysis of the technical, procedural and decision making aspects of an EIA carried out sometime after a proposal has been implemented.
Environmental Impact	A change in effect on an environmental resource or value resulting from human activities including project development, often called an "effect".
Environmental Impact Assessment (EIA)	A formal process to predict the environmental consequences of human development activities and to plan appropriate measures to eliminate or reduce adverse effects and augment positive effects.
Environmental Management	Management and control of the environment and natural resources systems in such a way so as to ensure the sustainability of development efforts over a long-term basis
Environmental monitoring	Observation of effects of development projects on environmental resources and values
Environmental planning	All planning activities with the objective of preserving or enhancing environmental values or resources
Erosion	Wearing away of rock or soil by the gradual detachment of soil or rock fragments by water, wind, ice, and other mechanical, chemical, or biological forces
Euryphagous	Feeding on a large variety of food
Eutrophication	The slow aging process during which a lake, estuary, or bay evolves into a bog or marsh and eventually disappears.
Evapotranspiration	The loss of water from the soil both by evaporation and by transpiration from the plants growing in the soil.
Exposure	A potential health threat to the living organisms in the environment due to the amount of radiation or pollutant present in the environment.
Fauna	All the animals of an area or a period of time
Fertilizer	Materials such as nitrogen and phosphours that provide nutrients for plants.
Flapship species	These are popular, charismatic species that serve as symbols and rallying points to stimulate conservation awareness and action.
Flood Plain	Area bordering a river which is flooded when the river rises over its normal banks.
Flora	All the plants growing in a particular area

Fluorocarobon (FCs)	Any of a number of organic compounds analogous too hydrocarbons in which one or more hydrogen atoms are replaced by fluorine.
Fly ash	Noncombustible residual particles from the combustion process carried by flue gas.
Food chain	Food chains describe the eating relationships between species within an ecosystem or a particular living place.
Food web	Food webs describe the transfer of energy between species in an ecosystem.
Greenhouse effect	The warming of the Earth's atmosphere caused by a buildup of carbon dioxide or other trace gases; many scientists believe that this buildup allows light from the sun's rays to heat the Earth but prevents a counterbalancing loss of heat.
Gregarious	Gregarious bamboo flowering means simultaneous flowering of bamboos in the whole forests; of animals that travel in herds or packs
Groundwater	Subsurface water and underground streams that can be collected with well, or that flow naturally to the earth’s surface though springs.
Habitat	The local environment, in which an organism normally lives and grows.
Habitat diversity	The number of kinds of habitat in a given unit area.
Hatchery:	A hatchery is a facility where eggs are hatched under artificial conditions, especially those of fish or poultry. It may be used for ex-situ conservation purposes, i.e. to breed rare or endangered species under controlled conditions; alternatively, it may be for economic reasons.
Heavy metals	Metallic elements with atomic number greater than 20, such as mercury and lead.
Herbivores	An herbivore is an animal that is adapted to eat plants and not meat.
Hotspot	Terrestrial biodiversity hotspot - Regions that harbor a great diversity of endemic species and have been significantly impacted and altered by human activities.
Hydrocarbons (HC)	Chemical compounds that consist entirely of carbon and hydrogen.

Hydroelectricity/Hydroelectric power	The production of electric power through use of the gravitational force of falling water.
Hydrogen sulfide (HS)	Gas emitted during organic decomposition and as a by-product of oil refining and burning.
Hydrology	Science that deals with the transportation and distribution of water in the atmosphere, on and beneath the earth's surface.
Hypolimnion	The hypolimnion is the dense, bottom layer of water in a thermally stratified lake. It is the layer that lies below the thermocline.
Impact assessment	A process of predicting and evaluating the effects of an action or series of actions on a defined target. Ideally impact assessment provides a systematic analysis of the enduring or significant changes in a system resulting from a given action or set of activities and then helps to determine if observed changes are positive or negative and intend or not.
Impoundment	A body of water or sludge confined by a dam, dike, floodgate, or other barrier.
Indicator species	The presence or fluctuation of an indicator species is believed (or hoped) to reflect either that of other species in the community or a change in the environment. However, it is uncertain that any species can serve as consistently good indicator. In addition, when using indicator species, it is important to note that specific conservation action targeted at an indicator species is likely to change its indicator ability.
Indirect discharge	Introduction of pollutants from a nondomenstic source into a publicly owned waste treatment system.
Infiltration	The penetration of water through the ground surface into subsurfact soil or the penetration of water from the soil into sewer or other pipes through defective joints, connections, or manhole walls.
Inorganic chemicals	Chemical substances of mineral origin, not of basically carbon structure.
Insecticide	A pesticide compound specifically used to kill or control the growth of insects.
Inundate	To flood; overflow
Irrigation	Technique for applying water or wastewater to land areas to supply the water and nutrient needs of plants.

IUCN Red List of Threatened Species	A system containing taxonomic, conservation status, and distribution information on taxa that have been valuated using the IUCN Red List Categories and Criteria, which is designed to determin the relative risk of global extinction, and which aims to catalogue and highlight those taxa that are facing a higher risk global extinction.
Key biodiversity area	An area comprising critical habitat for the survival of globally threatened and geographyically concentrated species, that can be managed for conservation.
Keystone species	These are species whose impacts on their community are greater than expected from their relative abundance. A subset of these are engineer species, which actually modify their ecosystem. While conservation of these species, will be very important for achieving corridor-scale conservaion outcomes, they are not necessarily targets for species -scale conservation in themselves.
kilowatt (kW)	The electrical unit of power, which equals 1,000 watts or 1.341 horsepower
kilowatt-hour (kWh)	A basic unit of electrical energy that equals one kilowatt of power applied for one hour.
Lacustrine	Lacustrine means "of a lake" or "relating to a lake".
Landslide	A movement of earth and rocks down a steep slope
Leaching	The process by which soluble constituents are dissolved and carried down through the soil by a perfolating fluid.
Least Concerned Species	A species is Least Concerned when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant species are included in this category.
Lentic	Standing water. Lentic refers to standing or still water.
Lentic ecosystem	Lentic ecosystems are the ecosystems of lakes, ponds and swamps.
Lotic	Running water. Lotic refers to flowing water.
Lotic ecosystem	Lotic ecosystems are the ecosystems of rivers, streams and springs.
Macrophyte	A macrophyte is an aquatic plant that grows in or near water and is either emergent, submergent, or floating. In lakes macrophytes provide cover for fish and substrate for aquatic invertebrates, produce oxygen, and act as food for some fish and wildlife.

Megawatts (MW)	A megawatt is one million watts or one thousand kilowatts, a measure of electrical power or generation capacity.
Methane	A colorless, nonpoisonous, flammable gas created by anaerobic decomposition of organic compounds.
mg/l	A milligram per litre is a measurement of concentration used to measure how many milligrams of a certain substance are present in one litre of liquid.
Microbes	Microscopic organisms such as algae, viruses, bacteria, fungi, and protozoa, some of which cause disease.
Mitigation	The act of alleviating or making less severe
Millenium Development Goals (MDGs)	Have targeted the integration of environmental and sustainable development considerations into country policies and programs and the reversal of the integration of the loss of environmental resources.
Mitigating measures	Modifications of actions that (1) avoid impacts by not taking a certain action of parts of an action; (2) minimize impacts by limiting the degree or magnitude of the action and its implementation; (3) rectify impacts by repairing, rehabilitating, or restoring the affected environment; (4) reduce or eliminate impacts over time by preservation and maintenance operations during the life of the action; or (5) compensate for impacts by replacing or providing substitute resources or environments.
Monitoring	Periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements or pollutant levels in various media or in humans, animals, and other living things.
Nitrate	A compound containing nitrogen that can exist in the atmosphere or as a dissolved gas in water and can have harmful effects on humans and animals.
Nitric oxide (NO)	A gas formed by combustion under high temperature and high pressure in an internal combustion engine.
Nitrogen dioxide (NO2)	The result of nitric oxide conbining with oxygen in the atmosphere; a major component of photochemical smog.
Nitrogenous wastes	Animal or vegetable residues that contain significant amounts of nitrogen.
Non-Governmental Organization	Private organizations that pursue activities to relieve suffering, promote the interests of the poor, protect the environment, or undertake community development, (World Bank Operational Directive 10.70)

Nonpoint sources	Pollution sources that are diffuse and do not introduced into a receiving stream from a specific outlet.
Near Threatened Species	A species is Least Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualify for a threatened category in the near future.
Nutritent	Any substance assimilated by living things that promotes growth.
Oak	Any fagacedus tree or shrub of the genus Quercus bearing the acorn as fruit
Oceanodromous	Oceanodromous fish migrate within salt water only
Omnivores	An omnivore is an animal that is adapted to eat both plants and animals as their primary food source.
Organic	Referring to or derived from living organisms.
Organic chemicals/compounds	Animal- or plant- produced substances containing mainly carbon, hydrogen, and oxygen.
Organophosphates	Pesticide chemicals that contain phosphorus; used to control insects.
Oxidation	**1)** The addition of oxygen, which breaks down organic waste or chemicals such as cyanides, phenols, and organic sulfur compounds in sewage by bacterial and chemical means. **2)** Oxygen combining with other elements. **3)** The process in chemistry whereby electrons are removed from a molecule.
Oxydative Redox Potential (ORP)	Reduction potential (also known as redox potential, oxidation/reduction potential or ORP) is the tendency of a chemical species to acquire electrons and thereby be rediced. Each species has its own intrinsic reduction potential; the more positive the potential, the greater the species' affinity for electrons and tendency to be reduced. In aqueous solutions, the reduction potential is the tendency of the solution to either gain or llose electrons when it is subject to change by introduction of a new species. A solution with a higher (more positive) reduction potential than the new species will have a tendency to gain electrons from the new species (i.e. to be reduced by oxidizing the new species) and a solution with a lower (more negative) rediction potentia will have a tendency to o9se electrons to the new species (i.e. to be oxidized by reducing the new species). Just as the transfer of hydrogen ions between chemical species determines the reduction potential of an aqueous solution. Like pH, the reduction potential represents an intensity factor.

Ozone (O_3)	Found in two layers of the atmosphere, the troposphere and the strasphere. In the troposphere (the layer extending 7 to 10 miles up from the Earth's surface), ozone is a chemical oxidant and major component of photochemical smog. In the stratosphere (the atomospheric layer beginning 7 to 10 miles above the Earth's surface), ozone is a form of oxygen found naturally that provides a protective layer shielding the Earth from the harmful health effects of ultraviolet radiation on humans and the environment.
Ozone depletion	Destruction of the stratospheric ozone layer that shields the Earth from ultraviolet radiation harmful to biological life.
Parastatal	A government owned company
Particulates	Fine liquid or solid particles, such as dust, smoke, mist, funes, or smog, found in air or emissions.
Pathogen	An organism or substance which causes disease
Pathogenic	Capable of causing disease.
Periphyton	Periphyton is a complex mixture of algae, cyanobacteria, heterotrophic microbes, and detritus that is attached to submerged surfaces in most aquatic ecosystems. It serves as an important food source for invertebrates, tadpoles, and some fish.
Permeability	The rate at which liquids pass through soil or other materials in a specified direction.
Pesticide	Substance or mixture of substances intedded for preventing, destroying, repelling, or mitigating any pest.
Phenols	Organic compounds that are by-products of petroleum refining, tanning, and textile, dye, and resin manufacturing.
Phosphates	Certain chemical compounds containing phosphorus.
Phosphorus	An essential chemical food element that can contribute to the eutrophication of lakes and other water bodies.
Photosynthesis	The manufacture of carbohydrates and oxygen by plants from carbon dioxide and water in the presence of chlorophyll, using sunlight as an evergy source.
Phytobenthos	The flora of the sea bottom or the bottom of inland waters. Phytobenthos are plants belonging to the benthos.
Phytoplankton	Wandering plants in the water. Phytoplankton are the autotrophic component of the plankton community.

pH	pH is a measure of the acidity or basicity of a solution. It is defined as the cologarithm of the activity of dissolved hydrogen ions (H^+). Hydrogen ion activity coefficients cannot be measured experimentally, so they are based on theoretical calculations. The pH scale is not an absolute scale; it is relative to a set of standard solutions whose pH is established by international agreement.
Plankton	The usually small marine or freshwater plants (phytoplankton) and animals (zooplankton) drifting with the surrounding water, including animals with weak locomotory power. Plankton consists of any drifting organisms (animals, plants, archaea, or bacteria) that inhabit the pelagic zone of oceans, seas, or bodies of fresh water.
Plantivore	A plantivore is an animal that is adapted to eat plankton.
Point source	A stationary location or fixed facility from which pollutants are discharged or emitted; any single identifiable source of pollution, e.g., a pipe, ditch, ship, ore pit, or factory smokestack.
Potable water	Water that is safe for drinking and cooking.
Potamodromous	Potamodromous fish migrate within freshwater only.
Powerhouse	A primary part of a hydroelectric dam where the turbines and generators are housed and where power is produced by falling water rotating turbine blades.
Ppm/ppb	Parts per million/ parts per billion, a way of expressing tiny concentrations of pollutants in air, water, soil, human tissue, and food and or other products.
Precipitation	Removal of solids from liquid waste so that the hazardous solid portion can be disposed of safely; removal of particles from airbone emissions.
Preliminary EIA	A preliminary attempt to evaluate environmental impacts in order to determine whether a full-scale environmental impact assessment is needed.
Prevention	Measures taken to minimize the release of wastes to the environment.
Primary wastewater treatment	First steps in wastewater treatment; screens and sedimentation tanks are used to remove most materials that float or will settle.
Rapid Assessment Program	A biological inventory program that asembles teams of scientists to produce rapid assessments of the biological value of poorly known areas that are potentially important biodiversity conservation sites, and thus catalyxe conservation action.

Raw sewage	Untreated wastewater
Residual	Amount of a pollutant remaining in the environment after a natural or technological process has taken place, e.g.., the sludge remaining after initial wastewater treatment, or particulates remaining in air after the air passes through a scrubbing or other pollutant removal process.
Reservoir	A body of water collected and stored in an artificial lake behind a dam.
Resettlement	The act of moving people and their animals to a new area of habitation.
River Basin	The area covered by the river, including its many tributaries, from its source to the sea.
Riverine	Situated on a river or river bank.
Runoff	That part of precipitation, snowmelt, or irrigation water that runs off the land into streams or other surfact water; can carry pollutants from the air and land into the receiving waters.
Salty	An adjective describing something with the properties, usually taste, of salt
Sedimentation	Letting solids settle out of waste water by gravity during wastewater treatment.
Sediments	Soil, sand, and minerals washed from land into water, usually after rain.
Sewage	The waste and wastewater produced by residential and commercial establishments and discharged into sewers.
Sewage sludge	Sludge produced at a municipal treatment works.
Scoping	An exercise involving the preliminary identification of the environmental issues surrounding a project that requires an assessment. Scoping identifies the potential impacts which are to be addressed in detail by the assessment. Scoping will usually initiate the public consultation/public participation process.
Screening	Screening is the process of determining whether or not an individual project proposal requires a full-scale EIA and what the level of assessment should be.
Sediment	Material deposited by water, wind or glaciers.

Shower	A brief and usually light fall of rain or snow.
Silt	Fine particles of sand or rock that can be picked up by the air or water and deposited as sediment.
Sludge	A semisolid residue from any of a number of air or water treatment processes. Sludge can be hazodous waste.
Smog	Fog made heavier and darkere by smoke.
Smoke	Particles suspended in air after incomplete combustion of materials.
Solid wastes	Nonliquid, nonsoluble materials, ranging from municipal garbage to industrial wastes, that contain complex, and sometimes hazardous, substances.
Species	A group of organisms capable of interbreeding and producing fertile offspring of both genders, and separated from other such groups with which interbreeding does not (normally) happen.
Species area curve	The number of species in relation to change in area of habitat.
Species diversity	Used to mean the variety of species in an area or on the earth; technically it is composed of three components: species richness, species evenness and species dominance.
Species dominance	The most abundant species in a particular area or in a community.
Species evenness	The relative abundance of species in a particular area or in a community.
Species heterogeneity	Measurement of relative abundance of species.
Species richness	The total number of species in a particular area. It is the total number of different species in a particular area or in a community
Stack	A chimney or smokestack; a vertical pipe that discharges used air.
Stenophagous	Feeding on a limited variety of food
Sulfur dioxide (SO2)	A heavy, pungent, colorless, gaseous air pollutant formed primarily by processes involving fossil fuel combustion.
Surface water	All water naturally open to the atmosphere (rivers, lakes, reservoirs, streams, impoundments, seas, estuaries, etc.); also refers to springs, wells, or other collectors that are directly influenced by surface water.

Suspended solids — Small particles of solid pollutants that float on the surface of or are suspended in sewage or other liquids.

Thermal pollution — Discharge of heated water from industrial process that can affect the life processes of aquatic organisms.

Total dissolved solids (TDS) — Total Dissolved Solids (often abbreviated TDS) is an expression for the combined content of all inorganic and organic substances contained in a liquid which are present in a molecular, ionized or micro-granular (colloidal sol) suspended form. Generally the operational definition is that the solids must be small enough to survive filtration through a sieve size of two micrometres. Total dissolved solids are normally only discussed for freshwater systems, since salinity comprises some of the ions constituting the definition of TDS. The principal application of TDS is in the study of water quality for streams, rivers and lakes, although TDS is generally considered not as a primary pollutant (e.g. it is not deemed to be associated with health effects), but it is rather used as an indication of aesthetic characteristics of drinking water and as an aggregate indicator of presence of a broad array of chemical contaminants.

Total nitrogen — Total Kjeldahl Nitrogen (TKN) is the sum of organic nitrogen; ammonia (NH3) and ammonium (NH4+) in the chemical analysis of soil, water, or wastewater (e.g. sewage treatment plant effluent). To calculate Total Nitrogen (TN), the concentrations of nitrate-N and nitrite-N are determined and added to TKN.

Total Suspended Solids (TSS) — A measure of the suspended solids in wastewater, effluent, or water bodies.

Toxic pollutants — Materials contaminating the environment that cause death, disease, or birth defects in organisms that ingest or absorb them.

Toxic substance — A chemical or mixture that may present an unreasonable risk of injury to health or the environment.

Toxicity — The degree of danger posed by a substance to animal or plant life.

Transparency — Transparency is the physical property of allowing light to pass through a material.

Turbidity — Turbidity is the cloudiness or haziness of a fluid caused by individual particles (suspended solids) that are generally invisible to the naked eye, similar to smoke in air. The measurement of turbidity is a key test of water quality.

Umbrella species	These have large home ranges but specific habitat requirements, such that their conservation is often assumed to save many other species automatically. However, the emprical evidence for this is scanty at best.
Upstream	Toward or in the higher part of the steam or the river
Urban runoff	Stormwater from city streets and adjacent domestic or commercial properties that may carry pollutants of various kinds into sewer systems or receiving waters.
uS/cm	Micro siemens Per Centimeter. Unit for electrical conductivity
Vector	An organism which carries or transmits a pathogen
Vegetation	All different types of plants that are found in a particular area or environment.
Vulnerable Species	A species is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable and it is therefore considered to be facing a high risk of extinction in the wild. A vulnerable species is a species which is likely to become endangered unless the circumstances threatening its survival and reproduction improve.
Wastes	Unwanted materials left over from a manufacturing process. 2) Refuse from places of human or animal habitation.
Wastewater treatment plant	A facility containing a series of tanks, screens, filters, and other processes by which pollutants are removed from water.
Wasterwater	Spent or used water from individual homes, communities, farms, or industries that contains dissolved or supended matter.
Water pollution	The presence in water of enough harmful or objectionable material to damage water quality.
Water quality criteria	Specific levels of water quality that, if reached, are expected to render a body of water suitable fore its designated use. The criterial are based on specific levels of pollutants that would make the water harmful if used for drinking, swimming, farming, fish production, or industrial processes.
Watershed	A region or an area over which water flows into a particular lake, reservoir, stream, or river. (OR) the region or area of land that forms the drainage of a stream or river. If a drop of rain falls anywhere within a watershed to become surface run off, it can flow out only through the same stream or river.

Watershed Management The analysis, protection, development, operation or maintenance of the land, vegetation and water resources of a drainage basin for the conservation of all its resources for the benefit of its residents.

Water quality A term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose.

Wetlands Land (marshes or swamps) saturated with water constantly or recurrently.

Zoobenthos The fauna of the sea bottom or the bottom of inland waters. Zoobenthos are animals belonging to the benthos.

Zooplankton Wandering animals in the water. Zooplankton are the heterotrophic (sometimes detritivorous) type of plankton. Zooplankton are the heterotrophic (sometimes detritivorous) type of plankton. Zooplankton are organisms drifting in the water column of oceans, seas, and bodies of fresh water.

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Biodiversity And Nature Conservation Association (BANCA)
Yangon, Myanmar.
October 2009.

EXECUTIVE SUMMARY

Regarding the big scale hydropower development in Ayeyawady basin, above Myitkyina, the main audience for this document are the people of Myanmar, in particular conservationists, developers, and highest decision-makers at political and administrative levels of our country. Before making their decisions they must be well informed, convinced and enlightened about the importance of environmental and biodiversity conservation in sustainable development of Myanmar. The other aimed audience for this document are Myanmar Ministry (1) of Electrical Power, China Power Investment Corporation (CPI) and and the Chinese scientific institution, Changjiang Institute of Survey, Planning, Design & Research (CISPDR) and concerned donor agencies, enabling them to provide outside assistance and cooperation for sustainable development in Myanmar.

Myanmar is rich in natural resources particularly forests, land and water resources in addition to biodiversity. Achieving sustainable development of these resources is vital to the country. Unplanned and environmentally naïve economic forces are driving the over-exploitation of Myanmar's forests, water resources, wetlands and coastal ecosystems. This accelerating degradation of natural resources increasingly threatens the country's prospects for long term sustainable development and is already limiting its future options. Reform of the political, legal, institutional and economic structures of the country is needed to ensure successful implementation of sustainable development of the country. One of the pre-requisites is to enact and enforce the drafted national environmental protection law without delay and make credible environmental impact assessments (EIAs) mandatory, prior major development programmes and projects.

Although EIA is not mandatory yet in Myanmar, **PART I** clearly justifies that EIA is not a hindrance to development of the country but ensures sustainable development. In relation to the big scale hydropower development in Ayeyawady basin, above Myitkyina, Part I provides an overall view on Union of Myanmar and its people, importance of Ayeyawady River, and it looks at Kachin State and its outstanding biophysical features. It also highlights the importance of EIA introduction to Myanmar, importance of BIA and terms of reference between BANCA and CISPDR. Part I also examines Myanmar's national environment policy, associated international environmental conventions and relevant national resource management laws. It also explores and vividly describes biodiversity richness in northern Myanamr. Part I also predict potential impacts on biodiversity on account of dam construction and urges immediate compensatory measures with prioritized actions to counter adverse impacts. It predicts potential impacts on aquatic ecology & fisheries and water quality and recommends prioritized actions to counter impacts.The potential impacts on livelihoods, public health & safety are predicted and prioritized actions to counter impacts are urged. It also examines trans-boundary wildlife and timber trade and recommends prioritized actions to lesson illegal trade of wildlife and forest products. Part I also describes about the background of hydropower development in Kachin State and explains about series of dams namely, Myitsone, Lasa, Chebwe, Yenam, Kaunglanphu, Wusot and Pisa. It summarizes overall recommendations and mitigating measures from policy perspective, environmental perspective, social perspective and administrative & technical perspective.

In concluding Part I, lack of social impact assessment in this study has been emphasized. And the need of systematic social impact assessment by competent social scientists has been recommended. Before approving the construction of a series of dams on Ayeyawady River above Myitkyina, Kachin State, the decision-makers are strongly urged to fairly balance between negative and positive aspects of dams (App. 2). The decision makers, developers, concerned engineers and dam designers are seriously advised to pay due consideration on the differences between bad and good dams and between environmental threatening and environmental friendly dams (App. 3).The core construction engineers are also strongly urged to pay serious attention on the appended suggestions towards dam construction (App. 1).

PART II aims at specialists and experts of diverse disciplines and describes in detail of

various fields of study at proposed dam sites. It provides in detail, the fauna report, the flora report and the aquatic report.

Fauna Report begins with introduction and explains about study areas and materials and methods and results. Detail study areas namely, Myitsone study area, Lasa study area, Chibwe study area, Wusok & Pisa study areas, Khaunglanphu study area and Yenam study area are described. This is followed by discussions on the results of mammals, amphibians and reptiles, and insects in each study area. Aiming at ornithologists, a separate ornithological report has been prepared and attaced. Threatened faunal species and their conservation status have been explained along with overall conclusions and discussions.

Fauna Report also comprises a separate Faunal Ecological Report.

Flora Report covers Myitsone study area, Lasa study area, Chibwe study area, Khaunglanphu study area, Yenam study area and Wusok & Pisa study areas.

For each study area, the flora report begins with introduction, aims and objectives. It explains about materials and methods and analyses results. This is followed by discussion and conclusion together with recommendations. Flora Report also comprises a separate Floral Ecological Report.

PART III adds in detail, on Aquatic Report, Environmental Baseline Study Report and Wildlife Trade Report.

Aquatic Report describes and discusses on aquatic ecological conditions, aquatic organisms and fish species in Mayhka, Malihka and Ayeyawady River. Temperature and dissolved oxygen concentrations were measured and recorded. Zooplankton, Periphyton, Benthos and Phytoplankton species composition, economically important fish genera and endangered fish species were also examined and recorded.

Environmental Baseline Study Report points out the baseline study as a prerequisite before dam constructions and describes about monitoring of surface water at low flow and high flow at 18 river stations of proposed dam sites and key tributaries of the river system. This study has been on pH, BOD, COD, water temperature, total suspended solids, nitrogen, phosphorus, phenol, cyanide, oil and grease, arsenic, chromium, mercury and zinc. As the local scientists have done their best within limited time along with some constraints, internationally well experienced expertise is needed to guide their study as this hydropower project would be a huge and sensitive one.

Wildlife Trade Report examines both forest products and wildlife products and briefs about illegal logging and wildlife trade in Kachin State. Traded wildlife species, their traded parts along with prices are described. The report looks at in-country market surveys including Myanmar-China border markets, quessionnaire surveys on livelihoods in relation to wildlife species, bush meat consumption, and wildlife and plant parts used in traditional medicines. It concludes with some recommendations after exploring the eight major trade routes of wildlife trade in Kachin State which are the current source of origin of international trade via China.

ENVIRONMENTAL IMPACT ASSESSMENT (SPECIAL INVESTIGATION) ON HYDROPOWER DEVELOPMENT OF AYEYAWADY RIVER ABOVE MYITKYINA, KACHIN STATE, MYANMAR

1. INTRODUCTION

1.1. Union of Myanmar and its People

Myanmar is the largest country on mainland Southeast Asia. It has a total land area of 677,000 square kilometers, and shares borders with five countries for about 6,151 kilometers sharing 274 kilometers with Bangladesh on the West, 1,339 kilometers with India on the North-West, 2,205 kilometers with China on the North-East, 225 kilometers with Laos on the East and 2108 kilometers with Thailand on the South-East. It has a total coastline of 2,229 kilometers (NCEA 2009).

Myanmar lies on the crossroads of two of the world's great civilization and densely populated countries, China and India. The population of Myanmar in the fiscal year 2005/06 is estimated at 55.4 million. Myanmar is a union of many nationalities speaking over one hundred languages and dialects, but living in close harmony.

Myanmar has three parallel chains of forest-clad mountain ranges that run north to south from the eastern extremity of the Himalayan mountain range, the Western Yoma or Rakhine Yoma, the Bago Yoma and the Shan Plateau. These three mountain chains divide the country into three river systems, the Ayeyawady, the most important river in the country, the Sittaung and the Thanlwin. Union of Myanmar has been made up of 7 States, namely Kachin, Shan, Kaya, Rakhine, Kayin, Mon, and Chin and 7 Divisions, namely, Ayeyawady, Bago, Tanintharyi, Yangon, Mandalay, Sagaing and Magwe.

1.2. Ayeyawady River

Ayeyawady River is the most important lifeblood river in Myanmar. It runs the whole length of the country through Kachin State, Sagaing Division, Mandalay Division, Magwe Division, Bago Division and Ayeyawady Division before entering into Bay of Bangal. Millions of people are depending on Ayeyawdy River for their livelihoods. Many towns, cities and village tracts are situated along left and right banks of Ayeyawady River. Also it is the most useful water way or navigation in Myanmar for transportation of people, various kinds of goods, timber rafts, etc. by using various sizes of ships, and boats. The Malihka and the Mayhka rivers merge in Kachin State to become the Ayeyawady, largely a glacier-fed river, stretches over a thousand miles long and it is one of the finest water ways in the world. This fertile valley flows through the dry zone in the heart of Myanmar and acts as a conduit of communication to over fifty million people. The hydropower development in Kachin State by constructing a series of large and medium dams may definitely impact on the people of Myanmar as a whole, in addition to adverse impacts on riverine, aquatic, terrestrial and wetlands ecosystems. Therefore the conceptual framework for the development of hydropower development in Kachin State must be based on river basin approach, that is, to consider the impacts starting from the water source origin in Kachin State, downwards along the length of Myanmar, to the mouth of Ayeyawady River at Bay of Bangal.

Ayeyawady is the biggest one among the five rivers of Burma. The catchment area of the river is 49000 km^2. It originates at snow covered mountainous ranges which have linkage to the Himalaya, at the height of 5789 metre above sea level at North Latitude 28 Degree. Roughly, it goes southward from north to Bay of Bengal along 2092 kilometers. The confluence of Mayhka and Malihka is 48 kilometers up from Myitkyina.

According to morphological characteristics of it, it can be divided into three portions.

(1) Reception Basin: its origin at Myitsone above Myitkyina to its junction with Chindwin river;

(2) Central Valley: Ayeyawady-Chindwin Junction to Seiktha Village; and

(3) The Delta: Seiktha village to outlet into Bay of Bengal.

The Ayeyawady Basin: Particularly the reception basin has many sites with high rainfalls and increased water volume, to produce hydropower generation; the delta, the lower part consists of a large agricultural lands; and middle part has an equilibrium of current flow volume seasonally; and these can be integrated as considerable factors.

On performing dam projects, the following typical characteristics of the Ayeyawady should be inclusive of due consideration (MOAI 2002):

(1) Most of the water catchments areas of Ayeyawady are situated at Reception Basin. There are a lot of deep forests and mountainous ranges with full of small streams and rapids. Water drains directly from high rain fall and melting of the snow, accounts 84 percent of current volume.

(2) Un-equilibrium of distribution of monthly current volume during the rainy season will cause extraordinary flood (flashflood) at juncture of Ayeyawady and Chindwin rivers when there are coincidentally high level of water at these two rivers.

(3) A lot of rivers and small rivers, which possess large catchments areas of receiving water, have their orifices into Ayeyawady at Reception Basin as rivulets.

(4) Frequent drought appears at central valley of Ayeyawady.

(5) At dry season, some points of the middle part have shallow water, hindering the use of inland water transportation.

(6) During rainy season, imbalance of seasonal current volume will cause flooded areas, and danger of floods appears eminently at the lower part of Ayeyawady.

(7) During dry season, sea water intrudes into the lower part of delta together with high tidal water volume, due to low volume of water current from upper parts.

(8) Many sand-beds and islands appear at the outlet to sea and these conditions lead to high level of basin of river gradually at lower part of delta. Thus the interval of frequency of floods becomes short and high and as a consequence the orifices become closed.

(9) Continuous impact of rivers such as changing pattern of current water, sand beds, landslides due to rapid water force, are still appearing.

Generally, dams can play an important role in meeting people's needs. However in making large dams on Ayeyawady, Mayhka and Malihka rivers, the welfare of the people to be displaced must be brought into due consideration. The last 50 years have highlighted the performance and the social and environmental impacts of large dams. The developers have fragmented and transformed the world's rivers, while global estimates suggest that 40-80 million people have been displaced by reservoirs (WCD 2000). The fragmentation of Ayeyawady River by a series of dams will have very serious social and environmental problems not only at upstream of dams but also to very far downstream till to the coastal delta. A longer and comprehensive EIA investigation is strongly recommended in such a very big and sensitive hydropower development which may have very significant adverse impacts.

1.3. Kachin State

It is the northernmost state in the union of Myanmar which is very rich in hydropower resources. The area of Kachin State is 89,041 km^2 (34,379 sq mi). Official government statistics state that the distribution by religion is 57.8% Buddhist, 36.4% Christian and the rest, animism.

1.3.1. Cities and Towns:- Myitkyina, a major city in the central area, is the state capital, while Bamaw is the main town in the southwest, and Putao the main town in the far north. Mogaung and Mohnyin are ancient cities inhabited mostly by Shans. Myitkyina is well known as one of the places in Myanmar where the allied forces of the west, led by General Merill's Marauders, landed and fought the enemy together with local rangers.

1.3.2. Communication:- The 18 townships in the states are linked by roads, railways, and airways. Most of the towns in the state are accessible by telephone communication, locally and internationally. The state's major towns are linked with other capital cities of Myanmar by road, railways, waterways, and airways. The State is linked to India by Ledo Road, also known as the Stilwell Road, built during World War II.

1.3.3. Geography:- Kachin State is part of the eastern edge of the Himalayan Range and is also continuous with the Yunnan escarpment, composing the Tibet-Myanmar frontier mountain ranges. Hkakaborazi, the highest mountain in South East Asia at 19 315 feet, and Indawgyi, the largest lake in Myanmar with 98 square miles, are all located in Kachin State.Kachin state is dominated by high mountainous with large valleys. The highest mountains in Myanmar and Southeast Asia are there the highest being Mt Hkakarborazi which is 5881 meters (19290 ft) high.

Its borders are Yunnan Province of China in the east, Shan State and Sagaing division in the south and southwest, Arunachal Pradash and Assam province of India in the west and Xizang Autonomous region (Tibet) of China in the north.

Mainly has 4 valleys. Putao valley, Myitkyina valley, Moekaung valley and Hukaung Valley. Here lies the origin of the Irrawaddy river. Myanmar people considered this river a total Myanmar river meaning that it originates and ends in Myanmar. But if the origin of a river is considered the furthest point from the main uppermost confluence then the origin can be considered to be originated from China. i.e Taron river.

Kachin State is located in the northern most part, is one of the seven States of the Union of Myanmar. Lies between China to the east and India to the west, and has a land area of 34,379.22 square miles.

1.3.4. Districts, Townships and Villages

The four districts constituted in the Kachin State are Myitkyina, Bhamo, Moehnyin and Putao. The number of townships and wards and village tracts constituted are 18 townships, 9 sub townships respectively.

1.3.5. Townships

(1) Mytikyina District

Township	Sub township
• Myitkyina	Sinbo
• Winemaw	Sadone
• Tanai	Shinbweyan
• Chibwe	

- Tsaw Law
- Ingyanyang

(2) Putao District

- Putao
- Naungmon Pannandin
- Machanbaw
- Khaunglanhpu
- Sumprabum

(3) Bhamaw District

- Bhamaw Lwejre , Dawt -phone-yan
- Moemauk
- Mansi
- Shweku Myohla

(4) Moehnyin District

- Moehnyin Hopin
- Moekaung Kamaing
- Hpakant

1.3.6. Outstanding Biophysical Features

a. Snow Capped Mountains: - In the foothills of the Himalayas in northern Putao situate Mt. Hkakaborazi, the highest snow-capped mountain in South East Asia. 19,269 feet (5881 meter) high and a very important watershed area for the eastern Ayeyawady river (Mayhka). The flagship trek of the area lies more than 440 kilometer away from nearest airstrip which takes nearly 6 weeks to complete. The route passes through the 1472-square-mile Hkakaborazi National Park. Apart from this there are several smaller peaks such as Mt. Lancrumadin of 3495 meters. Mt. Phongun Razi of 3485 meters, Mt. Phangran Razi of 4450 meters, Mt. Madwe Razi of 4500 meters and Mt. Slimatdin of 4800 meters etc which can be scaled by trekker with normal physical condition.

b. Flora: - More the 50% of Kachin State is generally covered by numerous types of forests with thousands of different plant species. Rhododendron is indigenous to Putao region and of the 600 known species of rhododendria, the English botanist collected 118 here in some 1920s, and some 107 of those may be still viewed at Royal Botanical Gardens in Edinburgh. Also the wild orchids bloom in great profusion in this region. Botanists also identified 19 species of pine with the expeditions. Over 800 kinds of orchids, 97 varieties of bamboo and 32 different types of rattan canes are also home to this region. The forests ranging from tropical monsoon evergreen to alpine forest can also be found in the northern most part of the state. The rich variety of plants and animal life in Kachin State reflects its geographical location as well as its varied topography and climate.

c. Fauna: - As many as 400 avian species were also recorded so far. Among them 15 rare species of Pheasant among them being a few on the endangered list, the Impeyan Pheasant, the Blood Pheasant. Blyth's Tragopan, Temminck's Tragopan, Sclater's Monal, Snowy-throated Babbler, Chestnut thrush, Red-tailed Laughing trush and Rusty bellied Short wing etc to name a few in the rare species list and some new identified species in Myanmar and South-East Asia. The area is home to numerous wild animals– including monkeys, deer, birds and butterflies – so it is no wonder paradise for scientific researchers and butterfly hunters. There is a safe habitat for wild elephants, tigers, takins, rare red pandas and other endangered species. Migratory birds from China and Mongolia, travel in thousands to the plateau of Putao in spring, and disperse in early monsoon.

1.3.7. Climate & Rainfall

Regarding climatic conditions, it is generally divided into three seasons: the hot summer, the rainy monsoon and the cold winter. Climatic conditions vary considerably from warm to humid in the lowlands and extremely cold in the highlands. In winter, mountains in the far north are snow capped. The rainy season starts in May in the lowlands and April in the highlands. The winter starts in December followed by a very short summer.

Regarding rainfall, and reference to rainfall isohyetes for Myanmar the Kachin state receives 80 - 150 inches of rain annually increasing as it goes north. The northernmost Putao district receives more than 150 inches of rain.

1.3.8. Access & Transportation

The capital of Kachin State is Myitkyina. It can be approached by all means of transportation, i.e car, railway, boat and air. Approaching by car, the roads system is in poor state. Mandalay to Myitkyina (779 km) is not recommended for tourists and foreigners. The capiatal of Kachin state Myitkyina can be approached via Shwebo - Myitkyina strategic road. Although this road was constructed as an all weather road now it is safe only to drive in the dry season. It is about 500 kilometers from Mandalay. Due to poor maintenance the road is very tough and takes two full days to drive from Mandalay.

Another approach is from Tha-Beik-kyin, Tagaung, Bhamaw road. This road goes along the eastern bank of Ayeyawady river. The length is almost the same but only a porter is better than the former road and the driving time is slightly shorter than the former one.

The railway from Mandalay was built since the Second World War. There are four trains from Mandalay to Myitkyina daily. The fastest train takes approximately 16 hours to reach Myitkyina. There are daily trains between Mandalay and Myitkyina which take somewhere between 24 and 30 hours to reach each destination.

Myitkyina can be also reachable from Mandalay by boat. The Ayeyarwady river is navigable from Mandalay to Bhamaw. But above Bhamaw, there are narrow sections and rapids and only small and powerful boats usually go along that part.

There are two airlines that regularly fly from Yangon to Myitkyina. The government owned Myanmar Airways flies 4 flights a week from Yangon. The flights are not regular. The private airline Air Bagan flies 3 flights a week.

1.3.9. Ethnic Minorities

There are 11 ethnic tribes in Kachin State. Jingphaw, Law Wor (Maru), Lacheik, Rawan (Khanoung) , Khamti Shan and Lesu. Kachin comprises of eleven ethnic minorities, namely Jinghpaw, Lachik, Dalaung, Lauwaw, Guari, Lisu, Rawang, Hkahku, Duleng, Atsi and Zaiwa. There are also other nationalities such as Shan, Bamar, Kadu, Kanan, Chinese and Indians living in the Kachin State.

1.3.10. Livelihoods & Festivals

As for grassroots people, agriculture is the main occupation with rice as the main crop. Kachin State is a place where grapefruit and other rare citrus fruits are available. Pineapple, starapple, djenkol bean (da-nyin in Myanmar) fruit and a kind of rice (hkatchyo rice in Myanmar) are among the best quality in the Myanmar market.

Kachin State celebrates Kachin State day on the 10th of January, and the New Harvest Festival in November. There are many locally celebrated festivals among the people. One of the common festivals among the Kachin people is the Manau.

1.3.11. Mineral Resources

Kachin State is rich in forest products, minerals, and gem stones some of which are still untouched. Phakant jade is one of the most famous products of the state and is very popular in the world. Gold can be panned in almost every river and stream of the state.

2. IMPORTANCE OF EIA INTRODUCTION

Economic, social and environmental change is inherent to development. Whilst development aims to bring about positive change it can lead to conflicts. In the past, the promotion of economic growth as the motor for increased well-being was the main development thrust with little sensitivity to adverse social or environmental impacts. The need to avoid adverse impacts and to ensure long term benefits led to the concept of sustainability. This has become accepted as an essential feature of development if the aim of increased well-being and greater equity in fulfilling basic needs is to be met for this and future generations.

In order to predict environmental impacts of any development activity and to provide an opportunity to mitigate against negative impacts and enhance positive impacts, the environmental impact assessment (EIA) procedure was developed in the 1970s. An EIA may be commonly defined as: 'a formal process to predict the environmental consequences of human development activities and to plan appropriate measures to eliminate or reduce adverse effects and to augment positive effects'. A different pattern of human behaviror will be needed to succeed. It will require shifing from the present reactive mode, when severe provlems or crises occur, to a much more proactive orientation in which preventive measures are taken on the basic of careful anticipation and foresight. (Norman et al. 1990.)

EIA is a management tool for planners and decision makers and complements other project studies on engineering and economics. Environmental assessment is now accepted as an essential part of development planning and management. It should become as familiar and important as economic analysis in project evaluation.

The aim of any EIA should be to facilitate sustainable development. Beneficial environmental effects are maximized while adverse effects are ameliorated or avoided to the greatest extent possible. EIA will help select and design projects, programmes or plans with long term viability and therefore improve cost effectiveness.

Initially EIA was seen by some project promoters as a constraint to development but this view is gradually disappearing. It can, however, be a useful constraint to unsustainable development. It is now well understood that environment and development are complementary and interdependent and EIA is a technique for ensuring that the two are mutually reinforcing.

Sustainable development describes it as ‘development that meets the needs of the present without compromising the ability of future generations to meet their needs and aspirations’ (WCED 1987).

EIA is "a process having the ultimate objective of providing decision-makers with an indication of the likely consequences of their actions" (Wathern 1988).

NEED to dispel the impression that EIA is an obstructive process that keeps people in poverty rather than one that ensures future generations and present generation will enjoy resource security and a good quality of life.

Although detailed steps in the EIA process vary from country to country, there are a number of generic steps which are followed internationally.

Screening is the process of determining whether or not an individual project proposal requires a full-scale EIA and what the level of assessment should be. Most countries have lists of activities for which EIAs are required (e.g. mining or major construction works). In addition, some countries have identified sensitive environments (e.g. cultural heritage sites) for which EIAs are needed.

Scoping determines the nature and extent of the required impact assessment. This phase entails the identification of issues that are likely to be important during the EIA and eliminates those that are not. The objective of this phase is to identify how the activities of the proposed development will impact on the various components of the environment. The impact assessment entails the identification and analysis of impacts, as well as a prediction of the significance of the impacts. Both negative and positive impacts are assessed.

Mitigation entails the identification of ways in which negative impacts can be avoided or minimized to limit costs, and ways in which positive impacts can be enhanced to ensure maximum benefit.

A single EIA report is produced and contains the integrated findings of the impact assessment and mitigation studies. This report shall be used by the authorities in decision-making. In all jurisdictions, the authorities must officially review the EIA report and decide whether it is of an acceptable standard of not.

2.1. China’s Concern on EIA

EIA is not mandatory yet in Myanmar. However regarding hydropower development of Ayeyawady River above Myitkyina, we should appreciate China's concern on EIA and should refer their EIA procedure. The PRC's first major environmental statute, the Environmental Protection Law (EPL), was enacted by the State Council in 1979 and revised in 1989. This law brought environmental management within the PRC's legal system and laid the foundation for future environmental legislation (Fuggle et al. 2000). The Environmental Impact Assessment Law (EIA Law) requires an environmental impact assessment to be completed prior to project construction.

The Law of the People’s Republic of China on Appraising Environmental Impacts (PRC 2003) has been adopted at the 30th session of the Standing Committee of the Ninth

National People's Congress on October 28, 2002, and is hereby promulgated for effect on September 1, 2003.

Article 1 of the above law has been enacted for the purpose of carrying out the strategy of sustainable development, prevent the unfavorable impacts of programs and constructions projects upon the environment. *Article 2* of the above law refers to the methods and institutions for analyzing, predicting and appraising the impacts of programs and construction projects that might incur after they are carried out so as to propose countermeasures for preventing or mitigating the unfavorable impacts and make follow-up monitoring. *Article 4* refers to provide a scientific basis for decision-making and *Article 5* encourages relevant entities, experts and the general public to participate in the appraisal of the environmental impacts in appropriate ways. *Article 10* refers the environmental impacts of special program including elements: a. An analysis, prediction and appraisal of the environmental impacts that might occur if the program is implemented; b. The countermeasures for predicting or mitigating the unfavorable environmental impacts; c. The conclusion of the appraisal upon the environment. *Article 17* calls for the report of the environmental impacts of a construction project shall include the following elements: a. An introduction of the construction project; b. The surrounding environment of the construction project; c. An analysis, prediction and appraisal of the environmental impacts that may be caused by the construction project; d. The measures for protecting the environment of the construction project as well as a technical and economical demonstration; e. An analysis of the economic gains and losses of the environmental impacts that may be caused by the construction project; f. Suggestions for carrying out environmental monitoring over the construction project; g. Conclusion of appraisal of the environmental impacts.

3. TERMS OF REFERENCE OF EIA BETWEEN CISPDR AND BANCA

Environmental policy without appropriate legislation will be ineffective as, in turn, will be legislation without enforcement. Economic and financial pressures will tend to dominate other concerns. In many developing countries legislation on environmental issues has been in existence for many years. Although EIA is not mandatory as yet in Myanmar, China has been trying it's best to undertake EIA practice before construction of a cascade of dams in Kachin State.

Changjiang Institute of Survey, Planning, Design & Research (CISPDR) of China and Biodiversity and Nature Conservation Association (BANCA), the consultative agency of Myanmar share the responsibility of the environmental impact assessment of hydropower development of Ayeyarwady River Basin above Myitkyina. As the lead unit, CISPDR is in charge of technology and quality of whole environmental assessment of this external entrusted project outside China. Screening is the process of determining whether or not an individual project proposal requires a full-scale EIA and what the level of assessment should be. However BANCA has been just responsible for environmental baseline study and Biological Impact Assessment (BIA) only that excludes social and economic components.

4. IMPORTANCE OF BIOLOGICAL IMPACT ASSESSMENT (BIA)

Biological impact assessment is an integral and important component of environmental impact assessment (EIA). Recent heightened concerns among the people, planners, natural resource managers, and academics across the globe for the biodiversity conservation have provided added impetus to BIA. BIA prepares an inventory of the biological resources that may be at stake once the proposed project is executed and also provides a broad understanding about the status of other components of the environment that are likely to be impacted. Soil, water and biological communities are interdependent and therefore the BIA provides cue towards health and conservation status of soil and water as well. BIA documents and collates the baseline data and information on the status of biodiversity and bioresources likely to be impacted by the proposed activity and suggests measures for mitigation of the impact. Thus the fundamental objective of the BIA is to conserve the biodiversity and ensure its sustainable utilization. In many countries it is a mandatory requirement before implementation of any major project and it is regulated by national acts and laws.

BIA's objective is to predict loss of genetic resources, habitats, ecosystems etc and to suggest measures to mitigate the impacts of the proposed activity. It is also done on a regular basis during the implementation of the project and at the end of the project period as a part of ecorestoration work. According to Tiwari (2005), the first step of BIA is to collect base line data on plants, animals and microbes found in the area likely to be affected by the activity. There are two major components of data collection for BIA : i) Structural components of the ecosystem which include listing of the variety of species, determining population size, distribution of organisms in trophic levels, identification of keystone species, horizontal and vertical sections of vegetation and habitat and ecosystem diversity including their status with regard to IUCN classification. The other ii) relates to the function of the ecosystems such as rates of primary productivity, respiration, export and import of materials etc. Data on utilization of biological resources and dependency of local people on bioresources are also collected. Based on the BIA study a biodiversity management plan is prepared which outlines the preventive and curative measures for mitigating the impact. The mitigation measures of biological impacts include setting aside or exclusion of critically important areas, compensatory afforestation, creation of green belts, and rehabilitation of species or individuals through active involvement of local community.

5. NATIONAL ENVIRONMENT POLICY OF MYANMAR

To establish sound environment policies in the utilization of water, land, forests, mineral, marine resources and other natural resources in order to conserve the environment and prevent its degradation, the Government of the Union of Myanmar hereby adopts the following policy:-

"The wealth of a nation is its people, its cultural heritage, its environment and its natural resources. The objective of Myanmar's environment policy is aimed at achieving harmony and balance between these through the integration of environmental considerations into the development process to enhance the quality of life of all its citizens. Every nation has the sovereign right to utilize its natural resources in accordance with its environmental policies; but great care must be taken not to exceed its jurisdiction or infringe upon the interests of other nations. It is the responsibility of the State and every citizen to preserve its natural resources in the interest of present and future generations. Environmental protection should always be the primary objective in seeking development".

The policy was proclaimed through the Gazette in accordance with Notification No. 26/94 dated 5 December 1994, of the Government of the Union of Myanmar.

6. INTERNATIONAL ENVIRONMENTAL CONVENTIONS, PROTOCOLS AND AGREEMENTS

International agreements are important because environmental considerations are part of the unified management of our planet (Norman et el. 1990). Myanmar has signed and is party to more than thirty International and Regional Conventions and Protocols. The most relevant environmental conventions are shown in the following Table 1. The protocols and conventions have significant impact in giving direction to local resource management.

Table 1. International and Regional Conventions and Protocols

Title	Date Signed	Date Ratified
Plant Protection Agreement for the South-East Asia and the Pacific Region, Rome, 1956		4-11-1959 (Adherence)
International Convention for the Prevention of Pollution from Ships, London, 1973		(Accession)
Protocol of 1978 Relating to the International Convention for the Prevention of Pollution from Ships, London, 1973		4-8-1988 (Accession)
United Nations Framework Convention on Climate Change, New York, 1992 (UNFCCC)	11-6-1992	25-11-1994 (Ratification)
Convention on Biological Diversity, Rio de Janeiro, 1992	11-6-1992	25-11-1994 (Ratification)
International Tropical Timber Agreement (ITTA), Geneva,1994	6-7-1995	31-1-1996 (Ratification)
Vienna Convention for the Protection of the Ozone Layer, Vienna, 1985		24-11-1993 (Ratification)
Montreal Protocol on Substances that Deplete the Ozone Layer, Montreal, 1987		24-11-1993 (Ratification)
London Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, London, 1990		24-11-1993 (Ratification)
The Convention for the Protection of the World Culture and Natural Heritage, Paris, 1972		29-4-1994 (Acceptance)
Agreement on the Networks of Aquaculture Centres in Asia and the Pacific, Bangkok, 1988		22-5-1990 (Accession)
United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/ or Desertification, Particularly in Africa, Paris, 1994 (UNCCD)		2-1-1997 (Accession)
Convention on International Trade in Endangered Species of Wild Fauna and Flora, Washington, D.C., 1973; and this convention as amended in Bonn, Germany, 1979 (CITES)		13-6-1997 (Accession)
Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas, Rome, 1973		8-9-1994 (Acceptance)
ASEAN Agreement on the Conservation of Nature and Nature Resources, Kuala Lumpur, 1985	16-10-1997	
Catagena Protocol on Biosafety, Cartagena, 2000	11-5-2001	
ASEAN Agreement on Transbpundary Haze Pollution	10-6-2002	13-3-2003 (Ratification)

International Treaty on Plant Genetic Resources for Food and Agriculture, 2001		4-12-2004 (Ratification)
Kyoto Protocol to the Convention on Climate Change, Kyoto,1997		13-8-2003 (Accession)
Declaration on ASEAN Heritage Parks	Dec 2003	
Stockholm Convention on Persistent Organic Pollutants (POPs), 2001		18-4-2004 (Accession)
The Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat, 1971 as amended in 1982 and 1987		8-11-2004 (Accession)
Establishment of ASEAN Regional Centre for Biodiversity	March 2005	

Source : NCEA 2005.

7. RELEVANT MYANMAR'S RESOURCE MANAGEMENT LAWS

The Environmental Law of Myanmar has been drafted since 2001 but not enacted as yet. Aiming at sustainable forest management and effective biodiversity conservation, and strengthening forest law enforcement and governance, there are two laws in Union of Myanamar. These are, the 1992 Myanmar Forest law (SLORC 1992) and the 1994 Protection of Wildlife, Wild Plants and Conservation of Natural Areas Law (SLORC 1994). Also there are the 2006 Conservation of Water Resources and Rivers Law and the 1994 Myanmar Mines Law. There are also Law Relating to the Fishing Right of Foreign Vessel(1989), Law Relating to Aquaculture (1989), Myanmar Marine Fisheries Law (1990) and Freshwater Fisheries Law (!991). These laws are intended for the development of fisheries, prevention of extinction of fish, safeguarding and preventing environmental degradation and sustainable management of the fisheries.

Today, many ecologically fragile forest areas and endemic species of both flora and fauna are highly endangered and risk extinction. In accordance with the above described two laws, without official permits no one is allowed to hunt, collect and trade in any forest and wildlife species. In 1998, the Forest Department had set Criteria and Indicators for Sustainable Forest Management. The depletion of Myanma wildlife and forest resources cannot be checked unless serious consideration through Convention on International Trade in Endangered Species of Wild fauna and Flora (CITES) and Convention on Biological Diversity (CBD), and measures adopted urgently (NSDS 2009).

However the politics and forest law enforcement and governance in Kachin State is quite complicated. The State Government literally controls every part of the Kachin State including forest resources. But practically most of the forest areas are controlled by the local armed groups which have made peace agreements with the State Government.

Regarding the code of conduct for Chinese enterprises working in foreign countries, the Global Environmental Institute (GEI) of China in collaboration with concerned authorities, had laid down the guidelines (GEI 2000). That Chinese silvicultural **Guide** applies - to regulating and guiding the whole process of the overseas activities of Chinese enterprises in silviculture, enabling them to protect and develop the global forest resources in a rational, efficient and sustainable way. Logging shall be conducted according to the law and forest destruction or any other unauthorized activity shall be strictly prohibited. The laws and regulations of the host country shall be abided by. The companies concerned shall be equipped with the current texts of laws and regulations concerning the activities related to silviculture of the host country. The laws and statutes shall be made known to the managers and staff. Fees and taxes payable and make payments on the timely basis according to the law. Forested lands are strictly protected and no illegal transformation of forestland for other purposes shall be tolerated. The company shall ensure the rational investment scope and structure of the sustainable silviculture. The habitat of the species, whose protection has been clearly prescribed by the laws and regulations of the host country, and international conventions, must be protected. No inappropriate collection activities shall be allowed. All the collection activities shall be in conformity with the statutes pertaining to the protection of wild fauna and flora of the host country. All the collection activities shall adopt the methods of sustainable utilization of resources, minimizing the damage of the local resources. Effective measures to be taken to restore, maintain and enhance biodiversity. The relevant conventions and agreements signed by China and the host country shall be observed.

And the Guide also emphasizes on High Conservation Value Forest. A high conservation value forest refers to a forest region rich in biodiversity of global, regional or national significance; a forest region with spectacular scenery of global, regional and national significance; a forest region possessing rare, threatened or endangered ecological system or being encircled in such a system; a forest region being able to meet the basic needs of the local communities; or a forest region playing a significant role in traditional community and cultural identities.

Gold mining being done both legally and illegally which is quite common in Kachin State is very difficult to be dealt with under the complicated resource governance scenario. However the Myanmar Mines Law, 1994, has some provisions for environmental protection including, among others, to protect the environmental conservation works that may have detrimental effects due to mining and there are restrictions for the holder of the mineral production permit, to refrain from any activities which may have detrimental effects to the public. However, during past 3years, approximately at the end of 2005, water in Ngaw-Chan-Kha changed in color. It is no longer clean and greenish blue, it becomes red and dirty. This horrible result may be due to the chemical waste disposal of metal purifying industry into the river. This metal purifying industry is located in China boundary between N 26' 06' 107" and E098'34'798". It is on the east bank of Ngaw-Chan-Kha river in China boundary above upstream of Gar-lan village in Myanmar boundary. The water in upstream of Ngaw-Chan-Kha river above the metal purifying industry was clean and greenish blue in color. But the water in downstream become red and dirty due to the chemical waste disposal of metal purifying industry into the Ngaw-Chan-Kha river. (See photographs). During past 3 years due to chemical waste disposal from metal purifying industry, water in Ngw-Chan-Kha river, from Gar-lan village to the place where it drains into Mayhka river, about 70 miles, become red and polluted. Photographs will show the conspicuous difference between the clear water from the springs on both sides of the river flows into the red and dirty water of Ngaw-Chan-Kha and red and dirty water of Ngaw-Chan-Kha flows into the clean water of Mayhka river. Photographs also shows the residues of waste products which deposit on the bank of the river when the water level in the river drops off.

8. BIODIVERSITY RICHNESS IN NORTHERN MYANMAR

From time to time, biogeographic descriptions have been done using available scientific information. In 1998, Bird Life International identified Endemic Bird Areas of the world to give priorities for biodiversity conservation (Stattersfield et al. 1998). The

World Wide Fund for Nature and the World Conservation Union identified the centers of plant diversity of the world with recommended priority areas for conservation of plant diversity (WWF and IUCN 1995). Recently, a conservation assessment of terretrial ecoregions of the Indo-Pcific based on more available scientific information has come out (WWF 2002). Myanmar's own conservation strategy is just a part of a broader strategy of regional and global biodiversity conservation.

In addition to assessing both negative and positive aspects (App. 2) of construction of dams, scoping of the current EIA on hydropower development of Ayeyawady River above Myitkyina, should be much broader and aim at landscape scale level approach and river basin approach. That is if possible to scope the whole Kachin State down to mouth of Ayeyarwady River. Three ecoregions and one world center of plant diversity, seven key biodiversity areas & one conservation corridor, three endemic bird areas & three important bird areas lie in Northern Myanmar.

On account of some constraints, especially the time constraint, the floristic study and vegetation analysis team and faunal team of this study were unable to cover all representative areas of floristically and faunally very rich Kachin State. However they were able to identify some of important and significant species of both flora and fauna which were already recorded.

A. Key Biodiversity Areas and Conservation Corridors (App. 4).

Key biodiversity areas situated in Kachin State are Kakaborazi National Park, Hpokanrazi Wildlife Sanctuary, Bumphabum Wildlife Sanctuary (all belonging to Eastern Himalayan Alpine Shrub/ Meadow Ecoregion and Northern Triangle Temperate Forest Ecoregion); Hukaung Valley Wildlife Sanctuary (Tiger Reserve), Hukaung Valley Extension Wildlife Sanctuary, Khaunglanpu, Namsan Chaung, (all belonging to the Ecoregion- Northern Triangle Sub-tropical Forests-Myanmar); and the Northern Mountains Forest Complex, the prioritized conservation corridor in Kachin State belongs to Northern Triangle Temperate Forest Ecoregion and Northern Triangle Sub-tropical Forests- Myanmar Ecoregion (App.6). The area above Myitsone (the Kachin cultural heartland) belongs to the Ecoregion – Mizoram-Manipur Kachin Moist Evergreen Forests. From biodiversity conservation point of view, these key biodiversity areas as a whole in Kachin State is nationally important, regionally significant and globally outstanding.

To compensate the adverse impacts on these biophysically and culturally very important areas on account of construction of dams and to promote sustainable development of Kachin State, the watersheds of Mayhka and Malihka Rivers as a whole must be well managed including the establishment of Mayhka National Park and Malihka National Park.(Fig. 1). This national park should be included in the network of existing Myanmar protected area system (App.5).

B. Ecoregions (App. 7)

1) The Ecoregion - Eastern Himalayan Alpine Shrub and Meadows comprises Bhutan, India, Myanmar and Nepal. This ecoregion is globally outstanding and supports one of the world's richest floral communities. The splendor and richness of these meadow communities in full bloom are difficult to describe. The alpine scrub and meadows in the eastern Himalayas are nested between the tree line at 4000m and the snowline at about 5500m and extend from the deep Kali Gandaki gorge through Bhutan and India's northeastern state of Arunachal Pradesh, to northern Myanmar, including the tallest mountains in the world-Everst, Makalu, Dhaulagiri, Jomalhari (WWF 2002) and also Myanmar's tallest peak Mount Kakabo Rhazi (5729m) is situated in this ecoregion.

The plant richness in this ecoregion sitting at the tip of the world is estimated at more than 7000 species; only the famous rain forests of Borneo are estimated to have a richer flora among the Indo-Pacici ecoregions (WWF 2002). The scrub vegetation of this ecoregion is dominated by colorful Rhododendron species that exhibit high species turnover along the west-east gradient from eastern Nepal to northern Myanmar. The characteristic assemblage of northern Myanmar consists of *R. calciphila, R. crebriflorum, R. chryseum, R. riparium, R. sanguineum, and R. saluenense* is entirely different from Nepal and Bhutan alpine scrublands (WWF and IUCN 1995). The herbs that lend springtime colour to the alpine meadows include hundreds of species from genera such as *Alchemilla, Androsace, Primula, Diapensia, Impatiens, Draba, Anemone,Gentiana, Leontopodium, Meconopsis, Saxifraga, Sedum, Saussurea, Rhododendron, Potentilla, Pedicularis,* and *Viola* (WWF and IUCN 1995).

The fauna of this Ecoregion - Eastern Himalayan Alpine Shrub and Meadows is said to be surprisingly rich in mammals and birds and Myanma portion of the ecoregion should be biologically explored by both native and expatriate scientists. Important mammal species in this region include the snow leopard, blue sheep, Himalayan tahr, and takin and avian predators such as the lammergeier, Himalayan griffon, black eagle, and northern goshawk (WWF 2002).

The Vespertilionid bat and the Chestnut-breasted partridge are near-endemic to this ecoregion (WWF 2002). 100 mammal species are known in this ecoregion and threatened species are snow leopard, takin, Himalayan goral, serow, Himalayan tahr (WWF 2002). Alpine meadows and scrub provide breeding habitats for such bird species as Himalayan and Sclater's Monals, Grandala, A.lpine Accentor and a number of finches (Robson 2000). 115 bird species are known in this ecoregion and there are several high elevation specialists such as, the Himalayan snowcock, Tibetan partridge, snow partridge, Satyr tragopan and the Himalayan griffon, that need conservation attention (WWF 2002).

Based on the information from expeditions carried out by both national and expatriate ornithologists, the following species are currently found (S.Chan, T.Aung, N.M.Shwe, pers.comm.) namely, Lophophorus sclateri, Sitta Formosa, Aceros nipalensis (Hkakaborazi National Park). Trans-boundary protected areas with adjoining countries should be considered in the interest of both global and regional significance.

2) The Ecoregion-Northern Triangle Temperate Forests lies in the extreme northern area of the northern Triangle of Myanmar. There have been no scientific surveys yet in this region except done by Kingdon-Ward, 50 to 80 years ago (Kingdon-Ward 1921, 1930, 1952). The biodiversity of this area may be very high and many scientists hope to find species new to science. Satellite imagery indicates that the ecoregion is stil virtually clothed in intact forests and presents a rare opportunity to conserve large landscapes that will support the ecological processes and the biodiversity within this eastern Himalayan ecosystem. The Chindwin, Malihka, and Mayhka rivers originate in these mountains and flow south to converge in the lower reaches to form the Ayeyawady River.

Biologically, the mountains are an ecotone of the Assam-Indian, Eastern Himalayan, Indo-Malayan, and Chinese floras and also Gondwana-era relicts have taken refuge here (WWF 2000). Thus, floristically, the ecoregion is extremely diverse and the complex topography, moist conditions by south-western monsoon funneled from Bay of Bengal has provided the localized climatic variations that promote endemism (WWF 2002). Floristically, the temperate forests lie between 1830 and 2700m. At lower elevations the forest transition into the subtropical forests and in the upper elevations, into the subalpine conifer forests. The temperate forests are characterized by *Alnus nepalensis,* *Betula cylindrostachya, Castanopsis sp., Schima sp., Michelia sp., and Bucklandia populnea (WWF and IUCN 1995), Lwin 1995). At higher elevations rhododendrons, especially Rhododendron decorum, R. magnificum, R. bullatum, R. crinitum, R. neriiflorum* are dominant in the vegetation (WWF and IUCN 1995).

At elevations above 2100m, the broadleaf forests transition into a mixed forest, where species of *Quercus, Magnolia, Acer, Prunus, Ilex, and Rhododendron* are mixed with

Picea brachytyla, Tsuga dumosa, Larix griffithiana, and Taiwania flousiana. The rich, diverse shrub flora is characterized by species of *Acer, Berberis, Clethra, Enkianthus, Euonymus, Hydrangea, Photinia, Rhododendron, Rubus, Betula, and Sorbus* (WWF and IUCN 1995).

Almost 100 species of mammals are known in this ecoregion and endemic mammals are the Gongshan muntjak and Fea's muntjak. However there are several other threatened species that deserve conservation attention, namely the tiger, takin, clouded leopard, red panda, wild dog, Asiatic black bear, stump-tailed macaque, capped leaf monkey, red goral, great Indian civet, back-striped weasel, Ayeyawady squirrel, and parti-colored squirrel (WWF 2002).

This ecoregion overlaps with the Eastern Himalayas endemic bird area (130) that contains seven restricted-range species (Stattersfield et al. 1998). 362 birds are known from this ecoregion, and the Rusty-bellied Shortwing is the only ecoregional endemic but there are several species that deserve conservation attention as they require mature habitats and have low tolerances for disturbances that are indicators of habitat integrity (WWF 2002). Some of thes species include the Oriental Pied-Hornbill, Wreathed Hornbill, Blyth's Tragopan, Himalayan Flameback, and Sclater's Monal (WWF 2002). The Sclater's Monal is vulnerable and according to Robson (2000), it is uncommon local resident, east of northern Myanmar and its status should be checked in this ecoregion.

3) The Ecoregion- Northern Triangle Subtropical Forests sits in the remote Triangle in northern Myanmar. In terms of species and biological richness this ecoregion is globally outstanding and floristically one of the most diverse regions in continental Asia (WWF and IUCN 1995). Scientifically it is the least explored except the early explorations of Kingdon-Ward in 19th Century (Kingdon-Ward 1921, 1930, 1952 quoted in WWF 2002). Biodiversity richness is highly underestimated and the place may likely harbour many more species than now attributed to it. The westernmost Sangpang Bum range forms the Indo-Myanmar boundary and the easternmost Gaoligong Shan demarcates the Myanmar-China border. Generally, the elevation exceeds 1500m but the peaks rise steeply to over 3000m. The Chindwin, Malihka and Mayhka rivers originate in these mountains and converge in the lower reaches to form the Ayeyawady River. With varied topography and biogeographic settings this ecoregion is at the crossroads of Assam-Indian, Eastern Himalayan, Indo- Malayan and Chinese flora, and also mingled with Gondwana relicts that have taken refuge here (WWF 2002), resulting in with a high floral diversity. The Indo-Malayan elements are now restricted to the river valleys, below 2400m, with the Indo-Himalayan flora stratified above (WWF and IUCN 1995).

The Ecoregion - Northern Triangle Subtropical Forests consists of subtropical broadleaf forests, subregional-scale patches of temperate broadleaf forests, subalpine conifer forests, and alpine meadows in the northern area (WWF and IUCN 1995). The subtropical forests are found between 500m and 1600m and commonly found are species of Magnoleaceae, Lauraceae and Dipterocarpaceae make up the associations below 915m, and species of Fagaceae, Meliaceae, tree ferns and climbing palms comprise the upper elevation associations(WWF and IUCN 1995). In these forests the characteristic tre spercies are *Acer pinnatinervium, Aesculus assamicus, Betula alnoides, Carpinus viminea, Castanopsis argentea, Magnolia pterocarpa, Persea spp., Litsea spp., and Lindera spp.*(WWF and IUCN 1995). In mature forests, trees are drapped with lianas (*Jasminum duclouxii, J. pericallianthum, Lonicera hildebrandii, Bauhinia spp., Mussaenda spp., Rubus spp.)* along the upper limits above 1525m; the forest is characterized by a predominance of Bujcklandia populnea (WWF and IUCN 1995).

The Ngawchang valley at 1000m and 1980m between Htawgaw and Ganfang in the western part of the ecoregion, has a pine-oak association that is characterized by *Pinus kesiya, Quercus incana, and Q. griffithi,*(WWF and IUCN 1995). A rich unique herb flora of *Anemone begoniifolia, Gentiana cephalantha, Gerbera piloselloides, Inula cappa, Lilium bakerianum, L. ochraceum, Primula denticulate, Senecio densiflora* grows in these open forests, considered a fire-maintained pre-climax community (WWF and IUCN 1995). Several endemic species are associated with these forests, including the terrestrial orchid *Paphiopedilium wardii,* and other endemics such as *Agapetes adenobotrys, A..pubiflora, Brachytome wardii, Lactuca gracilipetiolata, Lasianthus wardii,Paphiopedilum wardii, Strobilanthes stramineus* (WWF and IUCN 1995).

The Ecoregion - Northern Triangle Subtropical Forests harbours about 140 species of mammals (WWF data base 1999), including eight ecoregional species; Fea's muntjak, two squirrels, and Pere David's rock squirrel, two moles, Styan's water shrew, a Vespertilionid bat, and a murid rodent. Other species of conservation importance include, tiger, red panda, Asian elephant, gaur, takin, southern serow, pig-tailed macaque, Asamese macaque, stump-tailed macaque, capped leaf monkey, hoolock gibbon (primates are invaluable indicators of forest condition), wild dog, Asiatic black bear, back-striped weasel, great Indian civit, clouded leopard, red goral, Ayeyawady squirrel and particoloured squirrel (WWF 2002). During 1997, *Muntiacus putaoensis* was discovered during wildlife survey in the region. The bird fauna exceeds 370 species (WWF 2002). The Rusty-bellied Shortwing (*Brachypteryx hyperythra*) is this ecoregional endemic species and other focal species because of their need for mature forests and low thresholds of disturbance include Blyth's Tragopan (*Tragopan blythii*), Great Hornbill (*Buceros bicornis*) and the Wreathed Hornbill (*Aceros undulates*) and rufous-necked hornbill *Aceros mipalensis* (WWF 2002). Since the endangered White-winged Duck (*Cairina scutulata*) was found in northern Myanmar (Robson 2000) and (Thein Aung.pers.comm.) the status of this species should be checked in this ecoregion. Hooded Treepie (Crypsirina cucullata), an endemic species of Myanmar and vulnerable Blyth's Tragopan (*Tragopan blythii*), Hume Pheasant (*Syrmaticus humiae*) should be always monitored in this ecoregion. Also the status of vulnerable Ward's Trogon (*Harpactes wardi*) should be checked in broadleaved evergreen forests of this ecoregion.

Hukaung Valley Wildlife Sanctuary is situated in this ecoregion and the presence of tigers has been reported recently. The status of vulnerable Masked Finfoot (*Heliopais personata*), Indian Skimmer (*Rynchops albicollis)* Blyth's Kingfisher (*Alcedo hercules*) should be checked in rivers, pools and lakes of this ecoregion. In streams, rivers and water areas near broadleaved evergreen forests, the vulnerable and winter visitor, Wood Snipe (*Gallinago nemoricola*) and vulnerable Blyth's Kingfisher should be checked in these ecoregions. In tall grass and lowland habitats of this ecoregion, the status of vulnerable Jerdon's Babbler should be studied.

In accordance with the expeditions carried out by national and expatriate ornithologists, the following bird species are currently confirmed (S. Chan, T.Aung, N.M.Shwe, K.M.M.Thwin, H. Hla, pers. comm.) within this ecoregion, namely, *Pelecanus* *philippensis, Leptoptilos javanicus, Aythya baeri, Grus antigone, Haliaeetus leucoryphus, Aythya nyroca, Phalacrocorax niger (Indawgyi Bird Sanctuary), Pelecanus philippensis, Ardea insignis, Leptoptilos javanicus, Cairina scutulata, Gallinago nemoricola, Pavo muticus, Aceros nipalensis, Phalacrocorax carbo, Anhinga melanogaster, Pelecanus philppensis* (Hukaung Valley Wildlife Sanctuary), *Tragopan blythii, Lophophorus sclateri, Stachyris oglei, Ardea insignis, Brachypteryx hyperythra, Sitta Formosa, Aceros nipalensis, Alcippe ludlowi, Sphenocichla humei* (Hponkan Razi Wildlife Sanctuary), *Gyps bengalensis, Gyps indicus, Pelecanus philippensis, Pavo muticus,Leptoptilos javanicus,Grus grus, Ciconia nigta* (Kamaing and Mogaung areas in Kachin State), *Pelecanus philippensis, Leptolos javanicus, Anas Formosa, Heliopais personata, Phalacrocorax carbo, Aninhinga melanogaster, Grus grus, Ciconia nigra, Anser indicus, Tadorna ferruginea, Aythya nyroca, Glareola lacteal* (Ayeyawady River section between Myitkyina and Sinbo), *Gyps bengalensis, Grus grus, Ciconia nigra, Ardea insignis, Cairina scutulata* (Tawlawgyi and Nam Sam Chaung areas in Kachin State), *Pelecanus philippensis, Cairina scutulata,Gyps bengalensis, Pavo muticus* (Htamanthi Wildlife Sanctuary, and Uyu River in Sagaing Division).

C. World Centers of Plant Diversity (CPD)

Renowned botanists claimed that significance of plants as determinants of conservation priorities is unrivalled and have produced centers of plant diversity or the most important sites for plants worldwide (WWF & IUCN 1995). The flora of Northern Myanmar had been studied from time to time, but with big time gaps and not continuously on account of remoteness of the region and less encouragement. According to Kalaya Lu (2006), Reginald Farrer collected 118 seeds or specimens of Myanmar rhododendrons in 1920 and *plant* hunters George Forest and F. Kingdom Ward were the pioneer plant collectors at Northern extremities of Myanmar during 1921-1953. F.Kingdom Ward collected more than 150 species of Myanmar *Rhododendron.* and he wrote about it and his floral expeditions in famous books, Return to Irrawady(1956) and Burma Icy Mountain (1923). In 1981 Dr. Kyaw Soe and two members from Botany Department, Yangon University, undertook a botanical expedition in Northern Myanmar and collected specimens including medicinal plants (K. Soe 1982).

From regional and global perspectives, Myanmar has four world centers of plant diversity (WWF and IUCN 1995). North Myanmar is one of the world centers of plant diversity.

North Myanmar (CPD)

***Location*:** This CPD is located - North of latitude 25º 00’N and between longitudes 96º 45’E, including the whole of Kachin State, and the northern part of Sagaing Division. It comprises the Kachin Hills, the Angpawng Bum and associated ranges and river systems. The area is about 115,712 km² (WWF and IUCN 1995) and altitudinal ranges between about 150-5881m, Mount Kakaborazi is the summit. This region adjoins two other CPD sites (WWF and IUCN 1995), namely, Namdapha (IS4) in India and the Gaoligong Mountain, NuJiang River and Biluo Snow Mountains region (EA26) in China. There are only two extensive areas of lowland in North Myanmar, the Hukaung Valley in the west and the basin of the Malihka. Most areas apart from these valleys are above 1500m. Some of the highest peaks are, Hkakaborazi (5881m), Saramati (3862m), Bumba Bum (3411m), Chingwin Bum (3292m), and Nanggum Bum (3204). Principal rivers are the Chindwin, Malihka and Mayhka.

***Vegetation*:** The forest types are lowland tropical forest, various types of monsoon forest, mixed and coniferous temperate forest, Rhododendron forest and alpine meadows. The description of vegetation of the area is mainly relied on information of Kingdon-Ward (1944, 1945, 1946) and Pottinger and Prain (1898, quoted in WWF and IUCN 1995). Kingdon-Ward (1944, 1945) identified main vegetation types, which are described briefly below.

Tropical evergreen rain forest occurs up to 600m altitude on the Hkamti Plain and in the bottoms of the lower Malihka, the Nam Tisang and the Mayhka Rivers. The forest is almost entirely Indomalayan in composition and typical tree species are *Mesua ferrea, Stereospermum personatum, Terminalia myriocarpa, Dipterocarpus alatus,* and *D. turbinatus*. Pandans such as *Pandanus furcatus* and palms such as *Caryota urens,* strangling figs such as *Ficus elastica* and *F. benjamina,* tree ferns, lianes and climbers including the spectacular *Thunbergia grandiflora.*

Subtropical hill forest occurs at 450-1675m and the upper limit is defined by the lower limit of *Bucklandia populnea***,** which is found only above 1525m. The forests include Magnoliaceae, Lauraceae, Dipterocarpaceae, Fagaceae, Meliaceae, tree ferns, and climbing palms. Characteristick tree species include *Acer pinnatinervium, Aesculus assamicus, Betula alnoides, Carpinus viminea, Castanopsis argentea,* and *Magnoliapterocarpa.* Lianas include *Jasminum duclouxii, J. pericallianthum, Lonicera hildebrandii,* and species of *Bauhinia, Clematis, Mussaenda* and *Rubus.* Terrestrial orchids include *Cypripedium villosum* (endemic to Myanmar) and *Paphiopedilum wardii* (a strict endemic) and although the vegetation is Indomalayan in character, the flora above 1525m includes many Eastern Asiatic elements (WWF and IUCN 1995).

Subtropical pine- oak forest occurs at 1000-1980m and dominant trees are *Pinus kesiya, Quercus incana, Q. serrata, Q. griffithii.* The herbaceous flora includes *Anemone begoniifolia, Gentiana cephalantha, Gerbera piloselloides, Inula cappa, Lilium bakerianum, L. ochraceum* var *burmanicum, Primula denticulate* and *Senecio densiflora.*

Temperate rain forest (monsoon forest) includes warm temperate, cool temperate and temperate pine forests. Warm temperate rain forest occurs at 1525-2135 m in areas with distinct spring and winter seasons, with little snow in winter. Typical trees are *Alnus nepalensis, Betula cylindrostachya, Bucklandia populnea* and some palm like arborial Araliaceae. The epiphytic shrub flora is very rich including species in the Maddenii and Vaccinioides series of *Rhododendron*.

Cool temperate rain forest occurs at 1830-2440m. The indicator is the appearance of the main belt of large shrub rhododendrons, such as *R. decorum, R. magnificum, R. bullatum, R. crinitum and R. neriiflorum.* These flower mainly ijn February and March, coinciding with a major bird migration (WWF and IUCN 1995).

Temperat pine forest occurs at 1370-2440m and the dominant species is *Pinus excelsa.* This species is found on slopes and also within broadleaf forests of *Acer, Ilex, Laurus, Prunus and Quercus.* There is thick bamboo undergrowth and woody climbers include *Aristolochia griffithii, Clematis forrestii* and *Paederia foetida.*

Mixed temperate forest occurs at 2135-2745m and it is transitional between broadleaf temperate rain forest below and *Abies* (silver fir) forest above. The dominant genera are *Quercus, Magnolia, Acer, Prunus, Ilex, and Rhododendron* and coniferous species include *Picea brachytyla, Tsuga dumosa, Larix griffithiana* and *Taiwania flousiana.* The shrub flora is very diverse, including species of *Acer, Berberis, Clethra, Enkianthus, Euonymus, Hydrangea, Photinia, Rhododendron, Rubus* and *Sorbus.* The notable species of ground flora is *Chamaepericlymenum suecicum,* an arctic-alpine relict (WWF and IUCN 1995).

Silver fir forest occurs at 2745-3660m and at this altitude, deep snow lies for at least a month. The forest is dominated by *Abies fargesii,* and also with species of *Acer, Betula, Rhododendron,* and *Magnolia.* At higher altitudes the forest is more open and bamboo (*Arundinaria)* thickets occur. In open meadows, tall alpine herbs *Lilium giganteum, Meconopsis paniculata* and *Notholirion campanulatum* are found. From 3050m upwards, primulas increase with species such as *P. agleniana* var.*thearosa* (the tea-rose primula endemic to the Seinghku Valley), *P. calthifolia, P. eucyclia,* and *P. sikkimensis.*

Subalpine rhododendron scrub occurs between 3350-3960m and at least 20 species of *Rhododendron* are known to occur. The dominant above 3350m is *R. selense* with pink and cream flowers in spring. At least 12 dwarf species of *Rhododendron* are found in north Myanmar, about half are confined to subalpine scrub. A very wide range of herbaceous alpine plants is found including *Caltha palustris, Cypripedium tibeticum, Nomocharis souliei, Omphalogramma souliei,* and several primulas.

Alpine vegetation occurs between 3660 – 4575 m. Shrubs of several dwarf rhododendrons such as *R. calciphila, R. crebriflorum, R. chryseum, R. riparium, R. sanguineum*, and *R. saluenense* and *Cassiope fastigiata, Potentilla fruticosa and Rosa sericea.* The main herbaceous genera include *Alchemilla, Androsace, Anemone, Diapensia, Draba, Gentiana, Leontopodium, Pedicularis, Saussurea, Saxifraga and Viola.* Screes are colonized by species which have very long tap roots include *Picrorhiza scrophulariiflora* and *Oresolen wattii* (WWF and IUCN 1995).

Flora and Endemism**:** At least 6000 species were estimated by Kingdon-Ward who had made eight journeys there between 1914 and 1942. George Forrest explored the Upper Salween (Thanlwin), Mayhka and Shweli-Salween divides from the Yunnan side between 1917 and 1930, Reginald Farrer made collections in the Htawgaw area of extreme north-east Myanmar and other collectors who have visited parts of the area included Pottinger and Prain in 1898 and Burmese foresters, U Tha Hla and U Chit Ko Ko (WWF and IUCN 1995).

Floristically, the area is one of the richest and most diverse in mainland Asia. It is the meeting point of four distinct floras; the Assan-Indian the Eastern Himalayan, the Indomalayan, and the Chinese. Endemism is significant in most altitudinal zones including remarkable species such as a unique epiphytic lily, *Lilium arboricola.* According to WWF and IUCN 1995, the following are examples of *endemics* of each vegetation type:

Tropical evergreen forest: *Agapetes wardii, Albizia vernayana, Camellia stenophylla, Strobilanthes arenicolus and Syzygium cuttingii.*

Subtropical hill forest: *Agapetes adenobotrys, A. pubiflora, Brachytome wardii, Lactuca gracilipetiolata, Lasianthus wardii, Paphiopedilum wardii, and Strobilanthes stramineus.*

Subtropical pine forest: *Paphiopedilum wardii, Primula densa, and Stemona wardii.*

Warm-temperate rain forest: *Aeschynanthus wardii, Aster helenae, Diplycosia alboglauca, Ixora kingdon-wardii, Leycesteria insignis, Litsea cuttingii, Primula dictyophylla, Rhododendron dendricola, and Sorbus paucinervis.*

Cool-temperate rain forest: *Euonymus burmanica, Primula burmanica, Rhododendron agapetum, R. insculptum, R. magnificum, R. taggii, and Rubus chaetocalyx.*

Mixed temperate forest: *Acer taronense, Berberis hypokeriana, Ilex burmanica, Juniperus coxii, Prunus kingdon-wardii, Rhododendron butyricum and R. vesiculifolium.*

Silver fir forest: *Berberis burmanica, Gaultheria minuta, Primula eucyclia, P. agleniana* var. *thearosa and Sorbus wardii.*

Rhododendron scrub: *Cremanthodium wardii, C. farreri, Meconopsis violaceae and* 4 species of *Rhododendron.*

Alpine vegetation: Apparently few endemics, but among them *Primula fea.*

According to WWF and IUCN 1995, North Myanmar is a center of diversity for several genera of Ericaceae, including *Agapetes, Rhododendron*(more than 80 species), *Vaccinium, Rubus* (24 species)*, Sorbus(*at least 20), *Prunus* (at least 11), *and Pedicularis(*more than 10). Also there is one monotypic, near-endemic family, Dipterocarpaceae (*Dipentodon sinicus*), which also occurs in adjacent China.

Useful plants**:** Regarding timber- the most heavily exploited trees is *Taiwania flousiana,* the wood is exported to China to make coffins, and other timber species include *Pinus kesiya* and some *Castanopsis* species. Oil- from *Ricinus communis,* used in lamps. A dark blue dye is obtained from *Strobilanthes flaccidifolius,* while *Rubia manjith* yields a particular deep red madder dye. Beer is obtained from rice, *Steria and Eleusine. Caryota urens* is used by Kachins to construct the walls and floors where bamboos are scarce. The Marus boil and eat the pith of the stem as a kind of sago. Bamboos are used for carrying water, for making ropes, matting, bows and arrows. *Arundinaria* is used to make walking sticks and pipe bowls. Some of the rattan palms of the tropical and subtropiocal forest zones are used to make suspension bridges (WWF and IUCN 1995). Rosaceae contains several plants of food value, including *Cydonia cathayensis, Fragaria elatior* and many species of *Rubus.* Medicinal plants- Many plants are used as medicines by specific tribes. *Fritillaria roylei and Coptis teeta* are widely used for the treatment of malaria and as a tonic or aphrodisiac. These two species are dug up in vast quantities and exported to China and also to Mandalay and Yangon. Sometimes the whole medicinal plant species are used but sometimes particular parts are used for their different medicinal properties but are mostly traded in their raw and dried forms (TRAFFIC 2008).

D. Endemic Bird Areas (EBA) and Important Bird Areas (IBA)

EBA means an Endemic Bird Area as an area which compasses the over lapping breeding ranges of restricted-range bird species, such that the complete ranges of two or more restricted-range species are entirely included within the boundary of the EBA. This does not necessarily mean that the complete ranges of all of an EBA’s restricted ranges species are entirely included within the boundary of that single EBA, as some species may be shared between EBAs.

There are 4 EBAs in Myanmar. The study area of “EIA special investigations on Hydropower development of Ayeyawady Basin above Myitkyina” lies in the range of three endemic bird areas and one secondary area namely;

1) Eastern Himalayas EBA no130
2) Ayeyawady plains EBA no 132
3) Yunnan mountains EBA no 139
4) North Myanmar lowlands (Secondary area)

IBA means an Important Bird Area where the site is known or thought regularly to hold significant numbersof a globally threatened species; the site is known or thought to hold a significant component of a group of species whose breeding distribuitions define an Endemic Bird Area (EBA) or a Secondary Area (SA); the site is known or thought to hold a significant component of the group of species whose distrigutions are largely or wholly confined to on biome; a site may qualify as an IBA under any one or more of the four criteria listed below: a) the site is known or thought to hold, on a regular basis, 1% or more of a biogerographic population of a congregatory waterbird species, b) the site is known or thought to hold, on regular basis, 1% or more of the global population of a congregatory seabird or terrestrial species, c) the site is known or thought to hold, on a regular basis, at least 20,000 waterbirds, or at lest 10,000 pairs of seabird, of one or more species, d) the site is known or thought to be a "bottleneck site" where at least 20,000 raptors (*Accipitriformes and Falconiformes*) and/ or cranes (*Gruidae*) pass regularly during spring and/ or autumn migration.

There are 53 IBA in Myanmar. There are 12 IBAs in the Kachin state. The study area lies adjacent to 3 IBAs namely 1) Hkakaborazi National Park; 2) Hponkanrazi Wildlife Sanctuary; 3) Bumphabum Wildlife Sanctuary. These three IBAs together form an important portion of priority corridor for conservation in Myanmar known as Nothern Mountains Forest complex (Tordoff et.el 2005). The water shad areas of both Mayhka and Malihka rivers originate from these IBAs.

9. POTENTIAL IMPACTS ON BIODIVERSITY

Ecoregions which are nationally important, regionally significant and globally outstanding and wildlife species will be heavily disturbed and directly affected by clearing and logging of the inundation areas and follow-op construction activities for a series of dams in Kachin State. Of particular concern are loss and fragmentation of important ecosystems and the loss of key, endemic and endangered species of both flora and fauna. While most birds and mammals can be expected to disperse at the initiation of clearing and logging, some will inevitably be trapped by hydropower development activities. And thus are likely to affect long range movements of large mammals. The dam sites and watersheds of Malihka and Mayhka Rivers are within the core area for strict biodiversity conservation, and the dams and related facilities are close and within eco-regions (App.7), key biodiversity areas (App.4) and conservation corridors (App.6) and in one of the world's centers of plant diversity (WWF & IUCN 1995). Definitely there will be negative impacts on potential of availability of traditional medicinal plants. Regarding agro-biodiversity there may be potential negative impacts on some wild rice varieties and their ancestors which are thriving well in Chebwe Township (Kalaya Lu 2006). The area has been extensively disturbed by past logging and shifting cultivation, and currently by poaching, so the additional disturbance caused by the hydropower project is expected to add more negative impacts. Some of the reservoir areas are not central to the livelihoods of most of the local villagers, even though wildlife hunting is thought to be intense. In the future when the constructions start huge influx of Chinese workers is imminent and there is a strong possibility of severe deforestation for fire wood. Another serious factor to consider is bush meat consumption. At the moment bush meat consumption is not very high. Local hunters usually hunt for daily subsistence and if there an extra they sell it to other people. But during construction period there will be an increase of Chinese workers, the majority fond of bush meat. Therefore bush meat demand will be increased. The majority people of local races oppose construction of the dams especially Myison hydropower project. They consider the confluence as the cultural heartland of the Kachins.

10. IMMEDIATE COMPENSATORY MEASURES

On account of the construction of a cascade of hydropower dams in Kachin State, there will be severe negative impacts on regionally significant and globally outstanding three ecoregions, one center of world plant diversity; severe impacts on key biodiversity areas and conservation corridors of Myanmar; severe impacts on livelihoods and habitations of grassroots people of the region; disappearance of some wild rice varieties and their ancestors; disappearance and forever loss of the cultural heartland of Kachin people (Myitsone); reduction of ecotourism potential and loss of ecotourism sites and cultural sites in Kachin State; and some wildlife species, terrestrial and wetland ecosystems may suffer considerably due to deforestation, loss of typical habitats and habitat fragmentation. These must be compensated by following prioritized actions if constructions of dams are going to be approved in Kachin State.

Prioritized Action 1

Create and implement new protected area management and watershed management in the whole watershed areas of Malihka River and Mayhka Rivers. CISPDR/CPI will provide funds for protected area management and watershed management of both Malihka and Mayhka Rivers as a whole during the hydropower development phase. The whole catchment area of Ayeyawady is about 49000 km^2 and out of which the following will be recommended as prioritized actions (1) Establishment of Malihka NP(4040 km^2) and Mayhka NP (6854 km^2), encompassing Imaw Bum (the area with floral wealth is vital water source of Maykha and Ngaw Chan Hka Rivers, and is floristically strategic linkage between east and west Himalayan floral communities) which will be included in the protected area network of Myanmar(App.5), managed by Nature and Wildlife Conservation Division of Forest Department, Union of Myanmar (2) Watershed management of the remaining area (23643 km^2) which will be managed by Watershed Division of Forest Department, Union of Myanmar. This prioritized action could be done by collaborating between Ministry of Forestry, Ministry (I) of Electrical Power and China Power Investment Corporation (CPI). When the hydropower project becomes operational, approximately 1 percent of the annual proceeds from the sale of electricity will be provided to support Malihka NP & Mayhka NP and watershed management in Kachin state. If the annual fund provision is to be in excess of funds required for maintenance of Malihka NP & Mayhka NP and watershed management, a plan will be formulated to place the remaining funds in a “conservation fund” to be used for priority conservation programs nationwide. This is one of the exploring ways to establish a national conservation fund.

This prioritized action should be under a management team of various stakeholders including government authorities and departments of Myanmar, concerned Chinese corporations, scientific institutions from both China and Myanmar, environmental NGOs from both Myanmar and China, and local communities representing major races and various ethnic minorities of Kachin State.This prioritized action can offer more efficient dams and better protection of biodiversity, thus enhancing MDGs.

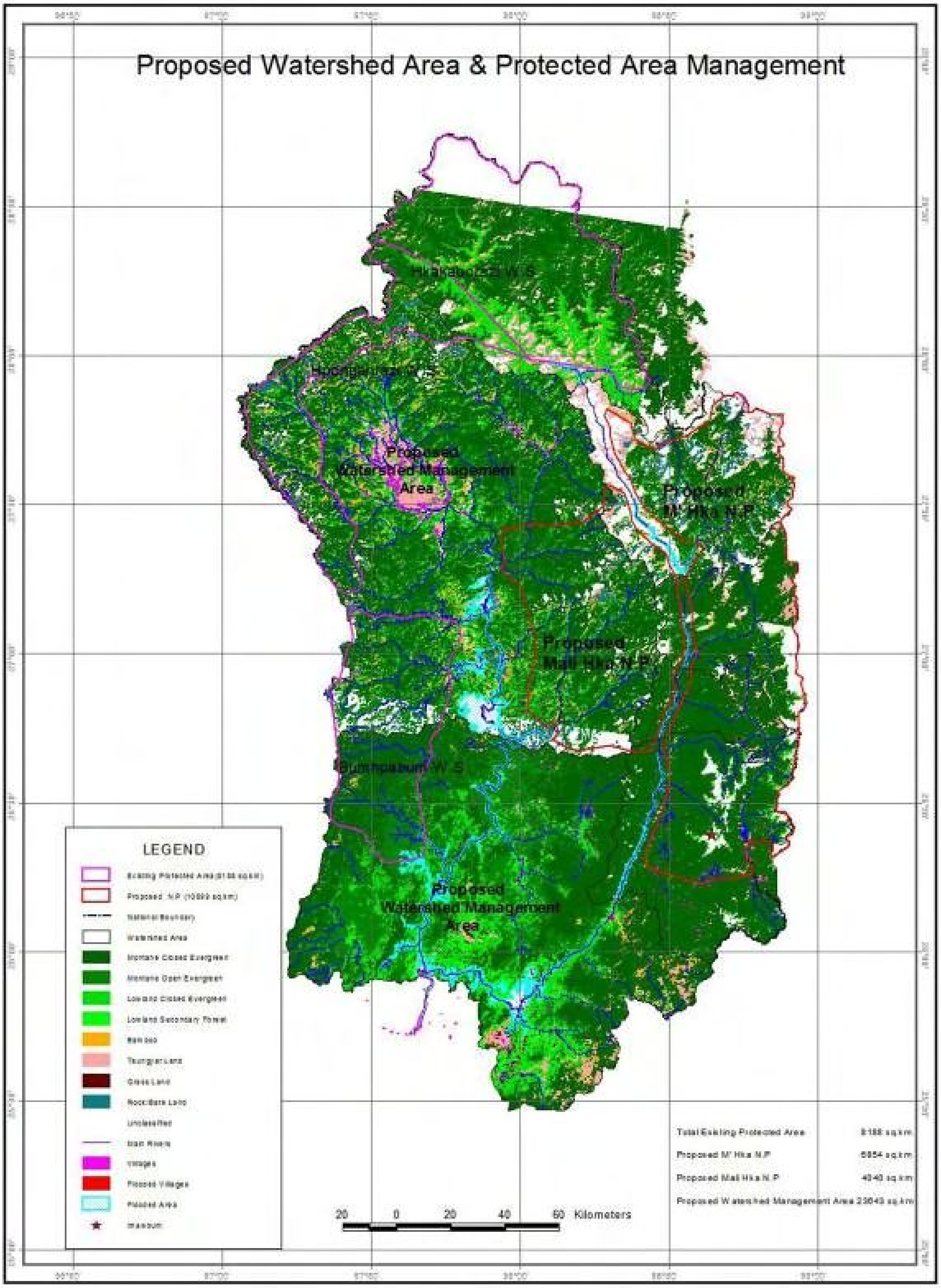

Fig. 1. Proposed watershed area and protected area management.

Prioritized Action 2.

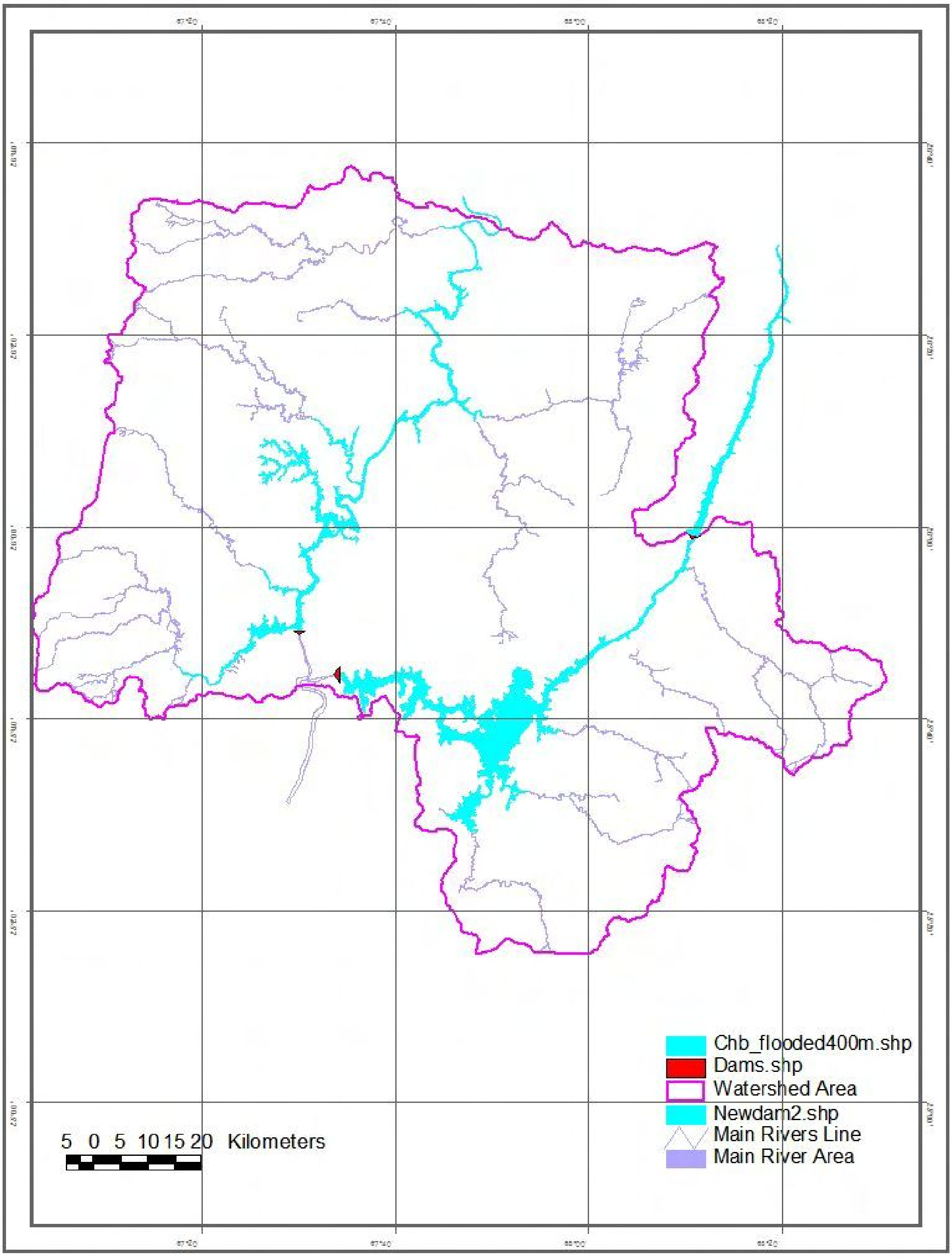

Fig. 2. Proposed alternative dam sites

With experts, find an alternative option to avoid construction of Myitsone Dam at the confluence. The best option would be to develop two smaller hydropower dams substituting already proposed Myitsone Dam and its location at appropriate two locations above the confluence of Malihka and Mayhka rivers. Selecting and identifying two dam sites, above the confluence, one on the Mayhka River and another on the Malihka River (see above map) shall avoid disappearance of the culturally very important confluence. Conducting social impact assessment is essential and the public should be disclosed about the hydropower dams and resettlement programs by having public meetings.

The new option of construction of two dams above the confluence, replacing the original proposed Myitsone dam may result in the following 16 flooded villages according to our GIS map analysis:

Hpala; Wang rong; Ri dam; Ma ga ta; Sum pi yang; Hpung in yang; Khin du yang; Ma li yang; Ja ya yang; Ning ma; N krung tu; Lot mai yang; Ale aung; Mung dong; Htunggoirn; and Gamgo.

The original proposed Myitsone Dam project may result in 32 villages will be flooded.

Prioritized Action 3

The roads from Myitkyina to Putao, and from Myitkyina to Chebwe will be flooded. These need to find new alignments which are clear of flooding and to build two new roads. In other words as compensation, it is essential to build new roads and bridges replacing the ones which are going to be submerged. One section of road to Putao from Myitkyina i.e from Tang Pe to Tiangzup approximately 30 miles will be submerged. Similarly a section of Myikyina - Chibwe road about 40 miles will also be submerged.

The 59th mile bridge, Sha Ngaw Bridge on the way from Myikyina to Chibwe; Inzup Bridge, Tianzup Bridge and some small bridges on the road from Myitkyina to Putao will be flooded.

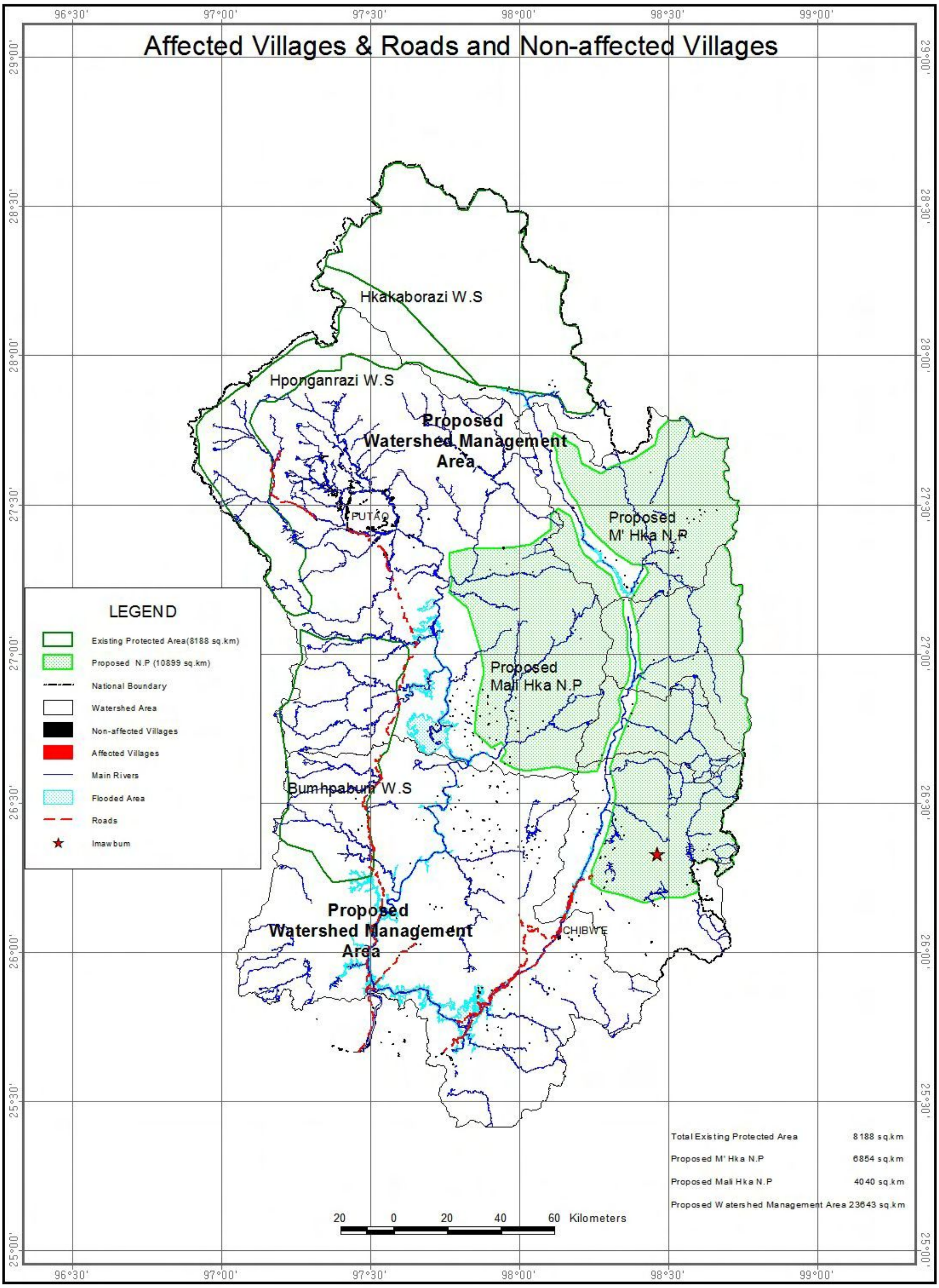

Fig. 3. Affected villages & roads and Non- affected villages

Prioritized Action 4

Regarding impacts on forests within the hydropower development area, funds will be provided to reforest and rehabilitate priority sites that have been degraded due to past commercial logging and shifting cultivation. Logging and clearing of the flooded areas will be contracted to logging companies through tendering. Detailed schedules and obligations of the contractor will be clearly specified in the contractual documents including delineation of reservoir areas and minimum logging and control over logging activities.

Prioritized Action 5

Many of the same measures will also ensure that wildlife is not exploited during dam construction period. In addition, the contractor will be held responsible for wildlife poaching by laborers. If a laborer is found in possession of wildlife species or other protected forest products, the contractor will be fined according to existing Myanmar law and the laborer will be dismissed; the same will apply to Project staff.

A small capture and release program will be undertaken, if necessary, for mammals trapped by logging and clearing operations. A plan for such activities will be prepared by a competent scientific NGO with assistance from the protected area management personnel.

Prioritized Action 6

To prevent from severe deforestation for firewood, Chinese workers should bring in their own gas stoves from China to the project areas. Serious regulation on hunting should be enforced. Community developments paying special attention to livestock breeding should be started as soon as possible. They should be in place before the constructions start.

11. POTENTIAL IMPACTS ON AQUATIC ECOLOGY & FISHERIES AND WATER QUALITY

An aquatic ecosystem is always firstly affected or disturbed on account of a dam construction. There should be adequate mitigating measures. Upstream of the dam, the habitat will change from free flowing to impounded water. The change in hydrological conditions will affect resident species that are unable to adapt to impounded conditions. Immediately downstream of the dam, the year round flow will be similar to conditions during the height of the dry season, and so will be less favorable to fish. Some species may be lost from the upper stretches of the rivers and the populations of other species may decline. Subsistence fishing is carried out in both upstream and downstream of the rivers and commercial fishing was not reported in the project villages, though some villagers occasionally sell their catch at local markets.

Huge amount of cubic meters of excavation will be required during dam construction and there will be serious erosions if proper engineering is not undertaken. A major short-term water quality issue is related to the flooding of forests. If not cleared, the drowned organic matter will decay during the first few years after impoundment and could result in the release of anoxic waters that are lethal for fish and aquatic animals. During construction there will be potential water quality impacts from washings from production of concrete, fuel, and oil, and from wastes generated at the camps.

Prioritized Action 1

During project construction, water pollution control measures such as appropriate siting of fuel storage, intercepting and treating of gravel washings, and provision of sanitation measures at the camps will be done. These measures will be attached to the contractor's documents as contractual obligations.

Prioritized Action 2

In the first year of dam construction period, migratory fish species from downstream and upstream will aggregate along the dam construction sites. Local people can catch these aggregates easily. The prioritized action must be banning or prohibition of fishing of these species. Then, these fish aggregates will have to be captured and released back at suitable places along the river. A small capture and release program will be undertaken, for migratory fish aggregates at both downstream and upstream of dam construction sites. A plan for such activities will be prepared by a competent scientific NGO with assistance from the government fishery management personnel. Fish passages should be integrated into dam design from the start. There should have fish ladders and fish passage accessories for migratory fishes.

12. POTENTIAL IMPACTS ON LIVELIHOODS, PUBLIC HEALTH & SAFETY

According to our GIS map analysis; altogether 51 villages shall be flooded on account of construction of a series of dams in Kachin State. Proper resettlement program must be a priority.

Main health risks during the construction stage are linked to (i) inadequate sanitation facilities in worker camps; (ii) introduction of new diseases, by immigrant workers; (iii) outbreaks of malaria in the labor force; and (iv) inadequate health services in the Project area. Measures will aim to secure public health and safety among the workers and nearby population through preventive actions and adequate facilities. The long-term, or operation phase, measures will aim to improve the general health status of the population in the region, with special attention given to potential risks concerning development of water- related diseases because of changes in the river system.

Additionally, the Project will support a public health improvement program based on the control of malaria in the Project area and the improvement of local health facilities.

Prioritized Action 1

Proper social impact assessment must be done before construction of each dam to know real impacts on livelihoods of the poor people living there. Proper resettlement program must be given the highest priority.

Prioritized Action 2

The following set of actions will be undertaken at the labor camps: (i) pre-employment medical screening and treatment of workers if required, (ii) control of importation of diseases in the camps through regular checkups, (iii) implementation of safety regulations and facilities on construction sites, and (iv) a malaria control program to reduce the risk of a malaria outbreak, through health education and provision of bed nets. The contractor will be required to prepare a health and safety plan in his Environmental Management Program.

Prioritized Action 3

A health education program, covering malaria, hygiene, and sexually transmitted diseases will be implemented. This task will be carried out by a competent non government organization under the supervision of the Ministry of Health. Because of the probable temporary influx of people into the project sites the Project will construct a health center which will be supplied with appropriate equipment and an adequate supply of drugs, as listed in the World Health Organization's "Essential Drug List."

13. TRANS-BOUNDARY WILDLIFE AND TIMBER TRADE

This report aims to highlight wildlife trade trends in threatened and at-risk wildlife species. Recent overexploitation of wildlife for trade has affected countless species, with elephants for ivory one of the most-well known examples. It also looks at the expanding international trade in Chinese traditional medicines. Our current Myanma traditional medicines dated back to many centuries. One source said that both Chinese and Vietnamese traditional medicines have been thousands of years old (TRAFFIC 2008). Over-utilization along with habitat loss has impacted and shrunk medicinal plant and animal populations, now considered endangered. Plant resources have been degraded due to lack of scientific standards and methods for sustainable collection. Secondly driven by market demand, many wild medicinal plants have been collected beyond their regenerative capacity. This over-collection paired with habitat loss, leads to sharp decline or even to local extinctions of some species, particularly those that cannot be cultivated. The wildlife meat trade is also included in this report. Freshwater turtles and snake species are common, including Box Turtle (*Cuora amboinensis*), Elongated Tortoise (*Indotestudo elongata*), both are CITES II- listed species and classified as Vulnerable on IUCN Red list. Species from Myanmar (Burmese Eyed Turtle *Morenia ocellata* and Burmese Flapshell Turtle *Lissemy*s *scutata* were common in markets in 1995, but absent by 2000, suggesting that the trade in wild-caught food turtles is unsustainable (TRAFFIC 2007A). The large turtles and Myanmar species may well no longer be available. Illegal trade of pangolin is also common. According to one source, in Myanmar, a pangolin costs RMB20/kg (USD3/kg). When smuggled to Kunming Province, China, the price rises to RMB400/kg (USD57/kg). Upon arrival at Guangdong province, the price goes up to RMB600/kg (USD171/kg) at special times such as just before Chinese New Year (TRAFFIC 2007). However this current study shows the price of a pangolin (skin with scales) in Myanmar has been USD 60/kg. During this study our wildlife trade monitoring team has observed wildlife parts such as heads of gibbons, bills of hornbill, skins and molar teeth of elephants, bones of cat species, oil, skull, canine and gallbladder of bear, horns and antlers of various wildlife species. Resolving illegal wildlife trade is impossible unless consumers are brought into due considerations. They should be regarded as our partners. Understanding the motivations of people in various parts of China for consuming wildlife foods and tonics is very important and long-term communication campaigns will reduce China's consumption of illegally traded and unsustainably produced wildlife products (TRAFFIC 2007). Regarding major wildlife trade routes, Makonkhen, Kangfang, Hpimaw, Pangwa, laiza, kambaiti, Lweje and Muse are exit points from Myanmar to China. A total of 28 wildlife species were recorded during this impact study and 25 species were listed as globally threatened according to IUCN Red List (see the detail in Part III which also shows traded wildlife species, prices and their conservation ststus).

Wildlife trade is big business, worth billions of dollars involving for example, some 88 million orchids, 6.2 million wild-caught live birds, and 7.5 million live-caught reptiles were traded globally between 1996 and 2001 (TRAFFIC 2007). Illegal and unsustainable wildlife trade not only affects the species being exploited. It also directly affects the livelihoods of millions of people- especially the world's poorest, who depend on local wild animals for meat and on local trees and plants for fuel and medicine. Illegal trade also undermines countries' efforts to protect and sustainably manage their natural resources.

Another area of trans-boundary wildlife trade is wood imports from Myanmar to China. China's demand for timber is growing each year. Unable to meet this demand from domestic wood resources since its 1998 logging ban, China has witnessed a rapid growth in timber imports and is now the second largest wood importer in the world (TRAFFIC 2007). Forests are essential to the long-term well being of our local populations, Myanma economy, and the regional biosphere as a whole. The 1992 UN Conference on Environment and Development (UNCED) recognized the importance of sustainability managing all types of forests in order to meet the needs of present and future generations.

Fig. 4. Wildlife trade at Laisa

Fig. 5. Wildlife trade at Laisa

Fig. 6. Wildlife trade at Laisa

Prioritized Action 1

Regarding the illegal trade of wildlife and forest products along trans-boundary, both China and Myanmar should abide by the UNCED Forest Principles and Agenda 21, and relevant UN conventions on biodiversity (such as CBD and CITES), climate change and desertification. Both countries should join regional cooperation to combat illegal logging following options for ASEAN and the East Asia Region (Brack 2006) and IUCN's initiatives of FLEG - Forest Law Enforcement and Governance (IUCN 2006).

Prioritized Action 2

Both countries should cooperate with TRAFFIC. TRAFFIC, the wildlife trade monitoring network recommends: supporting enforcement of CITES, the international convention that regulates international trade in wildlife, by promoting the inclusion of new species in the CITES appendices, by encouraging participation in CITES and keeping CITES strong ; tightening and enforcing legislation, by keeping countries comply with CITES regulations, running training workshops for customs officers, border police, nature conservation officials, to give them appropriate skills and tools to comply with and enforce wildlife trade laws including identification guides to recognize both legal and illegal species in trade; helping with anti-poaching efforts; and encouraging cross-border cooperation; discouraging purchase of wildlife goods such as products from endangered species; and working with local communities by providing practical help to overcome poverty and helping them use their local wildlife in a sustainable way.

14. BACKGROUND OF HYDROPOWER DEVELOPMENT IN KACHIN STATE

In recent years, according to developing need of national economy and society, the government of Myanmar gives priority to hydropower development and encourages and introduces foreign enterprises to exploit abundant water resources of Myanmar. As the largest river of Myanmar, Ayeyawady River flows from the northern part to the southern part. It is endowed with the richest hydropower resources. The hydroenergy of Ayeyawady River is mainly distributed in the basin above Myitkyina. The theoretical reserves of hydroenergy is about 18,540 MW and the total energy is approximately 162.4 billion kW.h. It has a high development value.

In December 2006, China Power Investment Corporation (CPI) and Myanmar Ministry (1) of Electrical Power signed the Letter of Intent for Hydropower Development on Ayeyawady River Basin above Myitkyina, Kachin State. According to requirements of the Entrusting Letter to Undertake the Preparatory Work for the Myanmar Hydropower Project CPI South Branch, Changjiang Institute of Survey, Planning, Design & Research (CISPDR) will undertake the hydropower development and utilization planning in the Ayeyawady Basin above Myitkyina, Myanmar.

According to basin characteristics of Ayeyawady River above Myitkyina and the requirement of national economy development in Myanmar on river exploitation, the tasks of basin development are for power generation and, concurrently, for flood control. After the completion of cascade power stations, it can fully meet the requirements of national economy development of Myanmar on power and can export large amount electricity to neighboring countries to obtain great economical returns. Therefore, the main task of development of Ayeyawady River above Myitkyina is power generation.

14.1. Power Generation

The water resources of mainstream of Ayeyawady River are concentrated in section above Myitkyina. Since Mayhka River and Malihka River feature high drop and large water flow, there are abundant water resources among which Malihka River has the richest water resource.

By estimation, Mayhka River spans approximately 353 km within Myanmar with a drop of 1,010m and an average gradient of 2.9%. theoretically, its power of hydroenergy reserves is 12,200 MW and the total energy is 106.9 billion kW.h. Malihka River spans approximately 375 km within Myanmar with a drop of 4,470m. The average gradients of the river above Man Nansai and the section downstream Man Nsai are 62% and 0.9% respectively. Theoretically, its power of hydroenergy reserves is 6,150 MW and the total energy is 53.9 billion kW.h. The total power of hydroenergy reserves of the basin above Myitkyina is approximately 18,540 MW and he total energy is approximately 162.4 billion kW.h.

14.2. Originally Recommended Hydropower Development Scheme

7 cascade hydropower stations are to be built in the hydropower development scheme of the Ayeyawady River Basin above Myitkyina, among which 5 cascade power stations are built on Mayhka River, one power station is built on Malihka River, and one is built 5km downstream the confluence mouth of the two rivers.

The hydropower development scheme for Ayeyawady River Basin above Myitkyina, recommended in this project are as follow:

Mayhka River: Yenam (1010m); Kawanglanghpu (875m); Pisa (665m);

Wutsok (525m); Chibwe (400m)

Malihka River: Lasa (370m)

Ayeyawady River: Myitsone (230m)

The total installed capacity of basin cascade development of Ayeyawady River above Myitkyina is 16500MW, with total power generation, 90.85 billion kW.h.

15. SERIES OF DAMS IN KACHIN STATE

Table 2. Reservoir Surface Area & Watershed area

No	Dams	Installed capacity (MW)	Reservoir area	Watershed area	Hectare/MW
1	Myitson	4100	64784 acres/ 26238 ha	11680 km^2	
2	Lasa	1900	60627 acres/ 24554 ha	15390 km^2	
3	Khaunglanghpu	2700	5948 acres/ 2409 ha	3455 km^2	
4	Yenam	1200	2265 acres/ 917 ha	5255 km^2	
5	Pisa	2000	1703 acres/ 690 ha	1950 km^2	
6	Wusok	1800	1229 acres/ 498 ha	1203 km^2	
7	Chibwe	2800	7935 acres/ 3214 ha	3796 km^2	
	Total	16500	144450 acres/ 58502 ha	42729 km^2	8.7 acres/MW i.e less than 3.5 ha/MW

Considering the reservoir surface area per MW, 3.5 ha/MW is acceptable in relation to international norm. However effective watershed management is essential. As immediate compensatory measures, systematic watershed management in Kachin State above Myitkyina and establishment of new Mayhka and Malihka national parks have been recommended above as prioritized actions to be taken.

Districts and Townships (flooded areas of dams)

1. **Myikyina District**
   a. Myikyina township
   b. Winemaw township
   c. Ingyanyan township
   d. Chibwe township
   e. Tsaw Law
2. **Putao District**
   a. Putao township
   b. Machanbaw township
   c. Sumprabum township
   d. Khaunglanhpu township
   e. Naungmon township

15.1. Myitsone hydropower project

15.1.1. General information

Flooded area and watershed area

The Myitsone Hydropower Dam project area is located between 25º40´ N, 97º 20´E and 26º50´ N, 98º 47´E and dam site is about 26/30 kilometres away from Myitkyina, Kachin State. The coverage annual rainfall at Myitsone (Tanphaye´village) is 100 inches and the annual flow of water into the dam is expected to be about 4540 m^3/s. The areas along on both sides of the Mayhka and Malihka Rivers will be inundated and some of the vital habitats of diverse wildlife species will be lost forever.

The largest plains are around the confluence and Sha-ngaw village. These flood plains are the places where villages like Tang Phe, Tianzup, Man Waing, Seinihku, Shangaw, Mantong, Hka War Yang, Ma Jang Yan, Nget Pyaw Daw villages etc are situated. Most of the population living in these villages are a mixture of Jingpaw, Lauwaw, Lacheik, Rawan and Lisu.

The area flooded will be 26238 hactare. That is, the reservoir area of Myitsone is 26238 hactare. This will include most of the area lower than 230 meters above sea level. The total watershed area of Myitsone is 11680 sq-km, covering the huge area of Mayhka and Malihka watersheds comprising intact forests.

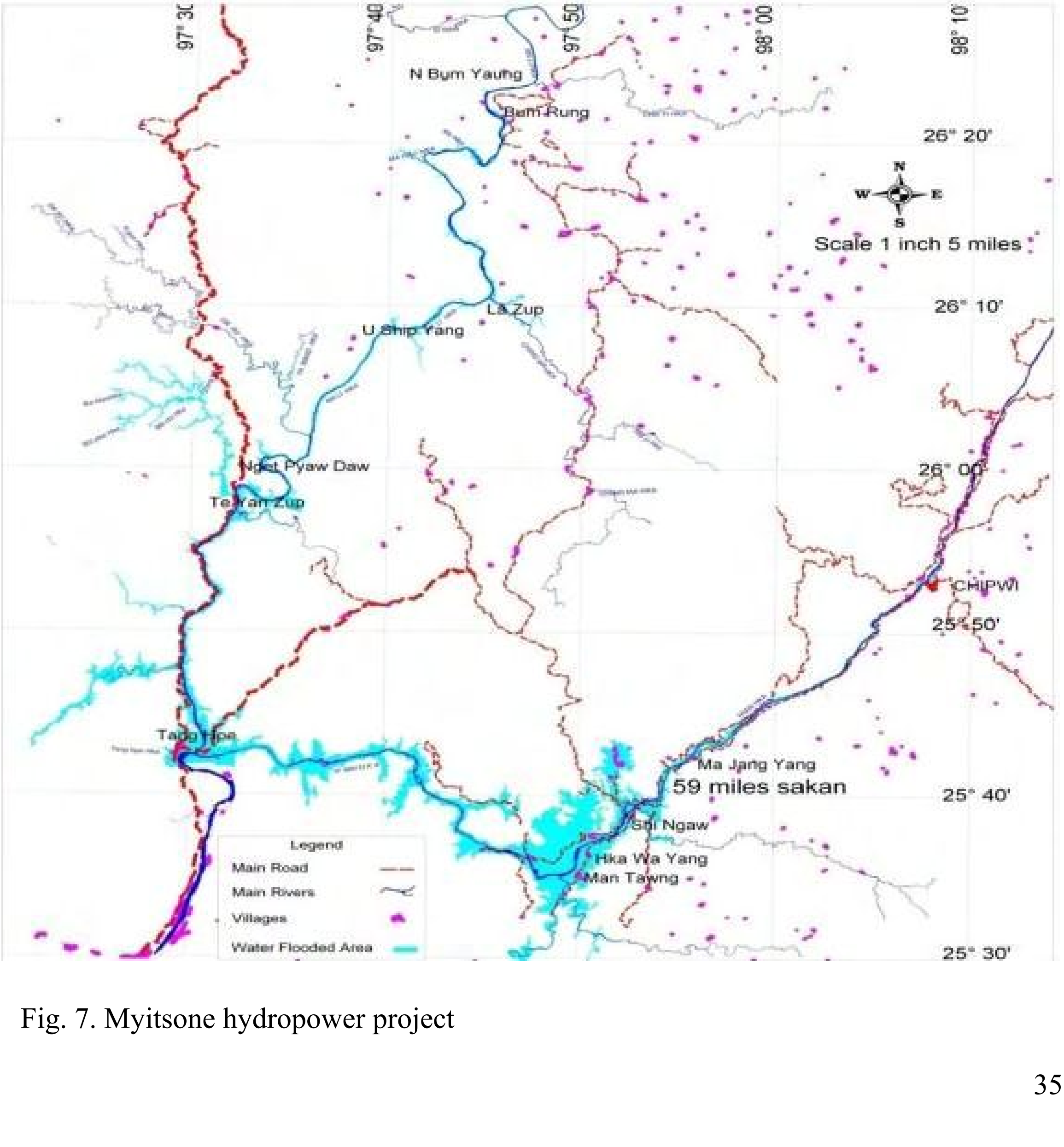

Fig. 7. Myitsone hydropower project

One section of road to Putao from Myitkyina i.e from Tang Pe to Tiangzup approximately 48 kilometres will be submerged. Similarly a section of Myikyina - Chibwe road about 64 kilometres will also be submerged.

The 59th mile bridge, Sha Ngaw Bridge on the way from Myikyina to Chibwe, Inzup Bridge, Tianzup Bridge and some small bridges on the road from Myitkyina to Putao will be flooded.

Thorough social impact assessment is essential here to clarify on negative social impacts.The 3,600 MW dam at the Myitsone, where the Malihka and Mayhka join to become the Ayeyaawady, according to one source, will inundate 47 villages, and enhance existing problems such as environmental and social impacts.

Acording to another source of reliable local information, if Myitsone Dam were built, 5,000 houses from 30 villages will be sunk and 8,000 people will become homeless. Additionally, 18,000 arable acres, forests and natural resources will be submerged. The dam will destroy the Mali-M'mai confluence, which is regarded as the Kachin cultural heartland.

5.1.2. Vegetation, habitats and endangered species

Most of the areas flooded are bamboo and secondary forest, shifting cultivation, waste land, orange orchards, grassland, heavily logged forests and gold mines. Some areas of primary forests are found in this flooded area. Good quality primary forests exist only above 500 meters above mean sea level.

From biodiversity point of view, the project area lies in WWF Eco-regions of Mizoram-Manipur-Kachin Moist Evergreen Forest. The whole Kachin state lies in three WWF Eco-regions namely, East Hamalayan Alpine Shrub/Meadow, Mizoram-Manipur-Kachin Moist Evergreen Forests, and Northern Triangle Temperate Forest. The Kachin State is also located within two priority corridor, namely Northern Mountain Forest Complex and Upper Chindwin Lowlands for conservation investment in Myanmar (Tordoff *et al*. 2005). This large conservation area in Kachin State is one of the biodiversity hotspots and is nationally important, regionally significant and globally outstanding. The project areas include low land evergreen forest, low land secondary forest, Oak forest, Bamboo forest and Banana forest.

According to the IUCN Red list (2000), the following plant species are recorded

1. *Aquilaria malacensis* Lam.,	VU
2. *Dipterocarpus turbinatus* Gaertn. f.	CR
3. *Holarrhena pubescens* Wall. ex G.Don	EX
4. *Shorea assamica* Dyer,	CR
5. *Caesalpinia sappan* L.	CR
6. *Dipterocarpus boudii* Koth.	CR
7. *Taiwania cryptomeriodes* Hyata	VU
8. *Caesapinia sappan* L.	LR/LC

9. *Elaeocarpus prunifolius* Wall. ex C. Muell. VU

According to the IUCN Red list (2009), the following fauna species are recorded;

1.	Chinese pangolin	*Manis pentadactyl*a	EN
2.	Bengal slow loris	*Nycticebus bengalensis*	VU
3.	Stump-tailed macaque	*Macaca arctoides*	VU
4.	Shortridge's langur	*Trachtpithecus shortridgei*	EN
5.	Eastern hoolock gibbon	*Hoolock leuconedys*	VU
6.	Dhole	*Cuon alpinus*	EN
7.	Asiatic black bear	*Urss thibetanus*	VU
8.	Sum bear	*Helarctos malayanus*	VU
9.	Clouted leopard	*Neofelis nebulosa*	VU
10.	Asian elephant	*Elephas maximus*	EN
11.	Gaur	*Bos gaurus*	VU
12.	Yunnan spiny frog	*Paa yunnanensis*	EN
13.	Keeled box turtle	*Pyxidea mouhotii*	EN
14.	Myanmar roofed turtle	*Kachuga trivittata*	EN
15.	Ruferous-necked Hornbill	*Aceros nipalensis*	VU

15.1.3. Navigation

Both rivers are navigable to a certain length. The Malihka river is navigable upto Maliyan village which is situated approximately 15 miles east of Sumprabum. Maliyan would be in the flooded area of Lasa dam. There are about a dozen rapids along the river way which indicates the requirement of strong and powerful engines to get through. But above Maliyan, the currents of the rapids become too strong and navigation by any type of boat is impossible and not advisable.

Navigation on Mayhka is also risky. There are about 10 rapids along the river from the Myitsone confluence to the confluence of Tong Pan Hka. Above that the current becomes too strong for navigation.

Name of flooded villages

According to our GIS map analysis, the following villages will be flooded.

Tang Hpe; Te Yan Zup; Naing Sein; Nget Pyaw Daw; Zup Ra Yang; Sa ni to yang; Kwin Htau; Tang Bauk Yang; The waing; N Bum Yaung; U Ship Yang; Bum Rung; La Zup; Hkam Be Yang; Bum Lai; N Dawng Yang; Daw Man Yang; Ma Jang Yang; Ka Pyi Kawng; Kh Wa Yang; Tum Pang; Ma Li Yang; Au Ra Yang; U Laung Yang; Man Tawng; Shi Ngaw; Brm Ba; N Sawp Zup; N Jip; Hkat Pwa Hmaw; Zai ro (Za ru).

Proper Social Impact Assessment and Economic Impact Assessment must be done to have a full EIA of the area.

15.1.4. Gold mines and adverse impacts

There are numerous gold mines along both rivers, severely impacting the river environment. But the mines on the Malihka are bigger in scale and are very destructive to the river. Tianzup village is the place where most mines are situated, resulting in, the colour of water in the Malihka changes from clear to extremely turbid reddish brown. These mining activities will certainly increase the sedimentation of Malihka river dramatically, shortening the life span of the dams. Many types of mining are observed, starting from small scale gold panning to hydraulic mining on the banks of the rivers.

A. Small scale digging and panning of gold

These are found everywhere in the Kachin State. The local people are using rudimentary tools and normally with few or no chemicals. Local people have been doing this practice since many generations ago. Earth or sand along the banks of rivers and streams are dug out and sieved on plastic netting. The residue on the sieve is then collected and panned by hand. This type of mining is least harmful to the natural surroundings.

Fig. 8. Small scale gold mining

B. Hydrawlic mining

Hydraulic mining is one of the most common types of mining. About 50% of the mines are of this type. The mines are situated on the banks of the rivers and streams. Chinese made 25 HP pumps with pipes attached to them are used for this type of mining. One set of mine has at least one set of pump and a pipe. Some people use more powerful engines like 100 or 200 HP Japanese engines with which they can host more powerfully and effectively.

On slopes along the river banks the earth is first blasted with water jet. Promising sites are selected by this way and once gold is traced the walls of the mines are hosed down with water. Rocks and wood which cannot be sucked by the pumps are removed by manual labour. The slime produced from the hosed banks is then sieved on fine plastic netting. By the end of the day, the sieved residue is panned and gold is separated using mercury. This type of mining operation is the most destructive to the environment. Sometimes river banks collapse, causing landslides and if the river is small the course of river channel changes. This type of mining produces large amount of hazardous mercury deposits.

Fig. 9. Hydraulic mining in Tianzup village

Fig. 10 Hydraulic mining in Shangaw village

C. Gold mining under water (suction dredging)

This type of mining is also common along both rivers but more on Malihka. This is for miners who want to move freely along the river in search of the most promising sites for gold. The engines are of same quality as described above but they are mounted on big boats or bamboo rafts. A suction dredge is directed by divers along the bottom of the river bed. Earth or sand is sucked up and sieved and the gold panned out as previously described above.

Fig. 11 Suction dredging on the Mayhka

D. Gold mining by bucket dredges

According to reliable local information, these are usually owned by Chinese companies. Dredges with powerful engines are mounted on big boats or rafts. They use two engine heads and iron buckets which rotate on chains. The bottom of the river is cupped or dredged up with the iron buckets and then sieved and panned. This method of mining operation ruins the river beds and cause the river banks to collapse, which is extremely destructive to the environment. This is quite common on the Malihka river but a few is also seen on Mayhka.

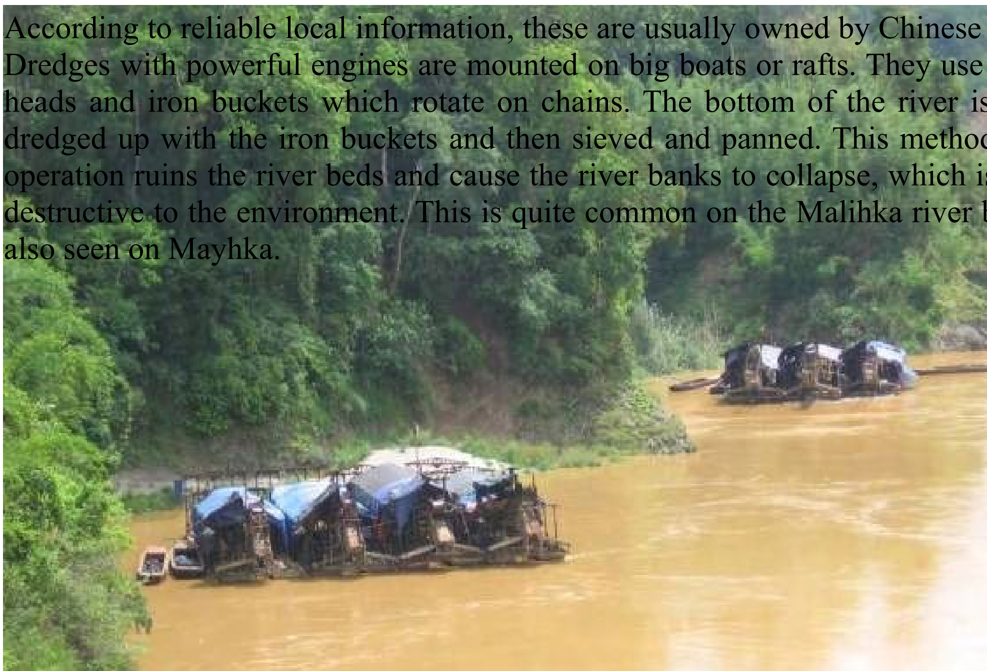

Fig. 12 Bucket dredges on the Malihka

Townships in the flooded area

1. Myitkyina
2. Ingyanyan
3. Chibwe
4. Sumprabum

15.1.5. Loss of cultural property

The confluence of Mayhka and Malihka river (called Myitsone in Myanmar) will be totally flooded on account of dam construction below the confluence. The Kachins take pride of possessing Myitsone on their land. They consider this confluence, their cultural heart land because it is the birth place of the mighty Ayeyawady River, the value of the latter knows no bound for the whole Myanmar people. Loss of Myitsone will be a terrible tragedy for all of Myanmar people especially the Kachins.

The majority people of local races oppose construction of the dams especially Myison hydropower project (S.Lashibauk pers comm.).They consider the Ayeyawady river confluence (Myitsone) as the cultural heartland of the Kachins. An alternative option should be seriously considered to avoid construction of Myitsone Dam at the confluence. The best option would be with experts' technical advice, to develop two smaller hydropower dams substituting Myitsone Dam location, at appropriate two locations above the confluence of Malihka and Mayhka rivers. Selecting and identifying two dam sites, above the confluence, one on the Mayhka River and another on the Malihka River shall avoid disappearance of the culturally very important site. Conducting social impact assessment is essential and the public should be disclosed about the hydropower dams and resettlement programs by having public meetings.

The dam site is located less than 100 kilometers from Myanmar's earthquake-prone Sagaing fault line. The highly sensitive Sagaing fault line runs north-south through Myanmar (Burma). Earthquakes have been experienced at places along the fault line. Dam breakage would be disastrous for Myitkyina, the capital city of Kachin State, which lies only 40 kilometers downstream. Formally and informally the people of Kachin State had already demanded the cessation of all dam activities in Kachin State. For the longevity of dams to be constructed in Kachin State, the opinion of the grassroots people should be brought into due consideration.

If Myanmar and Chinese sides were really concerned about environmental issues and aimed at sustainable development of the country, there is no need for such a big dam to be constructed at the confluence of Ayeyawady River. Instead two smaller dams could be built above Myitsone to produce nearly the same amount of electricity. Hence respecting the Kachin cultural values which surpass any amount of the overall construction costs.

15.2. Lasa hydropower project

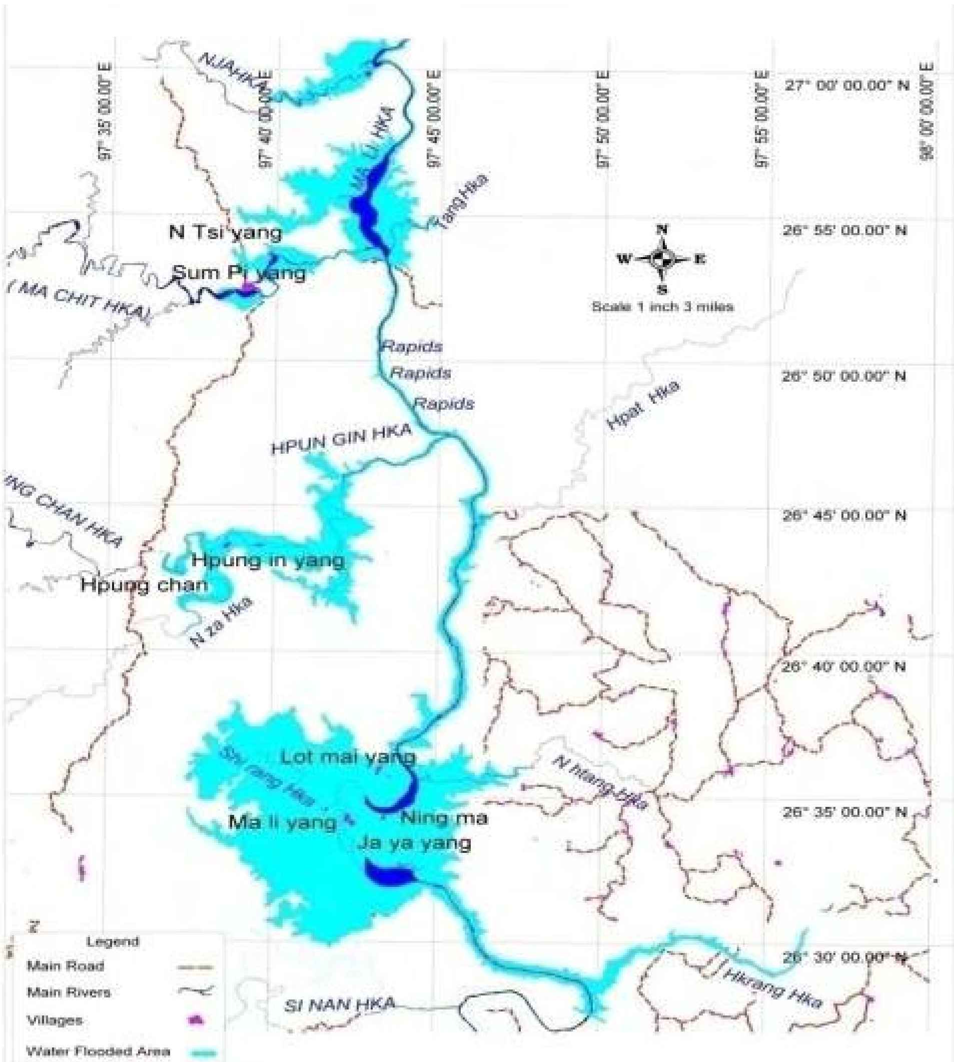

Fig. 13 Lasa hydropower project

15.2.1. General information

The Lasa Hydropower Dam project area is located at 26º28´N and 97º 49´ E, in Sumprabum Township and 144.2 km distance to the confluence at Myitsone (The junction of Malihka and Mayhka). The flooded area of Lasa dam is 24554 hactare. The total watershed area of Lasa is 15390 sq-km. Geographically, most of the area is the flood plain of Malihka river. After construction of the dam there will be four pools in the reservoir area. The biggest pool will be in a place around Maliyan village which is situated east of Sumprabum town. The locals used to call that place Pinle, meaning 'sea' in Myanmar language. That place is known to be like a sea when there are floods.

The biggest villages inundated will be Sumpiyan village which has over 200 households and a population of approximately 1200. Most of them are Jingphaw. There are about 40 hectares of paddy fields which provide rice to Sumpiyan village and its surroundings. Those will also be flooded. Also flooded will be Phon- in and Nansiyan villages, each having less than 20 household.

Majority of ethnic tribes living in the flooded area is Jingphaw. Before the state government made a peace deal with the KIA, Sumprabum used to be the strong hold of KIA. At that time the majority of Jingphaw in the Kachin state lived in Sumprabum.

The name “Sumpra” means a species of long grass good for feeding horses and bum means a mountain. Therefore Sumprabum means a mountain where a species of long grass for feeding horse grows.

15.2.2. Vegetation, habitats and endangered species

In that area much of the land is covered with bamboos, grass lands, cultivated lands, paddy fields of Sumprabum Township, scrub forests and at the edges some disturbed primary forests. Most of the primary forests in this area have been previously logged on account of easy accessibility. Big patches of genuine primary forest are rarely found in the flooded area.

In 1977 there was an outburst of rats in Sumprabum. This was on account of gregarious bamboo flowering in the area. It was believed that the bamboo seeds contained a hormone which encouraged sexual activity in the rats resulting in outburst of rat population. All the crops in Sumprabum were destroyed and the town became unsuitable for human habitation. Starting from that time the majority of the Jingphaws migrated to Myitkyina.

From biodiversity point of view, the Lasa Dam area lies within WWF Eco-regions of Mizoram-Manipur-Kachin Moist Eevergreen Forest and Northern Triangle Subtropical Forest-Myanmar. The catchment area of Chibwe Dam area is located in and between Hukaung Valley W.S and its extension and Bumphabum W.S. So the area as a whole is the biodiversity hotspot and outstanding area of conservation. The forest types are oak forest, lowland evergreen forest, highland evergreen forest and bamboo forest.

According to the IUCN Red list (2000), the following endangered plant species are recorded;

1.	*Aquilaria malacensis* Lam.	VU
2.	*Dipterocarpus turbinatus* Gaertn. f.	CR
3.	*Shorea assamia* Dyer	CR

According to the IUCN Red list (2009), the following fauna species are recorded;

1.	Chinese pangolin	*Manis pentadactyl*a	EN

2. Bengal slow loris	*Nycticebus bengalensis*	VU
3. Stump-tailed macaque	*Macaca arctoides*	VU
4. Shortridge's langur	*Trachtpithecus shortridgei*	EN
5. Eastern hoolock gibbon	*Hoolock leuconedys*	VU
6. Dhole	*Cuon alpinus*	EN
7. Asiatic black bear	*Urss thibetanus*	VU
8. Sum bear	*Helarctos malayanus*	VU
9. Clouted leopard	*Neofelis nebulosa*	VU
10. Asian elephant	*Elephas maximus*	EN
11. Gaur	*Bos gaurus*	VU
12. Yunnan spiny frog	*Paa yunnanensis*	EN
13. Keeled box turtle	*Pyxidea mouhotii*	EN
14. Giant Asian pond turtle	*Heosemys grandis*	VU
15. White-bellied Heron	*Ardea insignis*	CR
16. Ruferous-necked Hornbill	*Aceros nipalensis*	VU
17. Pallas's Fish Eagle	*Haliaeetrs leucoryphus*	VU

15.2.3. Gold mining and adverse impacts

Maliyan village used to be a major gold mining area during the last 15 years. Now less yield of gold and fewer discoveries of new mining sites elsewhere have made this place less occupied by miners. But the environment already damaged due to previous mines are quite evidenced everywhere.

Fig. 14. Gold mining: Water pollution caused by gold mining.

15.2.4. Navigation

From Myitkyina, Malihka is navigable till a few miles above Mayliyan village. After that the current in the rapids becomes very strong and the section of the river narrows down, making it impossible to navigate. Townships in the flooded area are Putao, Machanbaw and Ingyanyan.

The reservoir surface area of Lasa is 24554 hectare.

Name of flooded villages

According to our GIS map analysis, the following villages will be flooded.

N lwe yang; Yu sa ti; Sum pi yang; Hpa kan yang; Hpung in yang; Khin du yang; Ma li yang; Ja ya yang; Ning ma; N frung tu; Lot mai yang.

Proper Social Impact Assessment and Economic Impact Assessment must be done to have a full EIA of the area.

15.3. Chibwe hydropower project

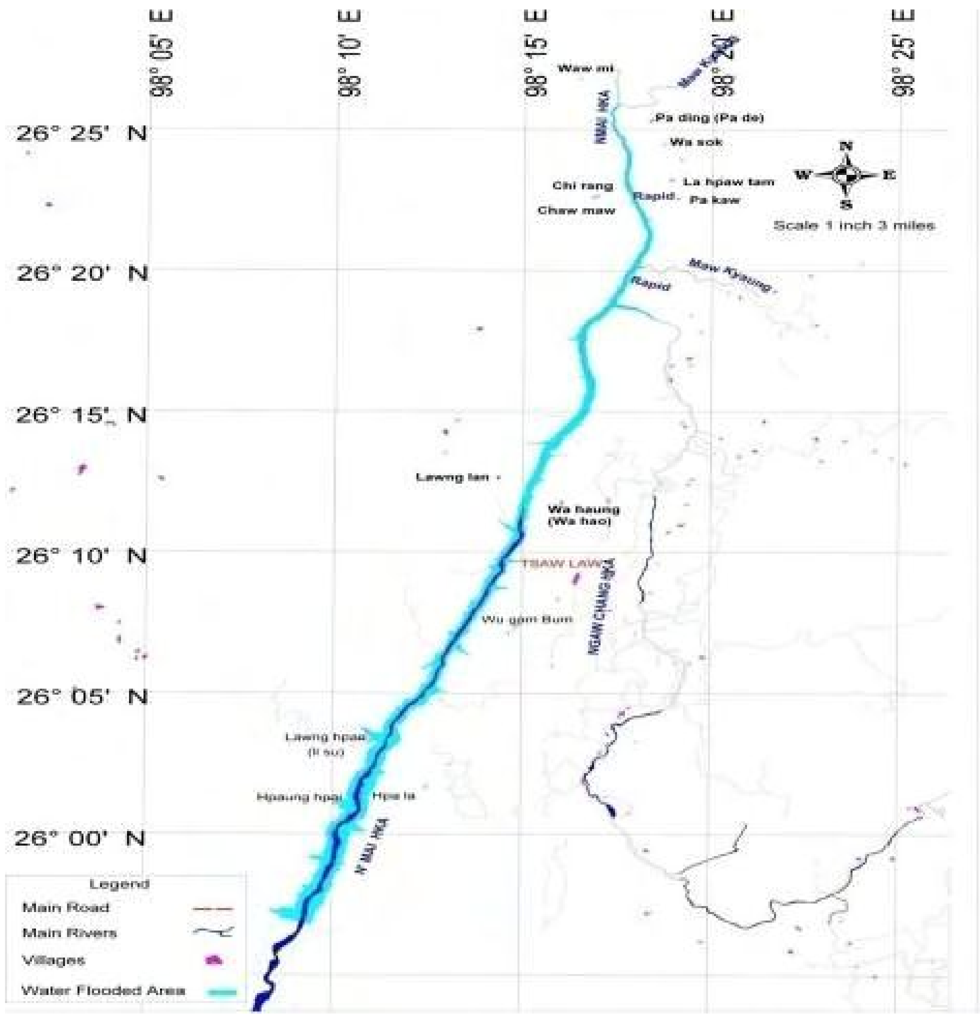

Fig. 15. Chibwe hydropower project

15.3.1. General information

The Chibwe Hydropower Dam project area is located on the downstream next to the Wusok Dam on the same river, Mayhka. It lies between 25º58´N and 98º 09´ E and reaches about 20 kilometres upstream from the confluence of Mayhka River and Chibwe Stream near Mandon Village, in Chibwe Township. The flooded or the reservoir surface area will be 7935 acres. The total watershed area of Chibwe Dam is 3796 sq-km. An adit has been observed to build small Chebwe dam to generate essential electricity for forthcoming construction of Myitsone and Chebwe dams.

There are no flood plains in the reservoir area. The flooded area is situated in the deep gorges between two mountain ranges where the Mayhka river flows. Townships in the flooded area are Chibwe, Tsaw Law and Ingyanyan. Some villages like Kaunghla, Phala, Manton which have less than 15 households are situated in the reservoir area and thus will be inundated. Majority of ethnic tribes living there are Lauwaw and Lacheik.

15.3.2. Chibwe Township & Tsaw Law Township

Chibwe Nge Dam or Small Chebwe Dam near Chebwe is being built to supply power during construction period of dams in Kachin State. Population of Chibwe township is 17100 according to 2007 – 2008 figures by immigration department. Main economy is cultivation and collection of NTFPs. Major crops are paddy (both taungya and rain dependent) edible oil crops mainly mustard and sesame. Regarding with the agro-biodiversity, the rudimentary type of wild rice and their ancestors such as *Oirza officinales. O.rafipogon,* and *O.granulata* thrive very well at Chibwe, Tamu and Ngaw Chary Hku river valley. A trace of these progenitor rice varieties indicated that wild rice is indigenous to N.E Kachin and considered to be the original locations for world rice cultivation. In Ngaw Chan Hka river valley, about 100 varieties of wild rice ancestor based local land races have still been cultivated (Kalaya Lu 2006) and the following ave been observed during this study;

1. *Oryza indicum* L. Cultivar Kauk – Nyin -Ni
2. *Oryza indicum* L. Cultivar Kauk – Kyan
3. *Oryza indicum* L. Cultivar Kauk – Nyin-Phyu
4. *Oryza indicum* L. Cultivar Kauk – Daung – Tit
5. *Oryza indicum* L. Cultivar Kauk – Nyin – Phyu
6. *Oryza indicum* L. Cultivar Khaw – Nar
7. *Oryza japonica* L. Cultivar Sat – Gar
8. *Oryza japonica* L. Cultivar Net – Paw - Kauk
9. *Oryza japonica* L. Cultivar Ja – Time
10. *Oryza japonica* L. Cultivar Kauk – Sar

The above native rice species and varieties were collected and identified and sample seeds were also kept in the herbarium.

Fig. 16. Charcoal bags in truckload in Chibwe Township

Fig. 17. A truckload of rattan in Chibwe Township

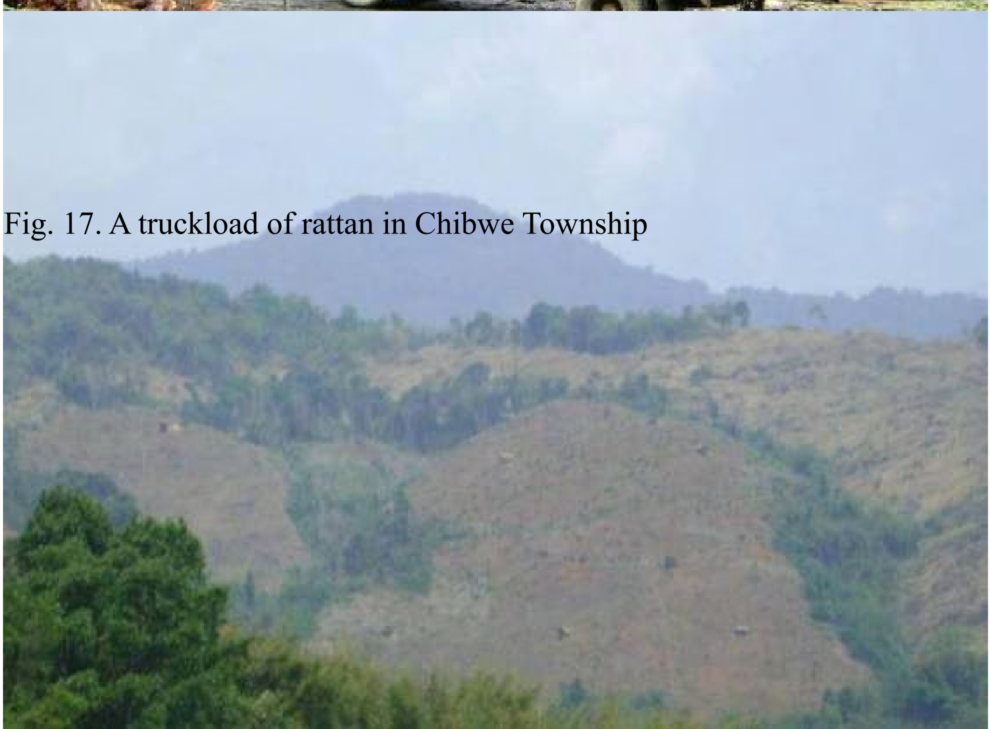

Fig. 18 . Shifting cultivation in Chibwe Township

A metal purifying industry is located inside China boundary between N 26' 06' 107" and E098'34'798". It is on the east bank of Ngaw-Chan-Kha river inside China boundary which is above upstream of Gur-lan Village inside Myanmar boundary. The water in upstream of Ngaw-Chan-Kha river above the metal purifying industry was clean and greenish blue in color. But the water in downstream become red and dirty due to the chemical waste disposal of metal purifying industry into the Ngaw-Chan-Kha river. (see photographs). During past 3 years due to chemical waste disposal from metal purifying industry, water in Ngw-Chan-Kha river, from Gar-lan village to the place where it drains into Mayhka river, about 113 kilometres, become red and polluted. Photographs will show the conspicuous difference between the clear water from the springs on both sides of the river flows into the red and dirty water of Ngaw-Chan-Kha and then red and dirty water of Ngaw-Chan-Kha flows into the clean water of Mayhka river. Photographs also shows the residues of waste products which deposit on the bank of the river when the water level in the river drops off. Tarong Wang and Ngaw-Chan-Kha are two transboundary rivers. Through negotiations, pollution control should be done at the downstream of the transboundary rivers between Yunan and Kachin State.

15.3.3. Vegetation, habitats and endangered species

Because vegetation in this area have to grow on steep slopes of more than 45 degrees it is impossible to find large areas of primary forest. Some patches less than 20 hectares of poor quality primary forests have been found on some slopes. Most of the forests in accessible areas are severely degraded due to prolong exploitation by both Myanmar and Chinese sides. But most of the vegetation in the reservoir area comprises shifting cultivations, secondary vegetation, a few river bank gardens and bamboo forests. No paddy fields are found here.

The project area lies in WWF Eco-regions of Mizoram-Manipur-Kachin Moist Evergreen Forest. The catchment area of Chibwe Dam includes Bumphabum W.S and Emawbum Mountain forest and is one of the outstanding hotspot areas for conservation. The forest types are highland evergreen forests, lowland evergreen forests, oak forests, bamboo forests, degraded forests, and low-land secondary forests.

According to the IUCN Res list (2003), the following plant species are recorded;

1. *Cephalotaxus griffithii* Hook. f. LR
2. *Taiwania cryptomeriodes* Hayata VU

According to the IUCN Red list (2009), the following fauna species are recorded:

1. Chinese pangolin *Manis pentadactyl*a EN

2. Bengal slow loris	*Nycticebus bengalensis*	VU
3. Stamp-tailed macaque	*Macaca arctoides*	VU
4. Eastern hoolock gibbon	*Hoolock leuconedys*	VU
5. Asiatic black bear	*Urss thibetanus*	VU
6. Red panda	*Ailurus fulgens*	VU
7. Marbled cat	*Pardofelis marmorata*	VU
8. Gaur	*Bos gaurus*	VU
9. Ruferous-necked Hornbill	*Aceros nipalensis*	VU
10. Beautiful Nuthatch	*Sitta formusa*	VU

15.3.4. Navigation

Because of strong currents navigation is totally impossible in this section of Mayhka river.

Ecotourism potential with canoeing activities may be possible with the help of experts' advice.

Name of flooded villages

According to our GIS map analysis, the following villages will be flooded.

Hpala; Wang rong; Sum pi yang.

Proper Social Impact Assessment and Economic Impact Assessment must be done to have a full EIA of the area.

15.4. Yenam Hydropower project

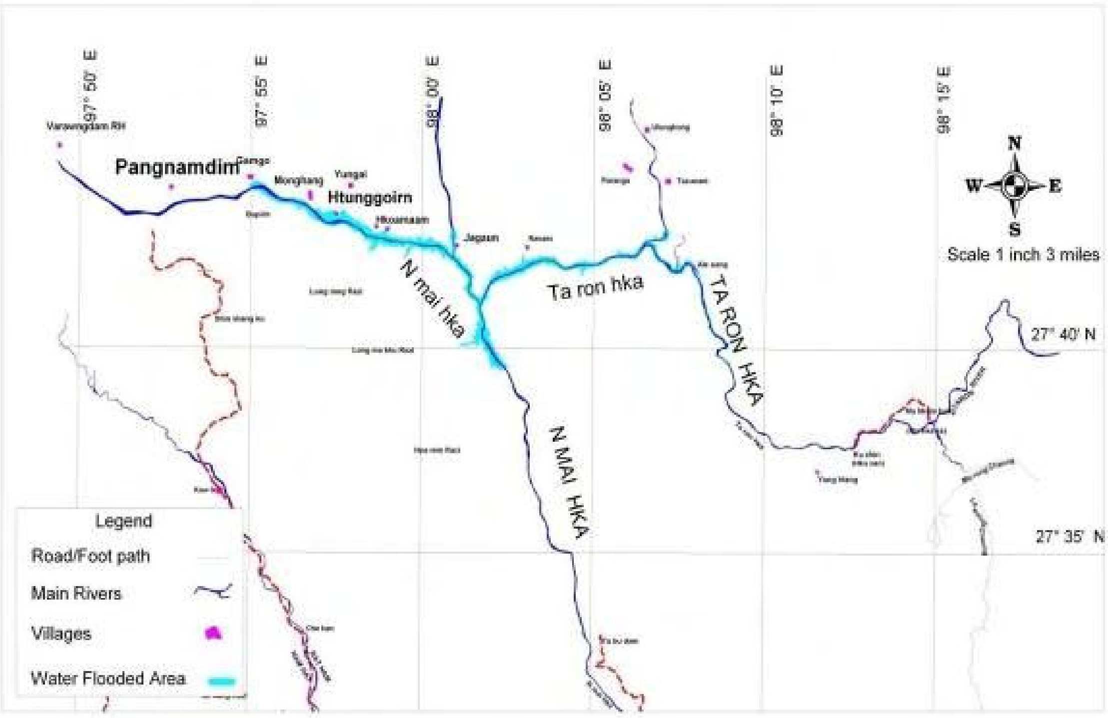

Fig.19 Yenam Hydropower project

15.4.1. General information

The Yenam Hydropower Dam project area is located between 27º40´20"N, 97º 01´36"E and 27º48´18"N, 98º 98´97"E near Aliaung Village, in Panandim Township, on downstream confluence mouth of Mayhka River and Tarone Stream. Among five hydropower stations on Mayhka River, Yenam Hydropower Dam site is on the upstream of Mayhka River and may be the first one on Mayhka River. The flooded area or reservoir surface area of Yenam dam will be 917 hectare. The total watershed area of Yenam is 5255 km^2.

The only village which will be flooded is Aliaung village. Recently gazetted Pannandim town is located above the full tank level and is spared from flooding. Ethnic tribes living there are Rawan, Lisu and Taron, which is also known as pygmies of northern Myanmar. The main administrative area in this area is Pannandim. It has been recently promoted to sub-township status from a village tract status. The population of Pannandim is 1670 according to 2008 immigration department figure. The main economy is Taungya cultivation. Major crops there are Taungya paddy, corn, maize and mustard. The reservoir area totally lies in Naungmon Township.

There is no primary forest in the flooded area. Storage water of the dam will be in deep gorges of the Namtamai valley and Taron river. Shifting cultivation, secondary vegetation, bamboo forest and river bank gardens will be the areas flooded.

15.4.2. Vegetation, habitats and endangered species

The northern boundary of the flooded area of this dam is also the southern boundary of Hkakaborazi National park. The flooded area does not have a huge impact on the national park because there are only very steep edges of the park with almost no primary vegetation. Forest types there are of evergreen, semi-evergreen in nature and are usually seen on higher elevations.

The Yenam Dam site lies in WWF Eco-region of Northern Triangle Temperate Forest. It is also located within the range of priority sites for conservation investment of Northern Mountain Forest Complex (BI 2995). Its catchment area also comprises Hkakaborazi N.P and Hponganrazi W.S. which are the biodiversity hot-spots and globally outstanding conservation areas. The forests in this area include high land evergreen forest and oak forest. Some degraded forests due to shifting cultivation are also found.

Fig. 20. Shifting cultivation

According to the IUCN Red list (2000), the following fauna species are recorded:

1. Chinese pangolin	*Manis pentadactyl*a	EN
2. Stump-tailed macaque	*Macaca arctoides*	VU
3. Eastern hoolock gibbon	*Hoolock leuconedys*	VU
4. Dhole	*Cuon alpinus*	EN
5. Asiatic black bear	*Urss thibetanus*	VU
6. Sum bear	*Helarctos malayanus*	VU
7. Red panda	*Ailurus fulgens*	VU
8. Marbled cat	*Pardofelis marmorata*	VU
9. Clouted leopard	*Neofelis nebulosa*	VU
10. Black muntjac(?)	*Muntiacus crinifrons(?)*	VU
11. Takin	*Budorcas taxicolor*	VU
12. Red goral	*Naemorhedus baileyi*	VU
13. Ruferous-necked Hornbill	*Aceros nipalensis*	VU
14. Beautiful Nuthatch	*Sitta formusa*	VU

15.4.3. Navigation

Navigation is impossible in these rivers because the rivers flow through deep gorges with rocky outcrops and the current is extremely strong. Ecotourism potential including canoeing activities may be possible with the help of experts' advice.

Name of flooded villages

According to our GIS map analysis, the following villages will be flooded.

Ale aung; Mung dong; Htunggoirn; Gamgo.

Proper Social Impact Assessment and Economic Impact Assessment must be done to have a full EIA of the area.

15.5. Khaunglanghpu hydropower project

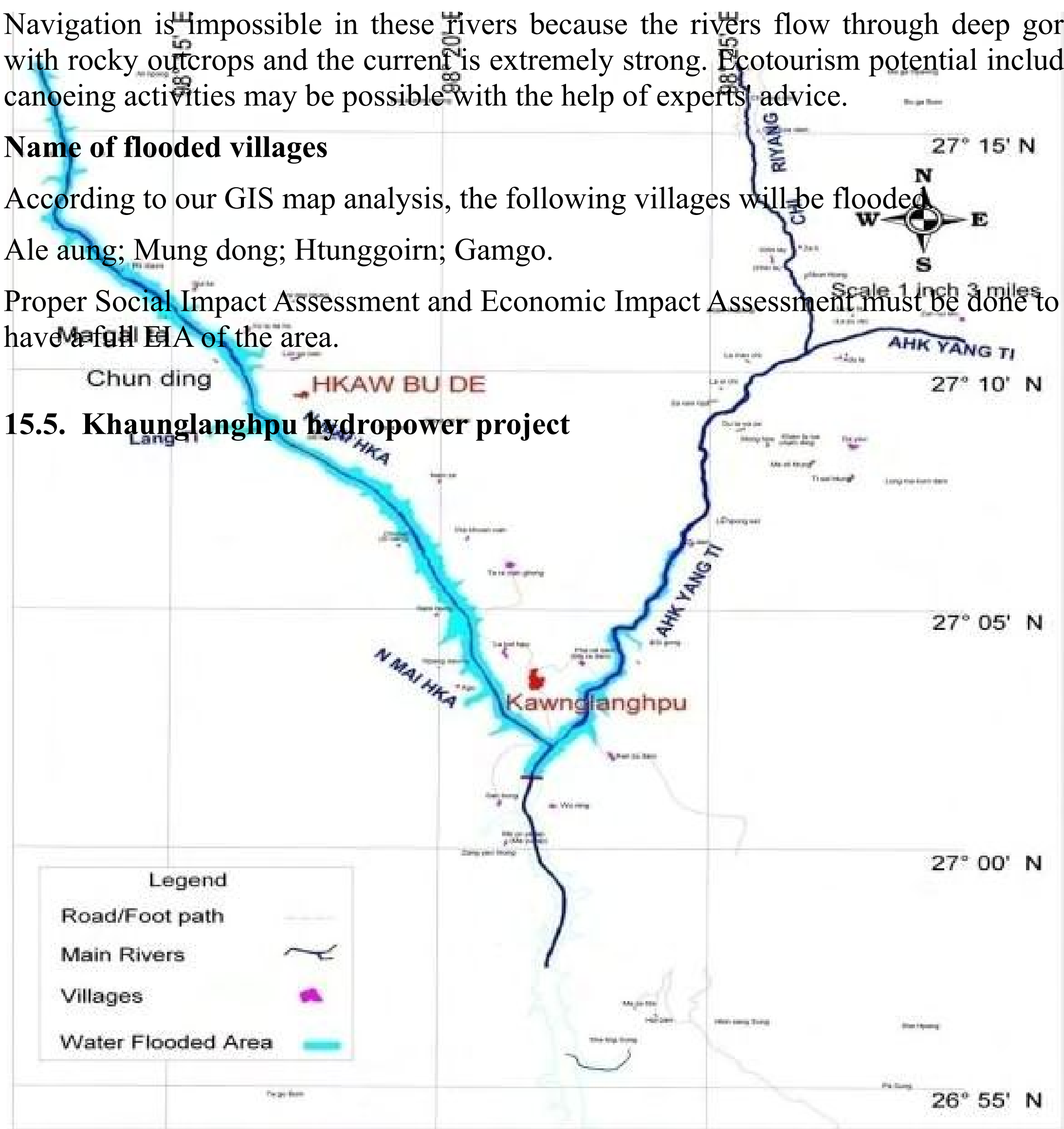

Fig. 21. Khaunglanghpu hydropower project

15.5.1. General information

The Khaunglanphu Hydropower Dam project site is located between 26º30´N, 98º 00´E and 27º30´N, 98º 40´E near Sangn hkun Hkyet village, in Khaunglanphu Township, on downstream confluence mouth of Mayhka River and Achanhti Stream. The dam site lies between high mountains and gorges. The elevation of Emawbum Mountain which comprises in the catchment area is 3100 m high.

The reservoir surface area of Kaunglanghpu dam is 5948 acres. The total watershed area of Kaunglanghpu is 3455 sq-km.

There are no primary forests in the reservoir area. Primary forests are only seen at high elevations. The flooded area lies totally in Khaunlanhpu Township. Ridam village and Ridam suspension bridge will be inundated. This should be compensated by all means. Local tribe living in Ridim are Rawans. Khaunglanhpu town is located at over 1462 metre and is free from flood. Ethnic tribes living in Khaunglanhpu are Rawan and Lisu. Because it is an administrative town, some Bamar national government staff also reside there. Population according to 2009 March census by immigration department is 19106.

Economy of Khaunlanhpu is mainly Taungya (shifting cultivation). Main crops are Taungya paddy, edible oil producing crops (mustard, sesame and groundnut) and corn. The main source of protein for the people is bush meat. But the hunters only hunt for daily subsistence and wildlife trading is rarely seen.

Fig. 22. Critically endangered species, *Schizothorax grahami* (Regan), recorded in Kaunglanghpu Dam area.

15.5.2. Vegetation, habitats and endangered species

Primary forests are only seen at high elevations. Forest types there are of evergreen, semi-evergreen in nature and are usually seen on higher elevations.

The Khaunglanphu Hydropower Dam area lies in WWF Eco-region of Northern Triangle Temperate forest. It is also located within the priority site for conservation investment of Northern Mountain Forest Complex (BI 2005).

The Hkakaborizi NP, Hponganrazi W.S and Emawbum mountain forest lie in its catchment area. So the area is biodiversity hot-spot area and globally outstanding for conservation. The forest types are high land evergreen forest lowland evergreen forest and oak forest.

The critically endangered freshwater fish species, *Schizothorax grahami* (Regan) has been recorded in Kaunglanghpu Dam area during this study. According to IUCN Red list (2000) the following floral species is recorded:

1. *Taiwania cryptomerioides* Hayata.	VU

According to the IUCN Red list (2009), the following fauna species are recorded:

1. Bengal slow loris	*Nycticebus bengalensis*	VU
2. Stump-tailed macaque	*Macaca arctoides*	VU
3. Dhole	*Cuon alpinus*	EN
4. Asiatic black bear	*Urss thibetanus*	VU
5. Takin	*Budorcas taxicolor*	VU
6. Xizhang warty treegrog	*Theloderma moloch*	VU
7. Blyth's Tragopan	*Tragopan boythii*	VU
8. Ruferous-necked Hornbill	*Aceros nipalenisis*	VU
9. Beautiful Nuthatch	*Sitta formusa*	VU
10. Snowy-throated Babbler	*Strachysis oglei*	VU
11. Kunming Snout Trout	*Schizothorax grahami*	CR

15.5.3. Navigation

This area is impossible to navigate. Flooded area is in deep gorge with swift current and big rocky outcrops. However ecotourism potential including canoeing activities may be possible with the help of experts' advice.

Name of flooded villages

According to our GIS map analysis, the following villages will be flooded:

Ri dam; Ma ga ta.

Proper Social Impact Assessment and Economic Impact Assessment must be done to have a full EIA of the area.

15.6. Wusok and Pisa hydropower projects

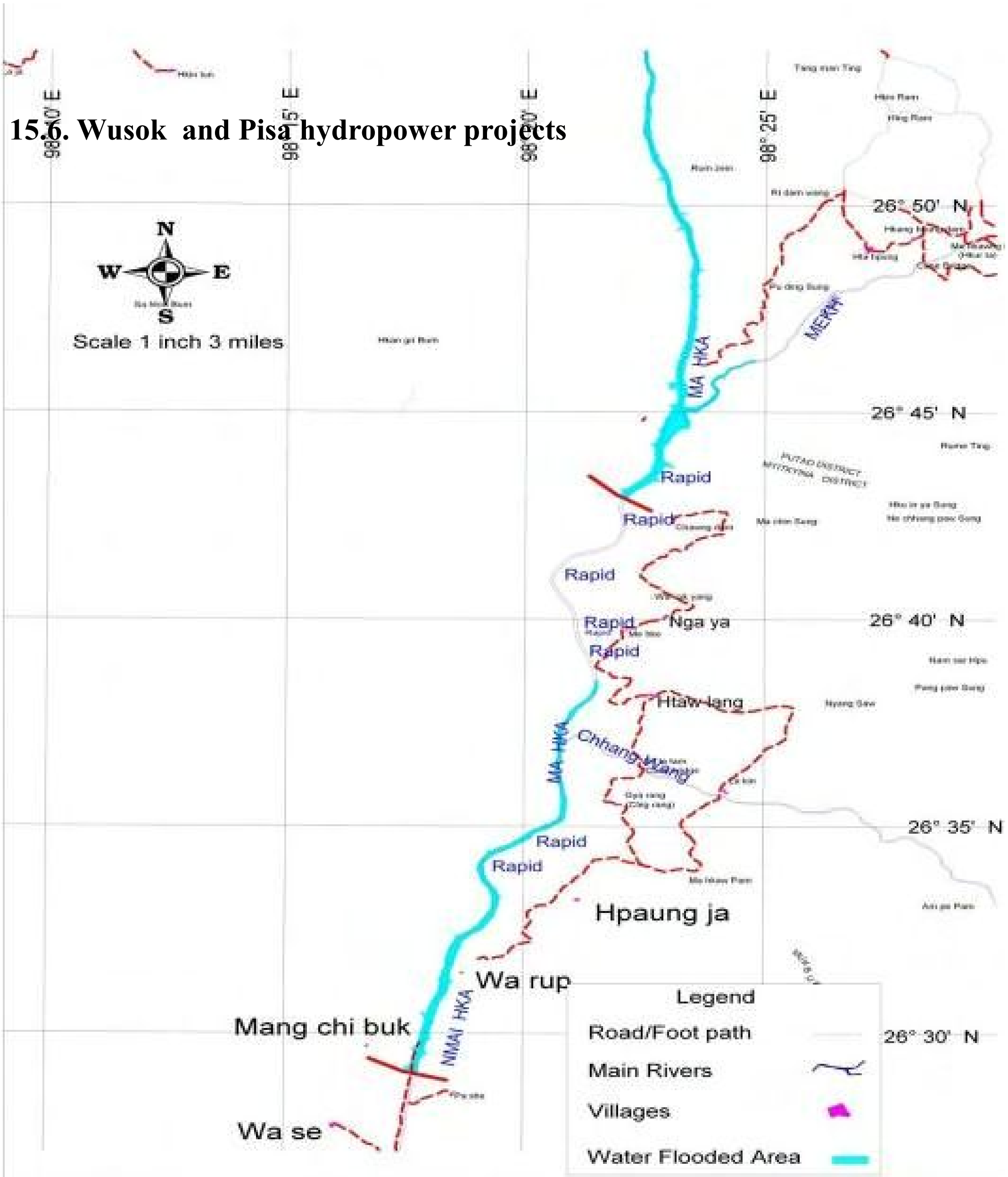

Fig. 23. Wusok and Pisa hydropower projects

15.6.1. General information

Both dams are situated in Tsawlaw Township. The Pisa Hydropower Dam project area is located on the stream next to the Wusok dam, lying between 26º44´N and 98º 22´E in Tsawlaw Township and about one kilometre downstream from the confluence of Mayhka River and Mekharame stream near one rapid of Mayhka River. The Wusok Dam lies between 26º31´N and 98º 18´E and about 34.5km distance from Pisa Dam. The total watershed area of Pisa and Wusok is 3153 km^2. The reservoir surface area of Pisa and Wusok is 1188 hectares.

Accessibility is extremely difficult to both dams. The only way to get there is on foot. The road from Myitkyina to Tsawlaw is motorable only in open or dry season. The very strong and tough 4 wheel drive vehicles are needed to reach Kyihtam village from Tsawlaw. The only mean from Kyihtam onwards to reach Wusok dam site is through walking only and may take 3 days. And from Wusok it takes 7 days to reach Pisa dam site.

There are no villages in the flooded area. The major ethnic tribe living there is Lauwaw. Lacheik are minorities in that area. Local communities rely on shifting cultivation to get their main source of carbohydrates. The main crop is Taungya paddy. Oil producing sesame, peanuts, corn, maize, and occasionally pluses and beans are grown in their slash and burn areas. Some of them earn their living by small scale wildlife trading with neighbouring China.

15.6.2. Vegetation, habitats and endangered species

Vegetation in the flooded area is mostly primary and undisturbed forests. As trees are growing on steep rocky slopes, the primary forests with stunted growth are found. Good quality undisturbed primary forests are only found on higher elevations.

The Pisa and Wusok Dams areas lie in two WWF Eco-regions of Northern Triangle Temperate Forest and Mizoram-Manipur-Kachin Moist Evergreen Forest. It is also located near the priority site for conservation investment of Northern Mountain Forest Complex. So the areas are the biodiversity hot-spot areas and globally outstanding for conservation. The forest types are highland evergreen forests, low land evergreen forests, oak forests, secondary degraded forests and bamboo forests.

According to the IUCN Red list (2009), the following fauna species are recorded;

1.	Stump-tailed macaque	*Macaca arctoides*	VU
2.	Shortridge's langur	*Trachtpithecus shortridgei*	EN
3.	Eastern hoolock gibbon	*Hoolock leuconedys*	VU
4.	Asiatic black bear	*Urss thibetanus*	VU
5.	Sum bear	*Helarctos malayanus*	VU
6.	Marbled cat	*Pardofelis marmorata*	VU
7.	Takin	*Budorcas taxicolor*	VU
8.	Red panda	*Ailurus fulgens*	VU
9.	Fishing cat	*Prionailurus viverrinus*	EN
10.	Ruferous-necked Hornbill	*Aceros nipalensis*	VU
11.	Wood snipe	*Gallinagp nemoricola*	VU
12.	Beautiful Nuthatch	*Sitta Formosa*	VU

15.6.3. Navigation

Navigation in the river is impossible because of narrow sections with swift current and rocky outcrops. However ecotourism potential including canoeing activities may be possible with the help of experts' advice.

Fig. 24. Water pollution of Ngawchang Hka

Fig. 25. Illegal logging in Wusok area

16. RECOMMENDATIONS AND MITIGATING MEASURES

16. 1. Recommendations and Mitigating Measures (Policy Perspective)

Convince the decision makers of Myanmar to approve the drafted environmental law so that EIA practice becomes mandatory, prior major development programs, such as hydropower projects.

Develop hydropower resources in an economically viable and environmentally sound manner to support sustainable development efforts.

Apply high EIA standards. This should be done with long lead times, competent staff, open process, independent review and follow-up. As screening determines whether or not an individual project proposal requires a full-scale EIA and what the level of assessment should be, this current study (BIA) should be regarded as Preliminary EIA. More detail assessments and evaluations including social component should follow.

1. Conduct social impact assessments on small and large villages on account of constructions of dams in Kachin State.

2. As EIA is not mandatory in Myanmar, both parties must follow PRC (2003) Law on Appraising of Environment Impacts.

3. In addition to assessing both negative and positive aspects, scoping of EIA should aim at landscape scale level approach and river basin approach down to mouth of Ayeyawady River.

4. Follow Myanmar National Sustainable Development Strategy and Myanmar Biodiversity Strategy and Action Plan.

5. Enforce the 2006 Conservation of Water Resources and Rivers Law.

6. Follow suggestions towards dam construction extracted from working papers for WCD (App. 1)

7. Before decision making, decision makers must study both negative and positive aspects of dams (App. 2).

8. Before approval of dam construction, decision makers, investors and construction engineers must study the differences between bad and good dams and environmental threatening and environmental friendly dams (App. 3).

9. A fraction of hydropower revenues is to be used to improve conditions of affected people around the reservoir (WCD).

10. Abide by the obligations of international conventions such as CBD, CITES, etc.

11. Enforce the wildlife law effectively and if necessary, revise it to be in compliance with CITES regulations.

12. Monitor the illegal trade of forest and wildlife products regularly by government authorities, NGOs and detect changing trends and dynamics in trade.and work closely in partnership with China.

13. Salvage or protection of cultural sites and properties.

14. Regarding Ngaw-Chan-Hka river pollution and to resolve this issue, there should be trans-boundary negotiations between China and Myanmar sides.

15. Create a financial mechanism to cover environmental costs during the project operation phase, that is, to pay for environmental management program implementation.

16. Consider to ban logging in Kachin State above Myitkyina.

17. Enhance partnership among the government, private sectors, and environmental NGOs to participate in environmental protection and sustainable resource management.

18. Resolve the complicated resource governance in Kachin State so that all the different parties or local authorities abide by the existing resource management laws of the country.

16.2. Recommendations and Mitigating Measures (Environmental Perspective)

1. Avoid areas of high biodiversity and hotspots.
2. Minimise species extinction.
3. Arrest continued loss of biodiversity.
4. Conserve essential ecological processes. Apply the precautionary principle when there is a threat of significant reduction or loss of biological diversity.
5. Resolve taxonomic and ecological information inadequacies that hamper conservation.
6. Guard unique species habitats in certain watersheds.
7. Give high priority to recovery of degraded ecosystems.
8. Avoid impacts on areas of high productivity of biological and economic importance.
9. Avoid areas of high biodiversity hotspots and species at risk should be brought into consideration during infrastructure development.
10. Avoid blocking short and long distance migrations.
11. Maintain the natural seasonal pattern of flow which is vital in life history stages such as migration, spawning and feeding.
12. Avoid blocking migratory fish species to avoid from extinction of genetically distinct stocks.
13. Do research and install devices for migrating species.
14. Integrate fish passages into dam design from the start.
15. Maintenance of at least minimum flow for fisheries.
16. Provision of fish ladders and other means of passage.
17. Protection of spawning grounds.
18. Should have fish ladders and fish passage accessories for migratory fishes.
19. Should have fish hatcheries for native fishes. in the suitable areas for restocking economically important indigenous fish species **.**
20. Establish reservoir fishery on cold water fish species in the hydropower development areas.
21. Design the project properly to reduce the impacts of this dam on aquatic and terrestrial biodiversity.

22. Maintain natural seasonal and daily river flow cycles. The natural seasonal pattern of flow is vital in life history stages such as migrations, spawning and feeding.

23. Sustain water quality. Appropriate temperature, oxygen, turbidity, and sediment levels are necessary for well-being of aquatic species. Pollution should be avoided.

24. Maintain discharge volume as much as possible.

25. Avoid cumulative effects of dams. There should be no more dams in close proximity.

26. Support to continue baseline studies on biodiversity. Knowledge on biodiversity is always incomplete. Reducing impacts on biodiversity calls for knowing where species, ecosystems and ecological functions are located. Lack of biodiversity information is a result of poor support for biological surveys and academic work on taxonomy and ecology. Comprehensive documentations of biological and ecological assessments are needed.

27. Regarding agro-biodiversity, carry out survey and research on wild rice varieties and their ancestors.

28. Ensure the current potential on availability of traditional medicinal plants.

29. Monitor impacts at old and new dams. One of the most serious information gaps is the lack of follow-up information on the environmental and biodiversity impacts following dam construction. Follow-up studies on dam impacts are required to plan for future environmental friendly dams.

16.3. Recommendations and Mitigating Measures (Social Perspective)

1. Launch social mobilization to convince people of the project benefits.
2. Construct dams with the consent of people living in the region.
3. Provide awareness to the locals about dam projects.
4. Should disclose to the public about the impacts and discuss with the locals and bargain on an income sharing basis.
5. Encourage self-reliance among the resettled population.
6. Compensate and provide employment to affected people if no land is available.
7. Ensure that affected villages sign contracts for compensation and resettlement.
8. Restrict the use of agricultural land for construction purposes as much as possible.
9. Develop systematic farming system towards permanent agriculture.
10. Restore the original living standards of the affected people.
11. Extend developmental assistance for up to ten years after resettlement implementation is completed.
12. Foster support for the affected people from the general population.
13. Include all compensation and resettlement costs in the project budget.
14. Ensure government approval of the land acquisition and resettlement plan.
15. Allow agricultural displaced people to resettle on land.

16. Enable urban affected people to choose houses in alternative locations or get cash compensation.

17. Promote livelihood inputs to relocated villagers of hydropower development area by using community forestry approach and agro-forestry practice. In addition to agricultural crops, suitable tree species are recommended for income generation.

18. Establish community forestry to provide NTFPs and develop sustainable alternatives to wood as a source of fuel.

19. Relocate people to suitable areas and provide compensation in kind for resources lost.

20. Avoid dislocation of un-acculturated people and where not possible, relocate in area allowing them to retain lifestyle and customs.

21. Provision of health and social services to resettled people.

22. Provide adequate health services, infrastructure, and employment opportunities.

23. Design and operation of dam to decrease habitat for vector and control of vector.

24. Maintenance of standard of living of resettled people by ensuring access to resources at least equaling those lost.

16.4. Recommendations and Mitigating Measures (Administrative & Technical Perspective)

1. Provide electricity coming out from this hydropower development to the people in Kachin State, some amount into national grid and surplus to export, thus enhancing MDGs.

2. Give the Kachin State Government overall responsibility for all resettlement.

3. Abide by Myanma Forest Law, Wildlife Law and Mine Law.

4. Both parties should be encouraged to abide by the Chinese silvicultural guide for corporations importing timber to China from abroad.

5. As Mayhka River is being polluted on account of improper waste disposal at Ngaw Chang Hka River by adjoining country, negotiate with China side for proper waste disposal treatment.

6. Maintain discharge volume avoiding zero discharge except in very extreme emergencies.

7. Sustain water quality with appropriate temperatures, oxygen, turbidity and sediment levels for well-being or survival of aquatic species and pollution should be avoided.

8. Land use planning efforts in watershed areas above dams to avoid increased siltation and changes in water quality.

9. Increase of productivity or improve management of land (agricultural, range, forestry improvements) to accommodate higher population.

10. Take measures to minimize impacts and take precautions to minimize erosion.

11. Do careful locations of camps, buildings, borrow pits, quarries, spoil and disposal sites.

12. Do land reclamation

13. Choice of resettlement site to avoid surpassing carrying capacity of the land.

14. Protection of equal areas in region to offset losses. Creation of useable land in previously unsuitable areas to offset losses.

15. Control of land use in watershed (especially prevention of conversion of forests to agriculture).

16. Establish compensatory parks or reserved areas.

17. Reforestation and/or soil conservation activities in watersheds.

18. Control of land uses, wastewater discharges, and agricultural chemical use in watershed.

19. Do air and water pollution control.

20. Stop logging and harvesting of NFTPs in the watershed of this hydropower development.

21. Enforce laws to stop illegal activities including gold mining, hunting, trapping, logging and collection of non-timber forest products.

22. Manage sustainably reserved forests near and around the dam site and manage threatened plant species by allowing cultivation those in nearby reserved forests.

23. Introduce independent environmental audits to verify the level of compliance with environmental standards and efficiency of impact mitigation measures.

24. Mitigation entails the identification of ways in which negative impacts can be avoided or minimized to limit costs, and ways in which positive impacts can be enhanced to ensure maximum benefit.

25. A longer investigation time is strongly recommended in such a very big and sensitive hydropower development project which shall have very significant adverse impacts.

26. Continued monitoring is essential during and after construction of dams, and compensatory and remedial measures to be taken accordingly.

17. CONCLUSION : Toward Sustainable Development of Myanmar

The main drawback of this study of EIA Special Investigation on Hydropower Development of Ayeyawady River above Myitkyina, Kachin State, done by BANCA is lack of Social Impact Assessment. Before approval of this hydropower development in Kachin State, systematic social impact assessment must be carried out by competent social scientists.

Before approving the construction of a series of dams on Ayeyawady River above Myitkyina, Kachin State, the decision-makers are strongly urged to fairly balance between negative and positive aspects of dams (App. 2). The decision makers, developers, concerned engineers and dam designers are seriously advised to pay due consideration on the differences between bad and good dams and between environmental threatening and environmental friendly dams (App.3). The core construction engineers are also strongly urged to pay serious attention on the appended suggestions towards dam construction (App. 2).

The large expenditure involved with the construction and operation of large dams and the benefits for power generation are of considerable long-term economic importance of the country.(BANCA 2006). However the importance of economic and engineering paradigms in development alone cannot lead to sustainable development and economic prosperity. A better understanding of the interplay between development and natural environment in which development takes place is necessary at the time of project planning to ensure environment security and economic prosperity of our country. (BANCA 2006). It becomes clear that sustainability has ecological, economic, and social dimensions, and only by accounting for all three can it be said that sustainability can truly be achieved. Also it is important to increase rural productivity in an environmentally friendly manner, which will generate income as a means for poverty reduction. Increasing public awareness about sustainable development is a matter of high priority.

Deforestation, loss of biodiversity, conversion of globally outstanding eco-regions, key biodiversity areas and the center of plant diversity into other land uses, soil erosion, water contamination and water-borne diseases, land clearance, excessive mineral extraction, improperly managed industrial effluents are environmental issues and causes, still found in Kachin State. There will be more environmental issues on account of a big scale hydropower development above Myitkyina. Resolving these issues, there should be an integration of environmental considerations and sustainable development concerns in national and sectoral development policies, planning and management processes. Also there is a need to enhance partnership among the government, private sectors, and environmental NGOs to participate in environmental protection and sustainable resource management.

When considering the question of impacts on ecosystems or biodiversity by large dams, all three dimensions of sustainability must be considered. Regarding Hydropower Development of Ayeyawady River above Myitkyina, Myanmar, proper selection of dam sites and proper dam designs can provide an acceptable environmental protection and at the same time can serve the country's desire for development. There must be a fair and equitable sharing of benefits coming out from this hydropower development among the stakeholders concerned, including the people of Myanmar in general and Kachin people in particular. Giving due considerations for effective implementation of prioritized actions, and by following mitigating measures along with recommendations, the hydropower development's adverse impacts can be kept to acceptable levels.

BANCA is always looking forward to seeing our country having a mechanism for combining economically sustainable growth with ecologically sustainable development.

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Appendix 1.

Suggestions towards dam construction (from working papers for WCD)

1. Recognize the important role of natural ecosystems in contributing to livelihoods and sustainable development.
   a) Assess the value of natural ecosystem functions and services during feasibility studies for both upstream and downstream communities. Water does not have a zero opportunity cost; **b)** Adopt a river basin approach to water and ecosystem management; **c)** Use multi-criteria decision-making that recognizes values other than costs and not simply a cost-benefit analysis; **d)** Rivers are a public trust and extractive use rights should not be permanently allocated; **e)** Identify users of the downstream and upstream natural resources and ensure that their needs are incorporated by the project .
2. Recognize the importance of biodiversity and promote its conservation.
   a) Ensure that dam projects comply with the provisions and guidance of the Convention on Biological Diversity, the Convention on Wetlands and other related nature conservation Conventions; **b)** Dams should not negatively impact any Red Data Book species; **c)** Dams should not be built in, nor should reservoirs impinge on, declared National Parks or Nature Reserves; **d)** Undertake comprehensive biodiversity surveys of rivers in order to allow the least ecosystem-damaging choices and trade-offs to be made. Ecological investigations should be placed on the same footing as engineering and economic assessments during project planning and not be .add-on. extras; **e)** River flows should not be reduced during commissioning to zero or levels likely to have a negative impact on biodiversity; **f)** Dams built on tributaries will have fewer impacts on migrating fish than those on the main stream.
3. Recognize and manage for uncertainty
   a) Recognizing that the precautionary principle should apply as it is at present impossible to predict all consequences of dam construction; **b)** Undertake baseline assessments of the riverine ecosystem and its biodiversity down to the river mouth, during feasibility studies to provide the information base needed to improve predictive capacity. **c)** Assess possible cumulative impacts.
4. Ensure effective participation in planning, design and management of dams.
   a) All EIA studies should be public documents; **b)** All stakeholders must participate in EIA and decision-making process. Utilize decision-making tools that Dams, Ecosystem Functions, and Environmental Restoration 88.This is a working paper prepared for the World Commission on Dams as part of its information gathering activities. The views, conclusions, and recommendations contained in the working paper are not to be taken to represent the views of the Commission encourage interdisciplinary discussion and stakeholder participation; **c)** Base decision-making on multi-criteria analyses, not simple cost-benefit analyses.
5. Maximize adaptive capacity. ü Allow for regular monitoring of ecosystems to ensure that management objectives are met.
   a) Every existing dam should have an environmental flow requirement; **b)** Review operating rules every five years to incorporate findings of monitoring programs and mitigate unexpected ecosystem changes; **c)** Undertake research programs to solve outstanding problems; **d)** Ensure every dam has a proposal for how it will eventually be decommissioned, especially with regard to design features for reservoir drainage, the treatment of accumulated sediment, and appropriate financial measures for ecosystem restoration; **e)** Include direct revenue sharing

(hydropower), or environmental trust funds as tools to ensure funds for monitoring and repairing ecosystem damage are available throughout the project's lifetime.

Appendix 1. (continued)

Suggestions towards dam construction (from working papers for WCD)

6. Promote incorporation of environmental management features into dam design.
   a) Include biologists and ecologists in the design team; **b)** Every dam on a river with migratory fish should have an effective fishpass and monitoring program; **c)** Dams that have pulsing flood releases due to hydropower should systematically have a downstream re-regulating weir that levels out day to day flow oscillations; **d)** Where water quality is, or is likely to be, an issue, variable level offtakes should be mandatory.

7. Promote the development of national legislative frameworks.
   a) Use environmental bonds or environmental trust funds as a guarantee of compliance; **b)** Ensure the developer/owner is responsible for managing dam-related ecosystem impacts and restoring the site at the end of the project's lifetime; **c)** Ensure that the environmental components of dam tenders are at a fixed cost and are not subject to the competitive tendering process that is used for the infrastructure; **d)** Undertake regular independent audits of environmental performance of major projects where complex mitigation measures are planned; **e)** National legislation should include provision for an intact rivers policy.

8. Apply high EIA standards.
   a) Apply high environmental impact assessment standards with long lead times, competent staff, open process, independent review and follow-up.

Appendix 2.

Negative and Positive Aspects of Dam

Negative aspects of Dam	**Positive aspects of Dam**
Dams kill rivers; dams can have devastating effects on rivers and freshwater ecosystems; fragmentation of rivers affects the migration of fish, disrupts the transport of sediments, cuts off the floodplains from life giving floods and threatens many endangered species; dams destroy livelihoods of millions of people from downstream, especially in developing countries; dams are expensive; the social and economic benefits promised for large dams and reasons have not been realized; inundation of huge tracts of inhabited land reduces the wellbeing of millions of people; creation of reservoirs flooded and destroyed many pristine biotopes, with negative impacts on biodiversity; dams transform "healthy" river ecosystems into impoverished reservoirs; downstream from dams, disruption of natural flow, sediment and energy dynamics destroys the integrity of ecosystems; although possible to mitigate against some negative effects, it is impossible to undo all the damage; large dams protect from annual floods but fail to hold back floods of longer return periods; large dams create health risks for people who live in their vicinity; hydropower is not a "clean" energy; reservoirs contribute to the greenhouse gases (i.e. decomposition of submerged vegetation releases carbon dioxide and methane);modern technologies (e.g. solar power)provide opportunities to reduce our dependence on large dams; environmental damage and degradation for human development is non-sustainable; The ecological, socioeconomic and health costs associated with their construction outweigh the benefits. The price paid is too high. Alternatives to large dams exist.	Dams have improved the economic and social well-being of many millions of people; they are the most important way of making surface water available at the place and time of demand; many dams will be needed in the future to manage the world's limited water resources; dams through creation of reservoirs create new habitat for some species; the destruction of ecosystems may be resulted from the disruption of natural flow regime; large dams provide flood protection, security of millions of people who live downstream; the health risks with dams and associated projects were not appreciated in the past; we can mitigate against the causes now; dams by increasing economic status can provide the impetus for improved health care; hydropower represents a "clean" sustainable energy source; the alternatives to hydropower (e.g. nuclear and coal fired power stations) create greater environmental and social economic problems; over the last 20 years, environmental issues have come to the fore, but people (especially in the developed world) are not prepared to make the changes to their life styles that doing away with large dams would entail; We now have a greater understanding of the negative ecological, socio-economic and health consequences of large dams, and to a large extent these can be mitigated against. The benefits of dams outweigh the costs.

Source: From Reports of WCD

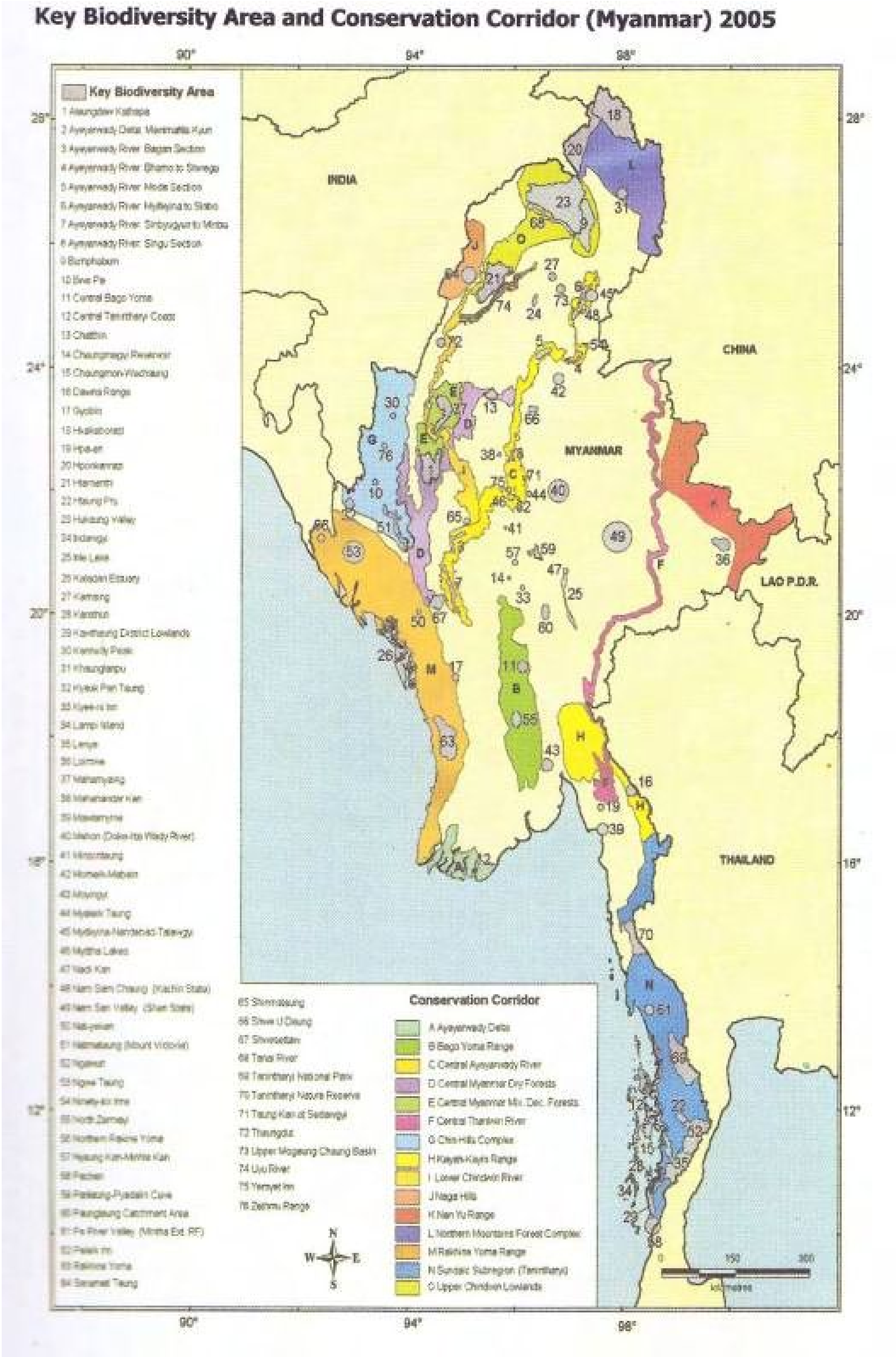
Appendix 3.

Differences between Bad / environmental threatening and Good / environmental friendly Dams

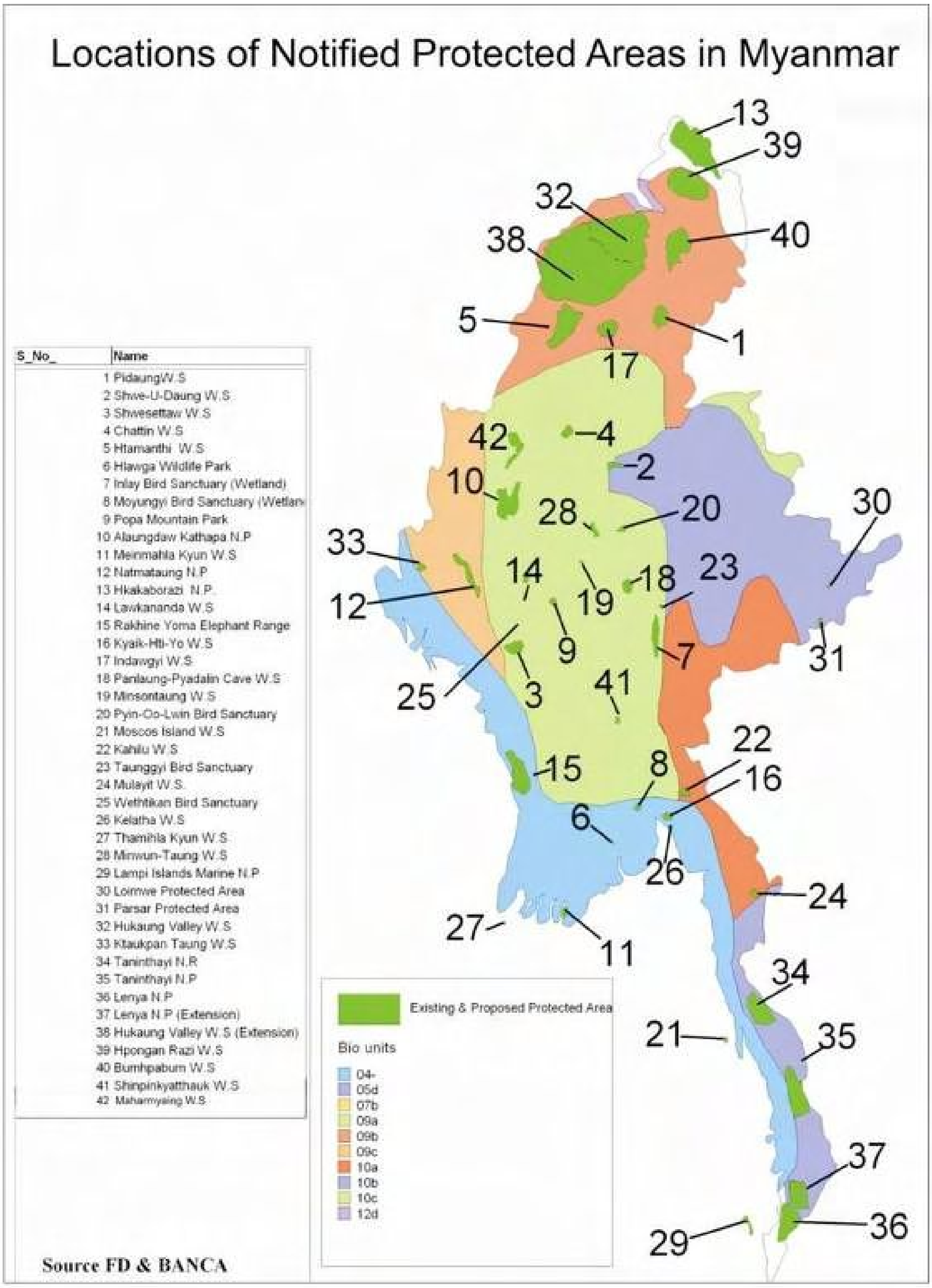
Bad Dams	Good Dams
(a) A large reservoir surface area; **(b)** much flooding of natural habitats and consequent loss of wildlife; **(c)** a large river with much aquatic biodiversity damaged; **(d)** a relatively shallow reservoir (sometimes with a fairly short useful life); **(e)** few or no downriver tributaries; **(f)** water quality problems due to the decay of submerged forests; **(g)** location in the lowland tropics or subtropics, conducive to the spread of vector-borne diseases; and **(h)** serious problems with floating aquatic weeds.	**(a)** A relatively small reservoir surface area (often in a narrow gorge with a high head and even a tunnel); **(b)** little loss of natural habitats and wildlife; **(c)** a relatively small (often highland) river with little aquatic biodiversity at risk; **(d)** a deep reservoir which silts up very slowly; **(e)** many downriver tributaries; **(f)** little or no flooding of forests; **(g)** no tropical diseases (often due to high elevations or temperate latitudes); and **(h)** no aquatic weed problems.
Environmental threatening dam	**Environmental friendly dam**
Several genetically distinct stock or species extirpated or driven to extinction; large areas of ecosystems/habitats lost or converted; 'Footprint' overlaps such areas; ecological integrity of such areas is disturbed, hampering their biological productivity; overall footprint of dam is large; several exotic species or ecosystems introduced; dam blocks routes of migratory freshwater species; seasonal flow patterns of discharge disrupted; discharge volume is greatly reduced; zero discharges frequent or prolonged; temperature, oxygen, turbidity, sediment, and acidity levels changed; methyl mercury is generated; unique habitats lost; no EIA carried out, or a poor one hastily conducted with serious impacts neither avoided nor mitigated; key decisions irrevocably made, and their input is given low priority; landscape and airscape planning and management not included in the process; water volume stored is high and wastefully used; no protected areas established.	No genetically distinct stocks or species extirpated or driven to extinction; only small areas of ecosystems/habitats lost or converted; 'Footprint' of dam avoids areas rich in species, endemic species, species at risk, or diverse habitats; highly productive inland rivers, lakes and estuaries are retained in their natural state; 'footprint' of dam is small in area; no exotic species or ecosystems introduced; dam does not block routes of migratory freshwater species; seasonal flow patterns of discharge maintained; discharge volume is little diminished; water never ceases flowing; water quality is natural; no methyl mercury generated; unique habitats conserved; excellent EIA conducted and impacts avoided or mitigated; environmental staff is an important part of the dam planning and construction team from project start; landscape and air-scape planning and management are included in the process to enhance dam performance and lower water demand; water volume stored is relatively small, but efficiency is high; protected land and freshwater areas created to enhance dam performance and conserve biodiversity.

Source: From Reports of WCD

Appendix 4.



Appendix 5.



Locations of Notified Protected Areas in Myanmar
S_No_ Name
1 PidaungW.S
2 Shwe-U-Daung W.S
3 Shwesettaw W.S
4 Chattin W.S
5 Htamanthi W.S
6 Hlawga Wildlife Park
7 Inlay Bird Sanctuary (Wetland)
8 Moyungyi Bird Sanctuary (Wetlan
9 Popa Mountain Park
10 Alaungdaw Kathapa N.P
11 Meinmahla Kyun W.S
12 Natmataung N.P
13 Hkakaborazi N.P
14 Lawkananda W.S
15 Rakhine Yoma Elephant Range
16 Kyaik-Hti-Yo W.S
17 Indawgyi W.S
18 Panlaung-Pyadalin Cave W.S
19 Minsontaung W.S
20 Pyin-Oo-Lwin Bird Sanctuary
21 Moscos Island W.S
22 Kahilu W.S
23 Taunggyi Bird Sanctuary
24 Mulayit W.S.
25 Wethtikan Bird Sanctuary
26 Kelatha W.S
27 Thamihla Kyun W.S
28 Minwun-Taung W.S
29 Lampi Islands Marine N.P
30 Loimwe Protected Area
31 Parsar Protected Area
32 Hukaung Valley W.S
33 Ktaukpan Taung W.S
34 Taninthayi N.R
35 Taninthayi N.P
36 Lenya N.P
37 Lenya N.P (Extension)
38 Hukaung Valley W.S (Extension)
39 Hpongan Razi W.S
40 Bumhpabum W.S
41 Shinpinkyatthauk W.S
42 Mahamyaing W.S
Existing & Proposed Protected Area
Bio units
04-
05d
07b
09a
09b
09c
10a
10b
10c
12d
Source FD & BANCA

Appendix 6.

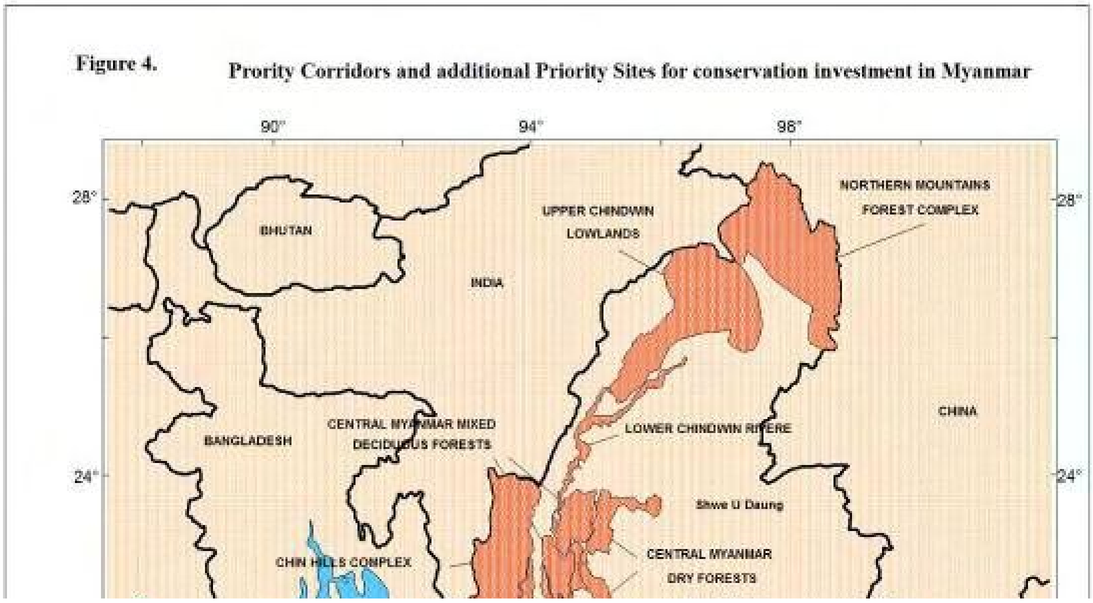
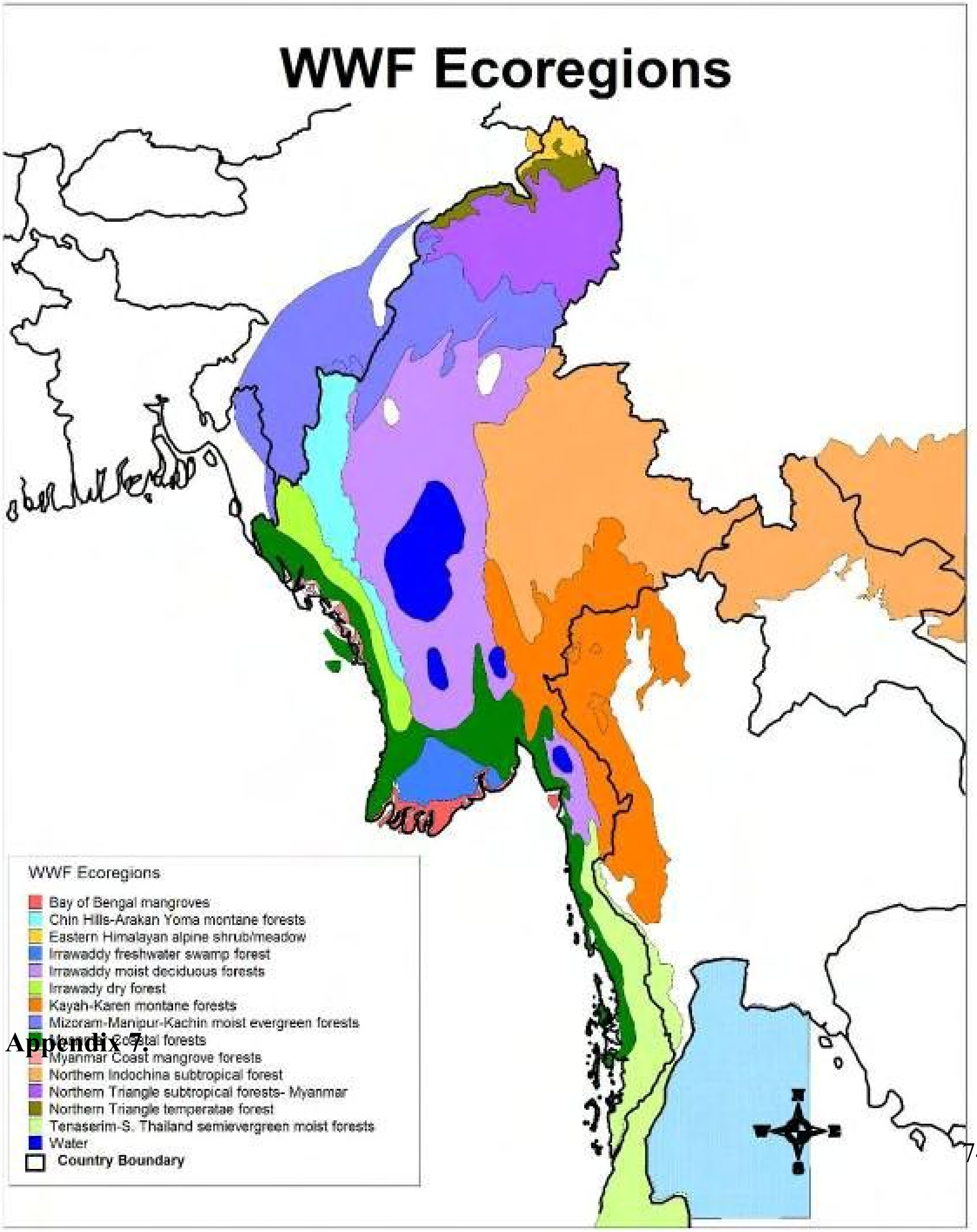


Figure 4. Prority Corridors and additional Priority Sites for conservation investment in Myanmar

WWF Ecoregions



Appendix 7.

Part – II

BRIEF HISTORY

Environmental Impact Assessment EIA special investigations for Hydropower Development of Ayeyarwady river basin above Myitkyina was carried out by Myanmar scientists from Biodiversity And nature Conservation Association BANCA together with the Chinese scientists from CISPDR starting from January 2009. Although the joint team encountered many difficulties they successfully ended the investigations by the end of May 2009. This is the first time Chinese and Myanmar scientists collaboratively carried out such a kind of investigation.

Discussions for conducting these investigations were held between BANCA, CPI and CISPDR from China starting from June 2009. But agreement was reached only after 5 months in November. Agreement contract for conducting EIA special investigations was signed between BANCA Biodiversity And Nature Conservation Association (Myanmar) and China Power Investment (Southwest Hydro Division) at Kunming on the 24th of December 2008. With less than 2 weeks preparation BANCA investigation team started their investigation by arriving at Myitkyina on the 7th of January 2009. During that time a training workshop in Yangon and first aid training in Myitkyina were the only measures BANCA was able to carry out. There was not enough time to collect old records, buy tents, sleeping bags, reference books and survey gears. All of these were brought and collected while conducting the investigations.

Two teams of Myanmar scientists (namely environmental baseline and monitoring team and wildlife trading investigation team) conducted their surveys separately from the main group. Environmental baseline and monitoring team carried out the investigations two times, once in the dry season when the water level was at the lowest and another in the rainy season when the level of water was at the highest in the rivers. The wildlife investigation team carried out their investigations sometimes in collaboration with the main group but sometimes separately, travelling up to the border towns and villages where wildlife trading was actively going on. Both of these teams did not follow the schedule of the main investigation team.

From these investigations the joint team managed to gather many significant records which expanded knowledge on the status and distribution of many floral, faunal and aquatic species of the Kachin state as well as the country, Myanmar. These results in turn helped to work out necessary mitigation measures which are vital requirements for the sustainability of the 7 hydropower dams.

The results of these surveys could not be considered comprehensive because of time limitation. The Myanmar team’s original plan was to conduct surveys simultaneously at four areas with four teams starting from early January. This would give a longer period for studies in each place for each team. Moreover, the survey time was planned to be 7 months. But the Chinese counterparts with their institutional duties could not employ that much time and because their intention was to have a Chinese Myanmar team carrying out surveys in collaboration, the time was limited to 5 months. Therefore they were only able to start the investigations by mid January. Accordingly the Myanmar team had to readjust their plan and conduct the surveys , thus resulting in a shorter time for surveys.

The expense of all these investigations was funded by China Power Investment Southwest Hydro Division and logistics for all teams was managed by BANCA.

Difficulties

The beginning of the investigation coincided with the Manaw festival which is considered the biggest event held in the Kachin state. All the hotels and resorts were fully booked and no rooms were available for the Myanmar team. After seeking help from Myikyina divisional administrative body the team was finally accommodated in the township gymnasium. Chinese scientists from CISPDR arrived Myitkyina on the 12th of January. Myitsone hydropower investigations started on the 14th of January with a joint investigation team of Myanmar and Chinese scientists. But they were able to work only a few days together because of a long Chinese New Year holiday from end January to mid February. All the Chinese scientists went back to China. Only Myanmar scientists were left to continue with the investigations in Myisone area. After Myitsone the Myanmar team flew to Putao in the first week of February for investigation of Khaunglanhpu and Yenam areas. In mid February the Chinese team drove to Putao to join the Myanmar team.

Due to language barrier there were some difficulties in communication between the Chinese and Myanmar scientists at the start. Chinese scientists also found it difficult to get accustomed to the culture and limitations of Myanmar. Since the Chinese scientists wished to work together with the Myanmar scientists, all have to go according to the Chinese program despite having only a limited time. Eventually both teams managed to reach a good understanding and the investigations were successfully carried out till the end.

The team encountered many difficulties such as :

1. The Chinese scientists were not able to fly to Putao because they only held border crossing passports (green cards). They had to make a tough 2 day motor car trip to Putao which could be reached in an air plane within 30 minutes.
2. There was no rain free month in this rugged area. That made logistical support and trekking extremely difficult.
3. No good boats and cars were available for the teams in some areas.
4. The roads to some areas were so bad that only six wheel drive trucks could be driven.
5. Some areas are so remote that walking is the only mean to get there. There were some areas which took a minimum of ten days walking. In those areas investigation time was sometimes limited to one day.
6. There were differences in meals between Myanmar and Chinese and the logistic team had to adjust to each team’s requirements. Sometimes there was shortage of supplies because of the remoteness of the area.
7. There were not enough porters in that area to carry gears and supplies for the joint team which has over 90 members. The maximum number of porters employed was recorded at 300.

8. The joint team encountered many boat and car accidents but fortunately none of them were fatal.
9. Some study areas were in extremely rugged terrain and too remote areas making it impossible for access. Therefore those areas were left out of the survey.

Most of the areas were controlled by local armed groups. The investigation teams were not permitted to move around and investigate freely in those areas. Permission from their headquarters was the most important requirement for those areas. Some of the investigation teams were sent back because they were not able to show permission. To conclude the investigations successfully many negotiations had to be carried out with all local armed groups and the regional authorities.

Team members of EIA special investigation team

No	Name	Designation	Speciality group
1	Dr Htin Hla	EIA team leader	Management and administration
2	U Tin Oo	Dy team leader	Management and administration
3	U Aung Kyaw	Dy team leader	Management and administration
4	Dr Than Win	Medical officer	Management and administration
5	U Mg Mg Soe	Manager	Logistic and support
6	U Aung Zaw Hla	Manager	Transportation
7	U Nyunt Khin	Manager	Logistic and support
8	U Mya Than Tint	Assistant manager	Logistic and support
9	U Mg Soe	Assistant manager	Logistic and support
10	U Chit Lwin	Assistant manager	Logistic and support
11	U Kyaw Htun	Accountant	Management and administration
12	Thin Thin	Assistant to accountant	Management and administration
13	U Kyaw Swar Htun	Assistant manager	Transportation
14	U Htun Htun	Assistant manager	Logistic and support
15	U Nyo Maung	Leader of Flora team	Management and administration
16	Dr Su Su	Leader of Fauna team	Management and administration
17	U Zaw Lun	Leader of Aquatic team	Management and administration
18	U Nyo	Leader of Baseline team	Management and administration
19	Dr Myint Aung	Team member	Ecology team(flora)
20	Mg Aung Aung	Team member	Ecology team (fauna)
21	Sabei Min	Team member	Wildlife trading team
22	Saw Mon Theint	Team member	Wildlife trading team
23	Dr Win Myint	Team member	Flora team
24	Thin Thin Su	Team member	Flora team

25	Khin Swe Lwin	Team member	Flora team
26	Khin Khin Soe	Team member	Flora team
27	Nay Phyo Aung	Team member	Flora team
28	Dr Kyaw Soe Naing	Team member	Flora team
29	Dr Kalaya Lu	Team member	Flora team
30	Tazar Aung	Team member	Flora team
31	Saw Moses	Team member	Ornithology team
32	Thet Zaw Naing	Team member	Ornithology team
33	Tin Aung Htun	Team member	Ornithology team
No	**Name**	**Designation**	**Speciality group**
34	Lay Ko Ko	Team member	Ornithology team
35	Thiri Dawei Aung	Team member	Ornithology team
36	Ma Nyunt Shwe	Team member	Ornithology team
37	Lay Win	Team member	Ornithology team
38	Sao Myo Zaw	Team member	Ornithology team
39	Swe Swe aung	Team member	Mammal team
40	Thandar Win	Team member	Mammal team
41	Thida Nyein	Team member	Mammal team
42	Maythu Htun	Team member	Mammal team
43	Myo Min Htun	Team member	Mammal team
44	Kyaw Naing Oo	Team member	Mammal team
45	Aung Than Soe	Team member	Mammal team
46	Yan Naing Hein	Team member	Herpetology team
47	Oum Kwe Shein	Team member	Herpetology team
48	Thaw Zin	Team member	Herpetology team
49	Kyaw Swar Aung	Team member	Herpetology team
50	Nay Myo Win	Team member	Herpetology team
51	Myin Thura Kyaw	Team member	Herpetology team
52	Min Thein Htet	Team member	Herpetology team
53	Aung Ko Ko	Team member	Herpetology team
54	Khin Mar Lwin	Team member	Entomology team
55	Khin Sandar Hlaing	Team member	Entomology team
56	Naing Naing Win	Team member	Entomology team
57	Phyo Thidar	Team member	Entomology team
58	San Wai Tint	Team member	Entomology team
59	Than Than Htay	Team member	Entomology team

60	Nay Myo Aung	Team member	Entomology team
61	Aung Moe	Team member	Entomology team
62	U Myint Pe	Team member	Aquatic team
63	Tint Wai	Team member	Aquatic team
64	Than Htay Oo,	Team member	Aquatic team
65	U Tue Nam	Team member	Aquatic team
66	U Di Moe Tun	Team member	Aquatic team
67	Aung Kyaw Win	Team member	Aquatic team
68	Htay Aung	Team member	Aquatic team

No	**Name**	**Designation**	**Speciality group**
69	U Htay Kywe,	Team member	Baseline team
70	U Kyaw Myo Khaing	Team member	Baseline team
71	U Thet Tun,,	Team member	Baseline team
72	U Aung Myo Thu	Team member	Baseline team
73	U Htay Aung	Team member	Baseline team
74	U Thein Zaw	Team member	Baseline team
75	Than Htun Aung	Team member	Baseline team
76	Aung Bo Bo Kyaw	Team member	Baseline team
77	Than Htut Win	Team member	Baseline team
78	Soe Naing	Team member	Baseline team
79	Zaw Win Myint	Team member	Baseline team
80	Thein Htay Aung	Team member	Baseline team
81	Win mg	Driver	Transportation
82	Khin Zaw	Driver	Transportation
83	Kyaw Soe Thu	Driver	Transportation
84	Ag Kyaw Oo	Driver	Transportation

CHAPTER 1

1. INTRODUCTION

1.1. Biodiversity of Myanmar

Myanmar is the largest country situated in mainland Southeast Asia, covering a total area of 676,581 sq.km (261,228 sq.miles) and within 9°53'- 28°25' N Latitude and 92° 10'-101° 10' E. It is nearly 2,195 km from north to south and 948 km wide in the central part. A number of rivers flow mostly from north to south. The elevation of the land surface varies from sea level in parts of the south to about 5,881 meters in the northern mountain ranges bordering China. It has distinctly different lowland and upland regions. The mountains cause many differences in temperature and rainfall.

Myanmar is a dynamic reservoir of biodiversity richness, unparalleled in mainland Asia and many other parts of the world. Of the 25 hotspots identified by Myers *et al*. (2000), Myanmar comprises the Indo-Myanmar hotspot. Myanmar contains parts of three sub-regions of the Indo-Malayan Realm. These are the Indian sub-region covering about 6% of the country, bordering Bangladesh in the west and India in the northwest; the Indochinese sub-region, covering the greater part of the country (91%), with a long common border with China, and the Sundaic sub-region comprising 3% of Myanmar territory bordering Thailand. The sub-regions are further divided into sub-units, of which there are a total of 10 covering Myanmar (MacKinnon and MacKinnon, 1986), reflecting differences in topography and in plant and animal distribution. The varied forest, other natural vegetation types and the rich fauna reflect these many ecological zones. Compared to other Asian countries, Myanmar is still extensively forested (Shepherd and Nijman, 2007a) and may still have significant population sizes of some fauna species.

1.2. Key Areas and Faunas of Myanmar

The key biodiversity values of eight Priority Corridors in Myanmar (Anon. 2005). One of these, the Northern Mountain Forest Complex, comprises the high mountains in the extreme north of Myanmar, along the international borders with India and China, and associated foothills and valleys to the south. The Priority Corridor contains an elevational gradient of over 5,000 m, from the summit of Hkakaborazi, Myanmar’s tallest mountain, to the valleys of tributaries of the Ayeyawady River. The Priority Corridor includes a correspondingly wide range of natural habitat types, from alpine meadows, through sub-alpine montane and hill evergreen forest, to lowland evergreen forest. The Northern Mountains Forest Complex supports a very high floristic diversity, including a large number of species endemic to the country (Kingdon-Ward, 1937 and 1944-45).

The Northern Mountain Forest Complex also supports a number of animal species characteristic of the eastern Himalayas, including red panda (Endangered), takin, Sclater’s monal and Blyth’s tragopan (all Vulnerable), as well as populations of the little-known black muntjac *Muntiacus crinifrons* (Vulnerable) (Rabinowitz *et al*., 1998) and Amato *et al*., 1999 explored leaf deer. In addition, the Priority Corridor supports important populations of Hoolock Gibbon and White-bellied Heron (both Endangered). Recently in 2009 IUCN Red List Data, red panda and eastern hoolock gibbon are listed as Vulnerable and White-bellied Heron is listed as Critically Endangered. The Northern Mountain Forest Complex represents one of the largest contiguous wilderness areas in the country, and the existence of contiguous forest areas in China and India, present opportunities for transboundary conservation initiatives. The Northern Mountans Forest

Complex contains two large protected areas: Hkakaborazi National Park and Hponkanrazi Wildlife Sanctuary. Most of the area under protection lies in the north-western part of the corridor, and there is a need to establish protected areas in the north-eastern part, especially in areas close to the international border with China, which lie within the Yunnan Mountains EBA.

Particularly high species diversity and endemism are found in the Eastern Himalayas in Myanmar's Kachin State (Myint Aung, 2006). In the refined analysis, the main criterion for determining hotspots status was species endemism, which uses a measure of irreplaceability (Anon., 2004). Patterns of endemism differ greatly among taxa. However, there are strong correlations among patterns of endemism in mammals, birds, reptiles, all of which require relatively large areas for geographic speciation. A total of four endemic mammal species, four endemic bird species, one Threatened endemic bird species and nine endemic amphibian species were completely assessed in Myanmar (Vie *et al*, 2009) and forty five species in mammal, 41 species in bird and 22 species in reptile are also categorised as number of threatened species in Myanmar. However, BirdLife International - the global bird conservation alliance (Anon., 2009) recently listed 51 species of threatened species (CR, EN and VU).

1.2.1 Mammals

The "Wild Mammals of Myanmar" was the first recorded compilation of mammals in our country (Tun Yin, 1967; 1993). Mammals belonging to 13 orders of the Class Mammalia have been described in it. The 13 orders in the wild mammals of Myanmar are Insectivora, Dermoptera, Chiroptera, Primates, Pholidota, Carnivora, Sirenia, Proboscidea, Perissodactyla, Artiodactyla, Lagomorpha, Rodentia and Cetacea. The recorded number of mammal species in Myanmar is about 300 of which 6 species are endemic (Dinerstein and Wikramanayake, 1993). Groombridge and Jenkins 1994, Bates *et al*. 2004 also reported that seven mammal species are thought to be endemic to Myanmar. But four mammal endemic species are recently assessed for Myanmar (Vie *et al.*, 2009). Those classified as endangered species are rhinoceros, tapir, thamin, elephant, tiger, takin, musked deer, goral, serow, clouded leopard and Irrawady dolphin. Thamin or Eld's deer is internationally critically endangered as the only wild populations are now found in Myanmar (with the exception of one small population in India). Range collapse and the extent of remaining habitat of thamin in Myanmar had been studied by the Smithsonian Institution. A new species of muntjac, *Muntiacus putaoensis* (Artiodactyla: Cervidae) from northern Myanmar was found by the Wildlife Conservation Society in Kachin State (Amato *et al*., 1999). Tiger action plan in Myanmar had been executed by WCS, Wildlife Conservation Society (Lynam, 2003). A research project on elephant conservation had also been initiated by the Smithsonian Institution. According to Sukumar (1989), Myanmar has a large area of forest with elephants, possibly larger than any other country in Asia. The elephant population in the wild is declining seriously on account of poaching, habitat contraction and fragmentation (Uga, 2000). The decline of the wild elephant population in Myanmar has become noticeable in recent years (Tin Than, 2008). Research on hoolock gibbon survey has been recently initiated by BANCA, Biodoversity And Nature Conservation Association (Geissmann *et al*., 2008).

Between 1996-1997, data on the status of 22 mammal species were collected from a remote region of North Myanmar (Rabinowitz and Saw Tun Khaing). The conservation issues of Kachin State, Myanmar based on literature review and stakeholder interviews were documented by Webb *et al.,* undated. Than Zaw *et al*., 2008 published information on the recent status and distribution of small carnivores in Myanmar. Hunting for subsistence and trade that constitute a major threat to wildlife populations within and outside Hkakaborazi National Park, north Myanmar was described by Rao *et al.,* 2005. Li Yiming and Li Dianmo, 1998 explained many species of wildlife are not only used as food (Hoa *et al.* 2004), but the inedible parts of the species are also used in TCM (Traditional Chinese Medicines) (Anon., 2000a). Besides habitat loss, wildlife in Myanmar is threatened by illegal and unregulated hunting for domestic and international trade (Martin and Redford, 2000; Rao *et al.,* 2005, Davies, 2005). Li Yiming *et al*., 2000 reported illegal wildlife trade across Sino-neighbouring country borders in Himalayan region. Shepherd and Nijman, 2007a; 2007b; 2008 observed that international trade in bear parts from Myanmar is significant and strongly indicates a serious lack of enforcement effort.

Among Myanmar's more than 300 species of mammals, some 45 species have been listed as endangered. Under the Wildlife Act 1994, so far, 39 mammal species have been declared "completely protected", 12 mammal species have been "protected" and 2 mammal species have been "seasonally protected".

1.2.2 Amphibians and Reptiles

The herpetofauna of Myanmar is poorly known. Early collections by Leonard Fea followed by collections by the British set the groundwork for our understanding of the biodiversity within Myanmar. Although many species were described from Myanmar primarily by British naturalists George Boulenger, Malcolm Smith and Frank Wall, during the late 19th and early 20th centuries, comprehensive surveys of the country's herpetofauna have not been conducted until initiated by the National Museum of Natural History, Smithsonian Institution, and the California Academy of Sciences. The Myanmar Herpetological Survey, a collaborative effort among the California Academy of Sciences (CAS), National Museum of Natural History, Smithsonian Institution (USNM) and the Nature and Wildlife Conservation Division, Forest Department, Ministry of Forestry, Myanmar, has surveyed throughout the country from 1999 to present, and as such has discovered new species (18 of which have been recently described in Slowinski and Wüster, 2000; Slowinski *et al*., 2001; Bauer, 2002, 2003; Schulte *et al*., 2004; *Vindum et al*., 2003; Wilkinson *et al.*, 2003, Wilkinson *et al*., 2005; Wogan *et al*., 2003; Zug *et al*., 2006), rediscovered some rare species (Wilkinson and Rao, 2004; Gonzalez *et al*., 2005), as well as new country division/state records (Leviton *et al*., 2003; Gonzalez and Vindum, 2005), and range extensions. The importance of documenting the composition of the herpetofauna within Myanmar has been pointed out in several region wide assessments (Inger, 1999; Bhupathy, 2000; Das, 2000). Because of the biogeographic position of Myanmar, and because so many type localities (84 according to Hamadryad Vol. 33, No. 1) lie within Myanmar's borders, an understanding of the patterns of distribution, and the evolutionary histories of Asia's amphibian and reptile species can not be fully understood until data from Myanmar can be incorporated into comprehensive regional assessments. At present, there are 82 amphibian and 289 reptile taxa (Zug *et al*., 2003) documented in Myanmar. CAS anticipate that the number of species confirmed from Myanmar will continue to grow as survey efforts in border regions with Bangladesh, India, China, Laos and Thailand, are carried out and research progresses. Records are organized alphabetically by family and then by genus and species. Distribution data for snakes belonging to the families Elapidae and Viperidae are further detailed in Leviton *et al*. (2003). Distributions for species belonging to the genus *Hemidactylus* within Myanmar are depicted in Zug *et al*. (2007). A total of 32 marine and non-marine chelonia species are recorded from Myanmar, six of them are endemic species. Some of them are listed under threat and near threatened species (Win Maung and Win Ko Ko, 2002).

1.2.3 Lepidoptera

Forest Department reported 1152 species of butterflies in Myanmar in 2002. Another report states that northern Myanmar is considered to be one of the richest in the world for Lepidoptera (Wikramanayake *et al*., 2002). Myanmar has 68 species of swallowtail butterfly (Dinerstein *et al*., 1993) making it the world's fifth richest area for this group. Ecotourists interested in butterfly collecting have been coming to the country, attracted by the relatively intact forests, especially in the northern part of the country. Kenyon (2004) attempted to indicate the range of species and estimated their numbers as 1250 while refining the knowledge of the country's butterflies in Alaungdaw Khathapa National Park, Popa Mountain Park, Pyin U Lwin and Kalaw.

1.3. Threats to Myanmar's Biodiversity

There are high numbers of animal species in Southeast Asia (IUCN, 2004) but they are subject to intensifying pressures. Human impacts are now a pervasive facet of life on Earth. In Myanmar, human population is increasing at about 2.02% per year (Central Statistical Organization 2001) and the export of timber as a source of hard currency are causing rapid encroachment of many of the remaining areas of largely natural habitats (Than Zaw *et al*., 2008). Species extinction, endangerment, and ecosystem degradation are not the aims of human societies, but are the unfortunate by-product of human activities. Natural resources such as timber, fish and wildlife are also strained by demands from Myanmar's neighbours, China, India, Thailand, and Bangladesh (Myint Aung *et al*., 2004). Many rural people eat and trade wildlife, and the country's common border with China is a powerful driver of wildlife hunting (Yiming and Dianmo, 1998; Li Yi-ming *et al*. 2000; Bell *et al*. 2004). Hunting for subsistence and trade together with habitat loss due to logging and shifting cultivation, adversely affect biodiversity in north Myanmar (Uga, 1995; Brunner *et al.* 1998; Rabinowitz, 1998; Lynam, 2003). In sum, logging, barely-restricted hunting, and destructive agricultural practices have spurred significant wildlife declines and rapid loss of natural habitats (Rao *et al*. 2002). The main threats to biodiversity in the Priority Corridor are shifting cultivation, hunting and timber extraction (including associated road construction). The latter two threats are driven by commercial demand from China.

1.4. Conservation Situation in Myanmar

Population growth and rapid economic development are critical concerns in many developing countries including Myanmar. Many species are declining to unsafe population levels, important habitats are being destroyed, fragmented and degraded, and ecosystems are destabilized through climate change, pollution, invasive species and direct human impacts. So, conservation which includes the prevention of further depletion of biodiversity, has become a serious concern.

Highlighting environmental and biodiversity conservation, Myanmar law encourages community forestry and people's participation in environmental and forest management. Specific legislation to protect wildlife began with Burma Game Rules and the Elephant Protection Act, the heritage of the Indian legislation, which had been in force for nearly a century. Separate legislation for Myanmar was promulgated only in 1936, in the Burma Wild Life Act. But, this old wildlife act was outmoded as far as the present concept of wildlife and biodiversity conservation is concerned. Hence new conservation oriented legislation was promulgated in 1994, entitled the Protection of Wildlife, Wild Plants and the Conservation of Nature Areas Act, and the defunct 1936 act was revoked accordingly. In addition to the implementation of the 1994 conservation legislation, the government's firm intentions regarding biodiversity conservation are evidenced by Myanmar becoming an early signatory of the 1992 Convention on Biological diversity and its subsequent ratification in 1994. This Conservation has now been ratified by over 170 countries. Furthermore, in 1997, Myanmar acceded to the Convention on International Trade in Endangered Species (CITES), which governs the import and export of endangered wild animals and plants and their products.

Accordingly, the Government of Myanmar has now initiated a much needed programme of nature conservation. Protection of soil, water, wildlife, biodiversity and environment is one of the current National Forest Policy's imperatives. This policy seeks to extend the Protected Area System (PAS). In 1981, the government of Myanmar and the United Nations Development Programme (UNDP) jointly initiated the 4-year Nature Conservation and National Park's Project (NCNPP) (Blower, 1980; Anon. 1983). Since initiation of the NCNPP, Myanmar's Protected Areas have increased from 14 to 33 and most of these fall within IUCN category IV, though they do not conform to all criteria (Myint Aung, 2006).

The National Commission for Environmental Affairs (NCEA) was formed in 1990 to coordinate and develop national environmental policy across ministries, and to liaise with foreign countries and non-government organizations regarding environmental matters (Bryant, 1996). The commission published a National Environmental Policy in 1994. In 2005, the NCEA was transferred to the Ministry of Forestry.

1.5. Justification for Present Study

Faunas contain some threatened species and a number which are actually endangered. There is an urgent need to better understand importance of wildlife and the role of animal ecology in areas proposed for development projects such as the inundation of valleys for dam creation, in order to evaluate such possibilities and, where necessary, make appropriate management recommendations. In the present case, the proposal to create seven dams in the north-east of the country poses potentially enormous changes to the natural environment of the region that provides habitat to a variety of animal species of great significance to Myanmar's globally important biodiversity. It is thus of national importance that a proper assessment is made of the likely impact of these development plans and, in particular, any threats to rare or endangered components of our fauna are identified. Only on the basis of such an assessment will it be possible to design management actions that minimize damage to the country's biodiversity.

1.6. Rapid Assessment

Rapid inventories are a relatively new conservation tool designed to assess the biological importance of priority sites for conservation (Rodrigues, 2006). Using short field surveys, usually of no more than four weeks, these inventories evaluate the biodiversity values of sites of global conservation interest, providing scientifically based recommendations for prompt establishment of protected areas and conservation action plans. Identifying conservation targets and ways of eliminating threats, and generating recommendations for immediate conservation action are the main goals of these inventories. None of these inventories are meant to yield complete information on the site. Rapid inventories should not be taken as the sole source of information on biodiversity. While they are a quick and effective way to document biodiversity, they do not provide complete species lists, and abundance information is limited and depends on the areas visited, the seasons in which inventory occurs and the time made available for the visits.

Mammals (especially large mammals) experience heavy human pressures and are important to document, providing a primary indicator of the conservation quality of the area. However, small mammals such as rodents and bats are important groups that if specifically surveyed can provide a more detailed evaluation of the site. Birds are one of the best-documented groups around the world. Because of their high species numbers, and the fact that the range, distribution, and biology are reasonably well known for most species or groups of species, birds are used as habitat indicators. Insects, because of their immense species richness, can rarely be used as a group for rapid inventories. Because of their sensitivity to disturbance, frogs and other amphibian are usually included in rapid inventories. Snakes, because of their low population densities and secretive habits, are difficult to include, however, they can add value as indicators of regional faunas. Because aquatic and terrestrial turtles as well as crocodilians are frequently hunted (WCS, 2000; van Dijk, 2000; Compton 2000; Platt *et al*.,2000; Bhupathy *et al.,* 2000; Anon., 2000b; Carpenter *et al*., 2004) they are always included and evaluated as target species for conservation actions (Platt, 2006).

The best data on global endangerment are collated in the IUCN Red List of Threatened Species (Groom *et al.,* 2006). The Red List is seen as a work in progress, undergoing constant revision both to document true changes in status, and to reflect updates in our knowledge. Through these efforts, the IUCN Red List has become the most complete data base in global status of species available.

1.7. Objectives of the Present Survey

- To examine the presence and absence of fauna species in proposed dams areas
- To determine their distribution and their relative abundance
- To evaluate the key species among them
- To investigate the direct and indirect threats to these faunas, including those that are likely to arise as a result of the proposed dam constructions and subsequent inundations of river valleys
- To recommend appropriate conservation measures for the long-term survival of key species in proposed dams areas.

CHAPTER 2

2. STUDY AREAS

The Ayeyawady River Basin above Myitkyina is located at the upstream of Ayeyawady River with 25°40’ ~ 28°50’ north and longitude of 97°26’ ~ 98°47’east. Its total catchment area is about 49,400 sq km, of which 43,600 sq km is in Myanmar and 5,800 sq km is in China. It has two origins, Mayhka River is the main east source of Ayeyawady River and the west source, Malihka River takes its rise from the mountains of northern Myanmar near the boundaries of China.

Seven power stations are planned to build in Ayeyawady River basin above Myitkyina, among which one is 5 km downstream the confluence mouth of two rivers, one is in Malihka River and five are in Mayhka River. Fauna composition (mammal, bird, reptile and amphibian, and butterfly species), their distribution, their habitat use and their threats were studied on these areas of proposed dams, named Myitsone, Lasa, Chibwe, Wusok , Pisa, Khaunglanhpu and Yenam (Figure 2).

CHAPTER 3

3. MATERIALS AND METHODS

A total of 31 persons participated in this fauna survey listed in Table 3. Fauna group is supervised by Dr. Su Su as a fauna leader. This study group was divided into four teams, viz Mammal, Bird, Reptile and Amphibian (Herpetofauna) and Insect with a leader in each group.

A number of rapid survey methods were used to obtain the various types of information.

1. **Observation** (with GPS readings and with or without binoculars/spotting scope), accompanied by written notes and photographs. General assessments of vegetation cover and environmental effects - human impacts were also observed.
2. **Specimen collection** for later identification. Dead animals and their body parts were collected on trials and forest, and also from local people (hunters).
3. **Interviews** with local villagers and hunters were used to obtain information about fauna species and their exploitation.
4. **Trapping** and mist netting were used to a very limited degree to sample the small mammals such as rats and bats.
5. **Identification** with the references.

3.1. MAMMAL

Participants

The survey was carried out from January to May 2009. The team comprised Aung Soe Than, Swe Swe Aung, May Thu Tun, Thandar Win, Thida Nyein, Myo Min Tun and Kyaw Naing Oo (Table 3).

A number of rapid survey methods were used to obtain various types of information. A variety of techniques were employed to investigate the presence, abundance and habitat use of mammals in the study area. These included the observation (with GPS readings by GPS 76S, GPS Emap, GPS 72) and recording of sign. Sign, appearance and key identification features were noted and photographed with Nikon COOLPIX 70043031, Nikon COOLPIX L18 71007717 cameras. General assessment of vegetation cover and human impacts were also observed.

Signs – footprints, scats and resting sites

General evidences of a species' presence in an area can be obtained from their scats and tracks (footprints). Searching for signs of mammals in surveys was carried out from January to May 2009, mainly concentrating on and beside the trails and roads and other branch roads in proposed dams areas. However, for correct identification of a species, characteristics of tracks must be noted very carefully. The size of the tracks themselves demands caution and most tracks found in the wild are likely to show incomplete details. Systematic searches were made around and on the wildlife trails that wild animals were thought to be using. Whenever possible, footprints were measured (width and length) with a measuring ruler. The footprints were also photographed.

All scats encountered were collected with a note of date and location and suspected species (where the form of the scat was distinctive). Some were photographed.

Other signs observed included soil disturbed by digging or scratching (for food) and resting sites. The resting sites in dense shrubs, found in undisturbed areas, green patches of ground vegetation (grasses and herbs) near water, and sometimes adjacent to human settlements.

Live trapping and Mist-netting

A limited amount of systematic live trapping and mist netting was done to investigate rats and bats respectively. Live-traps used, had a compartment size of 30 × 15 × 13 cm, were of wire mesh construction and were all made locally. Problems were encountered with live-traps being destroyed along the trails, and very limited live-trapping was done only in Myitsone area (I), the first place to be investigated. Traps were baited with chicken sausages and no small mammals were captured. Mist-netting was done in areas of Chibwe, Wusok, Khaunglanhpu and Yenam (III, IV, VI, VII), using 6 × 3 m nets with a mesh size of 3.8 cm, made in China.

Remains and observation

Carcasses and body parts of vertebrates were collected for later identification. Some were collected or seen on trails and in the forest, and also obtained from local hunters. This provided an indication of presence of various species of wildlife and, where possible, live animals were also carefully observed and photographed**.**

Camera trapping

Camera trapping, to gain information on diurnal and nocturnal activities of animals, was done by Chinese researchers.

Interview survey and verbal reports

In addition, interviews with local villagers and local hunters, KIA (Kachin Independence Army), NDKA (National Democratic Kachin Army), Lazun Aungwa insurgents, Anti-insurgents and staff of the Forest Dept. and WCS were used to obtain information about fauna species and their exploitation. Incidental information, such as that on the presence of species and threats to survival, was obtained from discussions with persons familiar with these areas.

Identification was carried out using the references of Tun Yin, 1966; Lekagul and McNeely, 1977; Corbet and Hill, 1992, Rabinowitz, 1993; Anon., 1996; Kanjanavanit, 1997; Francis, 2001 and 2008, Parr, 2003; Parr and Tin Than, Undated; Anon, 2005; and Qinghua *et al*., 2007.

3.2. REPTILE AND AMPHIBIAN (HERPETOFAUNA)

Participants

The survey started from January to May 2009. The team comprises Awan Khwi Shein, Thaw Zin, Myint Kyaw Thuya, Nay Myo Win, Aung Ko Ko, Min Thein Htet, Yan Naing Hein and Kyaw Swa Aung (Table 3).

Herpetofaunas were collected in the forest or along trails both night and day by hand with the help of long stick clipper made locally. Latitude and longitude of the localities were recorded using a Garmin 12 XL GPS (datum WGS 84). Collected specimen were euthanized and then fixed in 10% buffer formalin before transferred to 70% ethanol. Photo records were taken by digital cameras (SONY Cyber-shot DSC - S730 and Nikon COOLPIX L18). Morphological characters such as sizes, shapes, patterns, spots, stripes, color of the body, length of the body and scales counting were observed to identify and recorded in the data form. Measurements of the specimen were taken using digital calipers and measuring tapes. Encountered individual of species, general assessment of vegetation cover (microhabitat) and human impacts were also observed. Specimen was deposited into plastic boxes. Specimens were identified by using the following references of Anon. 2003; Anon. undated; Cox *et al*. 1998; Leviton *et al*. 2002, Win Maung and Win Ko Ko 2003 and Zug 1997 a,b,c,d,e. Interviews with local villagers and hunters were used to obtain information about fauna species and their exploitation.

3.3. INSECT (BUTTERFLY)

Participants

The survey was carried out from January to May 2009. The team comprised Aung Moe, Naing Naing Win, Than Than Htay, Khin Sandar Hlaing, San Wai Tint, Khin Mar Lwin, Phyoe Thida and Nay Myo Aung (Table 3).

The team mostly walked along the trails or path ways in the study areas. According to the availability of references, only butterflies were identified. Butterflies were collected by using the long-handled aerial nets (made locally) in the field survey. Morphological characters such as patterns, spots, stripes and colour of the body were observed to aid identification. Measurements of body and wing of specimens were also recorded. Photos were taken by using cameras (SONY Cyber-shot DSC-S730 and Nikon COOLPIX L18) whenever possible. Specimens taken were kept in triangle envelops on which were written the collection dates, location (GPS coordinates by using Garmin *GPS 76S* and *GPSmap 60CSx*) and collector's names. All specimens were preserved in the airtight plastic containers, so as to avoid humidity. Silica gel to absorb the vapour and moth ballsto prevent the growing of mold were put inside containers. Identifications were made with the references of Kenyon 2004; Mani 1986; Pinratana undated a, b, c, d. Observed days, observed individual frequencies of each species were recorded. General assessment of vegetation cover (microhabitat) and human impacts were also observed.

Table 3.List of fauna group

	Ornithology Team	Mammalogy Team	Herpetology Team	Entomology Team
1	Thet Zaw Naing*	Aung Soe Than*	Awan Khwi Shein*	Aung Moe*
2	Saw Moses	Swe Swe Aung	Thaw Zin	Naing Naing Win
3	Sa Myo Zaw	May Thu Tun	Myint Kyaw Thuya	Than Than Htay
4	Lay Win	Thandar Win	Aung Ko Ko	Khin Sandar Hlaing
5	Lay Ko Ko	Thida Nyein	Nay Myo Win	San Wai Tint
6	Tin Aung Tun	Myo Min Tun	Min Thein Htet	Khin Mar Lwin
7	Thiri Dawee Aung	Kyaw Naing Oo	Yan Naing Hein	Phyoe Thida
8	Ma Nyunt Shwe		Kyaw Swa Aung	Nay Myo Aung

***=Team leader**

CHAPTER 4

4. RESULTS

Some the specimens collected together by both teams were taken away to China by Chinese scientists for identification. Those taxonomy results are not included in the following Myanmar species checklists. They are described with seperate tables.

4.1. MAMMAL

Itinerary: The detailed itinerary is shown in Tables 4.1.1 and 4.1.2.The study sites of Mammal team are shown in Figures 4.1.1 to 4.1.7.

Species abundance: A total of 61 mammal species, under the various mammalian orders was recorded and identified as follows (Appendix 4.1.1): one species of Pholidota, two species of Insectivora, seven species of Chiroptera, six species of Primates, 17 species of Carnivora, one species of Proboscidea, 12 species of Artiodactyla and 15 species of Rodentia (Figures 4.1.8 to 4.1.19 and Table 4.1.3).

The following materials were obtained but did not provide sufficient evidence for precise identification: pangolin (smoked feet and verbal information), shrew (rotten carcass and visual), otter (footprint and information), ferret badger (dead body), civet (footprints and scats), small cat (footprints and scats) and muntjac (footprints and vocalization) (Appendix 4.1.1a). No hard (visual) evidence was found for the following nine species of mammal but verbal information only was obtained: sunda pangolin, northern treeshrew, northern pig-tailed macaque, golden jackal, Oriental small-clawed otter, hog badger, large spotted civet, binturong and jungle cat (Appendix 4.1.1b).

Conservation status: According to the conservation status of 2009 IUCN Red List Data, five species recorded by the survey are listed as Endangered (EN), 13 species are listed as Vulnerable (VU), seven species are listed as Near Threatened (NT), 28 species are listed as Least Concern (LC) and three species are listed as Data Deficient (DD) (Table. 4.1.4 and Appendix 4.1.1). Twelve, 13 and 5 recorded species are included in 2009 CITES Appendices I, II and III respectively (Table 4.1.5 and Appendix 4.1.1).

Endangered species (EN) recorded are Chinese pangolin *Manis pentadactyla*, Shortridge's langur *Trachypithecus shortridgei*, Dhole *Cuon alpinus*, fishing cat *Prionailurus viverrinus*, Asian elephant *Elephas maximus*. While Bengal slow loris *Nycticebus bengalensis*, stump-tailed macaque *Macaca arctoides*, eastern hoolock gibbon *Hoolock leuconedys*, Asian black bear *Ursus thibetanus*, sun bear *Helarctos malayanus*, red panda *Ailurus fulgens*, marbled cat *Pardofelis marmorata*, clouded leopard *Neofelis nebulosa*, black muntjac *Muntiacus crinifrons*, sambar *Rusa unicolor,* gaur *Bos gaurus*, Takin *Budorcas taxicolor* and red goral *Naemorhedus baileyi* are catergorized as Vulnerable (VU) in IUCN Red List Data, 2009 (Table 4.1.5 and Appendix 4.1.1).

A total of six mammal species were recorded more by Chinese researchers (it means they found and identified these 6 spp. in greater numbers and these are that non-Chinese did not find at all) shown in Appendix. 4.1.9. Two species of Artiodactyla and four species of Rodentia were recorded. Within these species, five species are listed as Least Concerned in 2009 IUCN Red List Data.

4.1.1. Myitsone, study area I

Wildlife: A total of 30 species of mammal were recorded by the various types of evidence. One species of Pholidota, one species of Insectivora, six species of Primates, 11 species of Carnivora, one species of Proboscida, four species of Artiodactyla and six species of Rodentia were encountered (Table 4.1.3 and Appendix 4.1.2).

Of these, the following eight species were directly sighted in the numbers shown in brackets: rhesus macaque (6), Shortridge's langur (1), yellow throated marten (2), Eurasian wild pig (7), southern red muntjac (1), black giant squirrel (1), hoary-bellied (Irawaddy) squirrel (1) and Himalayan (Myanmar) striped squirrel (3) at Myitsone surveyed sites (Appendix 4.1.2**).** Not only was the distinctive vocalisation of Eastern hoolock gibbon heard, but also information from locals was recorded. Distinct footprints of Asian elephant and digging signs of Eurasian wild pigs provided reliable identification for those two species. Twenty species were identified from wildlife remains, mostly obtained from local people who hunted places surrounding the study areas. Skulls and skins were most common, plus a taxidermy, tails, teeth, stomach and quills. Claw marks of bear, a footprint of otter, scats of civets and small cats, and vocalisations of muntjac were recorded but did not permit precise identification of the species. Only information on golden jackal, hog badger, binturong and small-toothed palm civet were got from local people (Appendices 4.1.2a and 4.1.2b).

Hunters were present in this area earlier but they are no longer active. The heads of muntjacs, sambars, monkeys were hung in the local peoples' houses. The insect survey team witnessed seven wild boars running across into the forest near Thae waine village (old road for going to Laiza – Myanmar China border town) while the KIA (Kachin Independent Army) shot at them**.**

According to information from local people, five domestic elephants are reared in this village. Wild elephants (3 individuals) are present in the west of Jubali village. Dung and footprints of elephants were found. A house destroyed by wild elephant was seen. Wild elephants - (9 individuals) are also present in the Bone-par mountain, north of Jubilee. It had 15 individuals earlier. Gibbons are not visible along Malihka River. However, monkey species are abundant.

Threats: KIA has access to guns and usually kills wildlife including mammals. However, they mostly kill mammals with snares and jaw-traps. Many traps were set up with markings in the forest. Habitat of mammals was degraded by logging and gold dredging.

Conservation Status: Conservation status of mammal species in Myitsone is shown in Table 4.1.5 and Appendix 4.1.2. IUCN Red List Data – EN: 4, VU: 7, NT: 4, LC: 14; CITES - Appendix I: 8, II: 9, III: 5; Myanmar status – Protected: 2, Seasonaly protected: 1

Conclusions and Discussion: Thirty one mammal species were identified with the type of evidences shown (Appendix 4.1.2). A few genera (6) were unidentified (Appendix 4.1.2a) and the species indicated only from verbal information (4) are listed in Appendix 4.1.2b.

A large majority of species were identified by wildlife remains and information. Information was easy to get from the local people, who had guns and were able to hunt at all times.

Chinese pangolin *Manis pentadactyla*, Shortridge's langur *Trachypithecus shortridgei*, eastern hoolock gibbon *Hoolock leuconedys*, dhole *Cuon alpinus* and Asian elephant *Elephas maximus* are listed as Endangered (EN) and Bengal slow loris *Nycticebus* *bengalensis*, stump-tailed macaque *Macaca arctoides*, Asian black bear *Ursus thibetanus*, sun bear *Helarctos malayanus*, clouded leopard *Neofelis nebulosa* and Gaur *Bos gaurus* are also listed as Vulnerable (VU) in IUCN Red List Data, 2009 (Table 4.1.5 and Appendix 4.1.2).

In summary, the total mammals recorded in Myitsone area 36.67 per cent were of endangered species (EN +VU), 13.33 per cent Near Threatened (NT), 46.67 per cent Least Concerned (LC) and 3.33 per cent Of Unknown Status (Table 4.1.4). It is important to note that the proportion of animals belonging to mammal species that are Endangered in this location is very high, indicating great significance to the biodiversity of Myanmar and calling for some carefully planned and executed conservation measures. Although there is some evidence that hunting may be in decline recently, there is no guarantee that this will remain so and the presence of many guns (with the KIA) must be regarded as a serious threat to wildlife in this area.

4.1.2. Lasa, study area II

<u>Wildlife:</u> Thirty five species of mammal were identified in Lasa area. One species of Pholidota, one species of Chiroptera, six species of Primates, 12 species of Carnivora, six species of Artiodactyla and nine species of Rodentia were encountered (Table 4.1.3 and Appendix 4.1.3).

Nine species of mammal, viz least pipistrelle (1), stump-tailed macaque (1), Shortridge's langur (9), common palm civet (2), black giant squirrel (2), Pallas's squirrel (1), Himalayan (Myanmar) striped squirrel (1), black (house) rat and chestnut white-bellied rat (Indomalayan niviventer) (dead body) were directly sighted at surveyed sites in Lasa area (Appendix 4.1.3). Vocalisations of eastern hoolock gibbon were recorded. Digging signs of Erasian wild pig were found. Pangolin and shrew were unidentified to species (Appendix 4.1.3a). Northern treeshrew and hog badger were recorded from verbal information only (Appendix 4.1.3b).

Wildlife remains including tails, dead bodies, teeth on jaws, quills, gall bladder, genital organ, stomach, claw and horn were found. Skulls and skins were the mostly observed remains.

Footprints of wild boar were found. It was reported that in 1997-98, some disease occurred in wild pig.

Vocalisation of gibbon was heard at Pone-in-yan village. Vocalisation of monkeys was heard at Suprabum and Maliyan villages.

<u>Threats:</u> Compared to Myitsone area, logging is much frequent in Lasa. Much gold mining was also found in Lasa. Hunters were present in Sumpiyan and Maliyan villages. Hunters use Tu-mee guns, snares and snap/jaw traps for hunting and they capture whatever wildlife is available.

<u>Conservation status:</u> Conservation status of mammal species in Lasa area is shown in Table 4.1.5 and Appendix 4.1.3. IUCN Red List Data – EN: 3, VU: 8, NT: 5, LC: 18; CITES – Appendix I: 7, II: 9, III: 5; Myanmar status – Protected: 1, Seasonally protected: 2

<u>Conclusions and Discussion</u>: Thirty five mammal species were identified with the type of evidences indicated (Appendix 4.1.3). Unidentified species and species recorded only from local information are listed in Appendices 4.1.3a and 4.1.3b.

A large proportion of the wildlife recorded was identified from remains and information. Information from the local people was the major type of evidence, probably because they are experienced in hunting.

Chinese pangolin *Manis pentadactyla*, Shortridge's langur *Trachypithecus shortridgei* and dhole *Cuon alpinus* are listed as Endangered (EN) and Bengal slow loris *Nycticebus bengalensis*, stump-tailed macaque *Macaca arctoides*, Eastern hoolock gibbon *Hoolock leconedys*, Asian black bear *Ursus thibetanus*, sun bear *Helarctos malayanus*, clouded leopard *Neofelis nebulosa,* sambar *Rusa unicolor* and Gaur *Bos gaurus* are also listed as vulnerable (VU) in IUCN Red List Data, 2009 (Table 4.1.5 and Appendix 4.1.3).

In Lasa area, 31.43 per cent of the mammals recorded are listed as Endangered species (EN +VU), 14.29 per cent as Near Threatened (NT), 51.43 per cent as Of Least Concern (LC) and 2.86 per cent as Of Unknown Status (Table 4.1.4). As in the case of Myitsone, there is a significant proportion of Endangered mammals in the Lasa study area (and an even higher one, >50%, of Near Threatened animals) that demands high quality conservation measures to accompany the proposed dam construction if serious damage to Myanmar's biodiversity is to be avoided.

4.1.3. Chibwe, study area III

<u>Wildlife:</u> Twenty eight species of mammal were identified by the type of evidences indicated. One species of Pholidota, one species of Insectivora, six species of Primates, five species of Carnivora, seven species of Artiodactyla and eight species of Rodentia were encountered (Table 4.1.3 and Appendix 4.1.4).

Seven species of mammal, viz stump-tailed macaque (1), Rhesus macaque (12), southern red muntjac (1), black gaint squirrel (2), Anderson's squirrel (2), Common (red) giant flying squirrel (1) and Bower's rat (Bower's white-toothed rat) (dead body) were directly sighted at Chibwe study sites (Appendix 4.1.4). In addition to hearing the vocalisation of Eastern hoolock gibbon, information obtained from locals was also recorded. Digging signs of Eurasian wild pig were distinct. Pangolin, shrew, otter and muntjac were unable to identify to specific species level (Appendix 4.1.4a). Sunda pangolin and northern pig-tailed macaque were recorded for verbal information only (Appendix 4.1.4b).

Dead bodies, scales, quills, foot, tail and horn were also found. Skulls and skins were the most numerous remains recorded.

One of the local houses at Tan-de has many wildlife skins and a baby muntjac was reared there as a pet. Wild boar was captured from Kaung-hla village by local people and made into a curry. A salt lick (especially for deers/wildlife) was found. Pangolins were captured by local hunters and those with a golden colour are more expensive. Otters were present in the last 3 years, found around Kaung hla and Phala villages. Tiger was found in the last 15 years around Chibwe. Vocalisation of muntjacs was heard from the forest on the other side of Mayhka River (Phala village) and from the west side of Mayhka River. Vocalisation of gibbon also could be heard from the east side of Mayhka River but they were not seen in the KIA area (other side of Phala village). Groups of sambar are present on the mountain, west side of Laung-phang, Phone-phang villages. Assam and stump-tailed macaques are present. Muntjacs were mainly recorded from information given by hunters. Wildlife is becoming rare, negatively affected by deforestation. Jaw-traps are mostly set up in the forest.

Heads and skins of wildlife were found in village houses. Lisu hunters are present on the other side of the river, wildlife skins are present in Maja village. Some opportunistic hunters were found in Kaung-hla and Tan-kin villages and some wildlife found as pets. Jaw/snap traps are frequently set up and found by the project researchers on the other side of the study area. Hunter groups (3, 2, 3) were found by the aquatic team.

Threats: Loggings were found in Chibwe area. Many slash and burn cultivations were also found on the hill-sides, including hill tops. Along the Mai Hka River, deep hills start from after Chibwe town. Local hunters were present as opportunistic hunters. Hunters use Tu-mee guns, snares and snap/jaw traps for hunting and they capture whatever wildlife is available. Hunters usually set up traps in the forest/jungle. Captured wildlife, especially pangolins, were sold at the border area.

Conservation status: Conservation status of mammal species in Chibwe area is shown in Table 4.1.5 and Appendix 4.1.4. IUCN Red List Data – EN: 1, VU: 8, NT: 6, LC: 11; DD: 1; CITES – Appendix I: 8, II: 7, III: 1; Myanmar status – Protected: 1, Seasonally protected: 3

Conclusions and Discussion: Twenty-nine mammal species were identified with the various types of evidences shown (Appendix 4.1.4). Unidentified species and species identified only from verbal information are listed in tables 4.1.4a and 4.1.4b. Wildlife remains were the most common among the various types of evidence.

Of mammal species recorded at this site Chinese pangolin *Manis pentadactyla* is listed as Endangered (EN) and Bengal slow loris *Nycticebus bengalensis*, stump-tailed macaque *Macaca arctoides*, Eastern hoolock gibbon *Hoolock leuconedys*, Asian black bear *Ursus thibetanus*, red panda *Ailurus fulgens*, marbled cat *Pardofelis marmorata*, sambar *Rusa unicolor* and Gaur *Bos gaurus* are listed as vulnerable (VU) in IUCN Red List Data, 2009 (Table 4.1.5 and Appendix 4.1.4).

Of mammals recorded in the Chibwe area, 32.14 per cent of endangered species (EN +VU), 21.43 per cent of Near Threatened (NT), 39.29 per cent of Least Concerned (LC), 3.57 per cent of Data deficient (DD) and 3.57 per cent of unknown status (Table 4.1.4). As in areas reported above, Chibwe has a relatively high proportion of endangered animals that will need special protection from the disturbances caused by dam building in the area.

4.1.4. Wusok, study area IV

Wildlife: Twenty two species of mammal were recorded as definite species in the Wusok area. One species of Insectivora, three species of Chiroptera, four species of Primates, four species of Carnivora, seven species of Artiodactyla, and three species of Rodentia were encountered (Table 4.1.3 and Appendix 4.1.5).

Seven species of mammal, viz least horseshoe bat (2), great Himalayan leaf nosed bat (1) and Stoliczka's Asian trident bat (2) as alives, Assam macaque (18), Stump-tailed macaque (1), Shortridge's langur (2) and southern red muntjac (3) were directly sighted at surveyed sites in Wusok area (Appendix 4.1.5). Not only vocalisation of Eastern hoolock gibbon, but also verbal information was recorded. Digging signs of Eurasian wild pig were distinct for species identification. Shrew, Otter and muntjac species were unable to identify to specific species (Appendix 4.1.5a).

Within 22 species of mammal remains, skulls were the most numerous recorded. Carcasses and skin were also found.

Wildlife are abundant at Wusok, especially muntjac. Otters are reported to have been present in the last 2 years. Local people killed wildlife, especially primates, as evidenced by plentiful skulls in the area. Other wildlife was mostly captured by using snares and jaw traps but every house has its own tumee guns. In Pa-she village

Assamese macaques were observed in large numbers. Eight monkey skeletons were seen hanging in a small Chinese restaurant at Wusok.

Threats: Local hunters are present. Habitat loss caused by clearing for plantation was found.

Conservation status: Conservation status of mammal species in Wusok is shown in Table 4.1.5 and Appendix 4.1.5. IUCN Red List Data – EN: 1, VU: 6, NT: 3, LC: 8, DD: 2; CITES – Appendix I: 5, II: 5; Myanmar status – Seasonally protected: 2

Conclusions and Discussion: Shortridge's langur *Trachypithecus is* listed as Endangered (EN) and stump-tailed macaque *Macaca arctoides*, Eastern hoolock gibbon *Hoolock leconedys*, Asian black bear *Ursus thibetanus*, sun bear *Helarctos malayanus*, marbled cat *Pardofelis mamorata*, takin *Budorcas taxicolor* are listed as Vulnerable (VU) species in IUCN Red List Data, 2009 (Table 4.1.5 and Appendix 4.1.5).

In Wusok area, 31.82 per cent of mammals recorded were of endangered species (EN +VU), 13.64 per cent of Near Threatened (NT), 36.36 per cent of Least Concern (LC), 9.09 per cent of Data deficient (DD) and 9.09 per cent of Unknown Status. (Table 4.1.4). As in other areas above, a significant proportion of the mammals in the Wusok area are in the internationally recognized 'Endangered' category that requires robust conservation measures, especially as works entailed in the proposed dam construction are likely to cause disruption and loss of their habitats.

4.1.5. Pisa, study area V

Wildlife: Sixteen species of mammal were recorded by the types of evidences indicated below: one species of Insectivora, two species of Primates, three species of Carnivora, six species of Artiodactyla and four species of Rodentia were encountered (Table 4.1.3 and Appendix 4.1.6).

The following five mammal species white-tailed mole (1), Rhesus macaque (12), southern red muntjac (1), Pallas's squirrel (1) and Malayan porcupine (2) were directly sighted at Pisa surveyed sites (Appendix 4.1.6). No Eastern hoolock gibbon was found; distinct footprints of Asian elephant and digging signs of Eurasian wild pig provided reliable identification for these two species. Within 16 species of mammal remains recorded, skulls were the most numerous and carcasses and skin and horn were also found.

Threats: Habitat loss, logging and hunting seemed fewer than in some other areas but proximity of this area to the international border crossing and the presence of roads for ready access potentially poses a serious long-term threat to its wildlife.

Conservation status: Conservation status of mammal species in Pisa is shown in Table 4.1.5 and Appendix 4.1.6. IUCN Red List Data – EN: 1, VU: 2; NT: 3, LC: 8, DD: 1; CITES – Appendix I: 3, II: 4, III: 1; Myanmar status – Seasonally protected: 2

Conclusions and Discussion: Sixteen mammal species were identified with the type of evidences shown (Appendix 4.1.6). As in other areas, wildlife remains were more numerous than other types of evidence.

Fishing cat *Prionailurus viverrinus* is listed as Endangered (EN) and red panda *Ailurus fulgens,* takin *Budorcas taxicolor* are listed as Vulnerable (VU) species in IUCN Red List Data, 2009 (Table 4.1.5 and Appendix 4.1.6).

In Pisa area, 18.75 per cent of endangered species (EN +VU), 18.75 per cent of Near Threatened (NT), 50 per cent of Least Concerned (LC), 6.25 per cent of Data deficient (DD) and 6.25 per cent of unknown status are calculated (Table 4.1.4).

This study area has fewer mammal species than other areas and only one classified as 'Endangered' and two as 'Vulnerable', hence it is of less conservation importance than some other areas. However, all of these three species are relatively rare within Myanmar and should be given maximum conservation protection, especially as they are near to the international border and thus vulnerable to hunting or capture for the wildlife trade.

4.1.6. Khaunglanhpu, study area VI

Wildlife: A total of nineteen species of mammal were recorded by the types of evidences shown below, comprising two species of Chiroptera, three species of Primates, four species of Carnivora, seven species of Artiodactyla and three species of Rodentia (Table 4.1.3 and Appendix 4.1.7).

Nine mammals within the following species Blanford's fruit bat (4), Stoliczka's Asian trident bat (3) and Assam macaque (2) were sighted at Khaunglanhpu survey sites (Appendix 4.1.7). There were no records of vocalisations. Footprint of muntjac, macaque and digging signs of Eurasian wild pig were observed. A shrew and a muntjac were unidentified to species level (Appendix 4.1.7a). Carcasses, skulls and horns were found as wildlife remains, with skulls being the most frequently recorded.

Hunters were found to be present in this area. They use du-lay or poisonous arrows. Wildlife remains/parts were found in local houses. Wild boars are plentiful during paddy ripening time, but disease occurred and, as a result, wild boars are becoming less abundant after 1996. Footprints of wild boar t were only just visible and they are becoming rare. Other villagers hunted wildlife and came to sell it in Khaunglanhpu. Hunters are not very visible in Khaunglanhpu. A bear was captured before the survey trip and, according to information received, was taken to China and sold there. Wildlife was mostly captured by using snap-jaw traps. Mythun are reared as domestic animals. The local people release them into the reserved forest and erect a fence to prevent them from disturbing their own cultivation land. Khaunglanhpu area is nearer to China than Yenam area.

Muntjac, takin and red serow are abundant in Khaunglanhpu and wildlife are more abundant on the western side of Mai Hka River**.** Glaciers are present on the mountains.

Threats: Habitat loss, logging and hunting seemed fewer in this area but the fact that this area is near to the international border crossing and roads are present constitutes a potential serious threat to traded wildlife species, whether for meat or the Chinese medicine market.

Conservation status: Conservation status of mammal species in Khaunglanhpu is shown in Table 4.1.5 and Appendix 4.1.7. IUCN Red List Data – EN: 1, VU: 4, NT: 3, LC: 9; DD: 2; CITES – Appendix I: 4, II: 5, III: 1; Myanmar status – Seasonally protected: 2

Conclusions and Discussion: Nineteen mammal species were identified with the type of evidences shown (Appendix 4.1.7). Wildlife remains were significantly more than the other types of evidences recorded.

Dhole *Cuon* is listed as Endangered (EN) and Bengal slow loris *Nycticebus bengalensis*, stump-tailed macaque *Macaca arctoides*, Asiatic black bear *Ursus thibetanus*, takin *Budorcas taxicolor* are listed as Vulnerable (VU) species in IUCN Red List Data, 2009 (Appendix 4.1.8).

In Khaunglanhpu area, 26.32 per cent of mammals identified were of endangered species (EN +VU), 15.79 per cent of Near Threatened (NT), 47.37 per cent of Least Concerned (LC) and 10.53 per cent of Data Deficient (DD) (Table 4.1.4).

Species and numbers of individuals recorded in this area are low compared to most other areas but a significant proportion of them are classified as 'Endangered, 'Vulnerable' or 'Near Threatened', indicating the need for strong conservation measures, at least with those particular species. Dhole (Asiatic wild dog), in particular is a highly endangered carnivore and should be given maximum protection wherever it is present within its range. It is a very important component of Myanmar's fauna.

4.1.7. Yenam, study area VII

Wildlife: Thirty two species of mammal were recorded by the types of evidences indicated below. They are one species of Pholidota, one species of Insectivora, three species of Chiroptera, four species of Primates, 13 species of Carnivora, six species of Artiodactyla and four species of Rodentia (Table 4.1.3 and Appendix 4.1.8).

Within sighted category were six mammal species, viz greater shortnosed fruit bat, Blandford's fruit bat and great woolly horseshoe bat were found as alive 2, 4 and 1 respectively. Rhesus macaque (5) and alive Hoary bamboo rat (3) were recorded at Yenam survey sites (Appendix 4.1.8). Both vocalization and information relating to Eastern hoolock gibbon was recorded. Signs of Eurasian wild pig were distinct for reliable species identification. Pangolin and otter are unidentified to species (Appendix 4.1.8a). Northern treeshrew, Nothern pig-tailed macaque, golden jackal, Oriental small-clawed otter, hog badger, large spotted civet, binturong and jungle cat were recorded from information only (Appendix 4.1.8b).

Only a little hunting was seen in Aleaung village, but there were more occurrences of hunting before WCS came. Hunters in these villages are opportunistic hunters. Mythun is present as a domestic animal in Yenam. Black muntjac or gongshan muntjac was captured by the camera trapping of He Bing (Chinese researcher). The other mammal, brush-tailed porcupine was also captured by camera traps.

Threats: Wildlife, including mammals was mostly killed by traps using snares and jaw-traps. Many traps were set with markings in the forest. Habitat loss, logging and hunting appeared and serious in this area and there is also a road present facilitating access across the international border.

Conservation Status: Conservation status of mammal species in Yenam is shown in Table 4.1.5 and Appendix 4.1.2. IUCN Red List Data – EN: 2, VU: 10, NT: 3, LC: 15, DD:1; CITES - Appendix I: 6, II: 11, III: 3; Myanmar status –Seasonally protected: 1

Conclusions and Discussion: Thirty two mammal species were identified with the type of evidences (Appendix 4.1.8). Wildlife remains were recorded more among the type of evidences and it seems more huntings were done in the past.

Chinese pangolin *Manis pentadactyla*, dhole *Cuon alpinus* are listed as Endangered (EN) and stump-tailed macaque *Macaca arctoides*, Eastern hoolock gibbon *Hoolock leuconedys*, Asian black bear *Ursus thibetanus*, sun bear *Helarctos malayanus*, red panda *Ailurus fulgens*, marbledcat *Pardofelis marmorata*, clouded leopard *Neofelis nebulosa,* black muntjac *Muntiacus crinifrons*, takin *Budorcas taxicolor,* red goral *Naemorhedus baileyi* are also listed as Vulnerable (VU) in IUCN Red List Data, 2009 (Appendix 4.1.8).

In Yenam area, 37.5 per cent of endangered species (EN +VU), 9.38 per cent of Near Threatened (NT), 46.88 per cent of Least Concerned (LC), 3.13 per cent of Data deficient (DD) and 3.13 per cent of unknown status are calculated (Table 4.1.5).

4.1.8. Overall Conclusions and Discussion

A total of 61 species of mammals representing eight mammalian orders, viz Pholidota, Insectivora, Chiroptera, Primates, Carnivora, Proboscida, Artiodactyla and Rodentia were recorded among the seven survey areas. The greatest number of species (17) was found in the order Carnivora; while 15 rodent species and 12 Artiodactyl species were found. Myitsone (I) study area contained representatives from all eight orders (including uniquely elephants – Proboscida), while Yenam (VII) recorded species from seven orders (Table 4.1.3).

Pangolin, shrew, otter, ferret badger, civet, small cat and muntjac species were recorded but unidentified into specific species.

Sunda pangolin *Manis javanica* and Chinese pangolin *Manis pentadactyla* are found in Myanmar and listed as EN (IUCN, 2009). Chinese pangolin *Manis pentadactyla* (EN) was recorded in Myitsone (I), Lasa (II), Chibwe (III), Yenam (VII) survey areas. Sunda pangolin *Manis javanica* distributes in southern and middle part of Myanmar (Corbet and Hill, 1992; Francis, 2008 and IUCN, 2009).

In otters, Eurasian *Lutra lutra* and Oriental smooth clawed otter *Aonyx cinerea* are listed as NT and VU. These otters distribute in northern Myanmar (Corbet and Hill, 1992; Francis, 2008 and IUCN, 2009). Oriental smooth clawed otter *Aonyx cinerea* recorded information only from Yenam (VII) survey area. It is possible that the otter recorded is the hairy-nosed otter *Lutra sumatrana* which was recorded in north Myanmar in 1939 and a specimen is still in the Natural History Museum, London (Duckworth and Hills, 2008). But hairy-nosed otter *Lutra sumatrana* distributes in southern Myanmar (Francis, 2008). This species is currently internationally red-listed as Endangered (EN) species (IUCN, 2009). However, otters are almost eradicated from the areas which faces massive hunting pressure and large-scale habitat conversion. It may have suffered the same massive recent trade-driven decline of all otter species.

Sunda pangolin and large spotted civet are not recorded as being distributed in northern Myanmar but information obtained from survey areas suggests they may be present. One of the reasons could be that some wildlife species were traded to Myanmar across the China border into our study areas and thus we can find wildlife which was not formerly known to be distributed in northern Myanmar.

Hog badger *Arctonyx collaris* listed as NT. Civet includes many threatened species such as the Otter civet *Cynogale bennettii* (EN) and Large Spotted civet *Viverra megaspila* (VU). Otter civet *Cynogale bennettii* only distribute in the southern Myanmar but large spotted civet *Viverra megaspila* distribute in whole Myanmar (Francis, 2008). This Vulnerable species is recorded only information from Yenam (VII) area. Large Indian civet *Viverra zibetha* is listed as NT and small tooth palm civet *Arctogalidia trivirgata*, masked palm civet *Paguma larvata*, common palm civet *Paradoxurus hermaphroditus* which recorded in the survey areas are listed as CL.

There are a variety of muntjacs and a lot of detail is needed to identify a species with certainty. Black muntjac *Muntiacus crinifrons* is catergorized as VU and recorded as body parts as well as information from Yenam (VII) area. Southern red muntjac *Muntiacus munjak* is listed as LC. It distributes in southern Myanmar (Francis, 2008; IUCN, 2009) but its remains and information were recorded in Myitsone (I), Lasa (II), Chibwe (III), Wusok (IV), Pisa (V) and Khaunglanhpu (VI). Fea's muntjac *Muntiacus feae,* Gongshanensis muntjac *Muntiacus gongshanensis* and Leaf muntjac *Muntiacus putaoensis* are catergorized as DD found in Myanmar. The information of these DD species need to be investigated.

Thus, both species and orders of mammals in the study areas of proposed dam sites represent an immensely significant cross-section of Myanmar's biodiversity and, as such, demands robust conservation measures if serious damage to their populations is to be avoided. However, in addition to this general conservation consideration, it must be pointed out that among the species recorded were 5 Endangered (EN) species and 13 Vulnerable (VU) species (29.51% of the total) and 7 Near Threatened (NT) species (11.48% of the total) shown in Table 4.1.4.

A number of serious existing threats to these animals were identified, including habitat destruction by logging, slash and burn cultivation, gold mining and human encroachments. Equally serious in some study areas was the impact of hunting both for meat and for trade with nearby China of live animals, as well as animal parts used in oriental medicine. The easy availability of guns in most areas, as well as their proximity to the international border with China adds to the seriousness of these threats. It is therefore essential that these existing threats be addressed within conservation plans for the seven dam areas.

This summary of numbers of species, the conservation status of the mammals and existing threats to their survival in the surveyed areas emphasizes the importance of adequate, well planned conservation being included in the work plans (and budgets) for the dam construction work. A competent and experienced wildlife conservation planning group should be engaged to draw up a detailed conservation management plan for each of the proposed dam construction areas. Unless this is done the construction of these dams will spell disaster for the wildlife in this entire region of northern Myanmar and will almost certainly result in a number of rare species being totally exterminated.

4.1.9. Threatened species (EN and VU)

According to the 2009 IUCN Red List of Threatened Species. Version 2009.1. <www.iucnredlist.org>, the range, population, habitat and ecology, threats, and conservation actions relating to the above endangered and vulnerable species (EN and VU) recorded by the survey are as follows with findings:

4.1.9.1. Endangered (EN) species

(1) Chinese pangolin *Manis Pentadactyla*

Findings: The scales and smoked-foot of Chinese pangolin were found from the local hunter's house in Kyihtan village of Chibwe area. The presence of the species was informed by local hunters and villagers in Myitsone, Lasa, Chibwe and Yenam areas. According to the information, this species seems not to be common in these areas.

IUCN Red List (2009): The species is heavily hunted inside of China, and is heavily hunted for export to China in other range states, primarily for medicinal purposes. The populations have been greatly reduced in the last 15 years and decline suspected to continue over the next 15 years, at a rate of over 50%. The species is thus listed as Endangered.

Range Description: This species occurs in the Himalayan foothills in eastern Nepal, Bhutan and northern India, northeastern Bangladesh, across Myanmar to northern Lao PDR and northern Viet Nam, northern and northeastern Thailand, and through southern China. The limits of its range are poorly known, and complicated by high levels of exploitation. The species is probably widespread in northern Myanmar, although there are few records and the exact distribution is not well known (Salter 1983; Corbet and Hill 1992; J.W. Duckworth pers. comm. 2006).

Countries: Native: Bangladesh; Bhutan; China; Hong Kong; India; Lao People's Democratic Republic; Myanmar; Nepal; Taiwan, Province of China; Thailand; Viet Nam.

Population: Virtually no information is available on population levels of any species of Asian pangolins. These species are rarely observed due to their secretive, solitary, and nocturnal habits, and there is not enough research on population densities or global population (WCMC *et al.* 1999; CITES 2000). There have been few documented records.

Population Trend: ↓ Decreasing

Habitat and Ecology: This species is found in a wide range of habitats, including primary and secondary tropical forests, limestone forests, bamboo forests, grasslands and agricultural fields, and grasslands (Chao Jung-Tai 1989; Gurung 1996).

Threats: Threats to Asian pangolins include rapid loss and deterioration of available habitat and hunting for local use and for international trade in skins, scales, and meat. The species is intensively used, for its skin, meat and scales, and is evidently subject to heavy collection pressure in many parts of its range. The species may be harvested for local (i.e. national-level) use, or for international export either before or after processing. Observations in mainland Southeast Asia indicate that there is very heavy unofficial, or at least unrecorded, international trade in pangolins and pangolin products. The species trade levels are significant across its range, although precise estimates are unknown (CITES 2000).

Conservation Actions: This species is listed on CITES Appendix II. It is protected by national or subnational legislation in Bangladesh, China, India, Lao, Myanmar, Nepal, Taiwan, Thailand, and Viet Nam. Greater enforcement and management to prevent poaching in protected areas is urgently needed.

(2) Shortridge's langur *Trachypithecus shortridgei*

Findings: In Myitsone area, a single of Shortridge's langur was sighted on a tree near Ingarong stream of Jubilee village on 8 May. In Lasa area, one group of seven individuals near Hpawan village on 12 April, 2009 and another group of two individuals near Hpung-in-yan village on 17 April, 2009 were sighted. Two individuals of this species were seen by the bird team on 19 April, 2009 in Wusok area. A skull was found at Sutjar village in Jubilee camp of Myitsone area. In Lasa area, nine skulls were found at the hunters' houses in Lotmaiyan, Jarayan and Maliyan villages, and on the road to Lasa area, a dead body recently shot by local hunter was encountered by Chinese scientists on 6 April, 2009. The presence of the species was also recorded through interviews with local people in Myitsone and Lasa areas.

IUCN Red List (2009): Listed as Endangered as there is reason to believe the species has declined by at least 50% over the past three generations (36 years, given a generation length of 12 years) due primarily to hunting and habitat loss.

Range Description: This species occurs in southwestern and northeastern Myanmar. In Myanmar, south of the Hukaung valley, it is found only east of the Chindwin River, with allied *T. pileatus* to the west (Pocock 1939). The situation in the Chindwin headwaters (Hukaung valley) is unclear, because animals show morphological variation suggesting the possibility of intergradation with *T. pileatus* and/or undescribed variation within *T. shortridgei* (Duckworth and Tizard pers. comm.). Morphologically typical animals also occur east of the Hukaung (Pidaung) and north almost to Hkakaborazi (Pocock 1939). It also occurs along the Dulong River in Gongshan District, Yunnan (Groves 2001).

Countries: Native: China, Myanmar.

Population: Numbers are not known, but are believed to be declining owing to loss of habitat and hunting. The total population must be small, given the species' restricted geographical range.

Population Trend: Decreasing

Habitat and Ecology: This species occurs primarily in evergreen and semi-evergreen forests. It is largely arboreal, sometimes terrestrial, and folivorous. Records with known altitudes range from 200 to 2,500 m (Pocock 1939) but it is possible that the species does not have viable populations in the upper 600-1,200 m of this range: collecting expeditions very rarely encountered it in the highlands, compared with its evident abundance in the Chindwin lowlands. It does not occur in the lower Chindwin, below the change from largely evergreen forest to largely deciduous.

Major Threat(s): These animals are hunted for food and traditional "medicine," sometimes as illegal exports to China. Habitat loss for agriculture and wood extraction is also a major threat. As well as direct loss of habitat through inundation this will result in massive increases in hunting as the construction labourers will be expected to live off the land, and the reservoir formed will greatly increase accessibility to a huge area of foothill forest; without specific, directed, management, hunters will no doubt take advantage of this. A very large area of suitable habitat falls within the proposed Hukaung Tiger Reserve, but it is unclear whether this area supports morphologically typical animals. If they do not occur in Hukaung, habitat loss is a sever threat to the species, because most other protected areas in the Myanmar part of its range are highland, and habitat below 900 m is heavily degraded and fragmented, and such processes are ongoing.

Conservation Actions: This species is listed in CITES Appendix I. In Myanmar it is a protected species under the Wildlife Protection Law and occurs in at least two protected areas: Hukaung Tiger Reserve where taxonomic status is unresolved, Hpoganranzi Wildlife Sanctuary and Hkakaborazi National Park. In China it is a protected species and occurs in one protected area, Gaoligongshan Nature Reserve (L. Yongcheng pers. comm.).

(3) Dhole, Asiatic Wild Dog *Cuon alpinus*

Findings: One skin at a hunter's house in Tanbawyan village of Myitsone and another one at a hunter's house in Ridam village of Khaunglanghpu area were found on 22 January and 18 March respectively. In Lasa area, a skull was found at the local hunter's house in Jarayan village on 26 April, and the presence of this species was recorded through interviews in Lasa and Yenam areas.

IUCN Red List (2009): It is estimated that fewer than 2,500 mature individuals remain in the wild and the declining population trend is expected to continue. Main threats to the species include ongoing habitat loss, depletion of prey base, interspecific competition, persecution and possibly disease transfer from domestic and feral dogs.

Range Description: In Central and eastern Asia, there have been no confirmed. There is a recent report of a dhole that was captured in Jiangxi district, south China (C. Bellamy pers. comm.). The species is still found in Tibet today, particularly in areas bordering the Ladakh region of India (R. Wangchuk pers. comm.), and the Tibet Forestry Bureau has reported that dholes are still "common" in parts of southeast Tibet (S. Chan, in litt.). Dholes reportedly still occur in the Ladakh area of Kashmir, which is contiguous with the Tibetan highlands in China (R. Wangchuk pers. comm.).

In Myanmar, dholes were recorded by camera trapping at 11 of 15 survey areas scattered across the country, only four of which were protected. Dholes and/or leopards have apparently replaced tigers as the top predator in these areas (Myanmar Forest Department 2003).

Countries: Native: Bangladesh; Bhutan; Cambodia; China; India; Indonesia; Kazakhstan; Kyrgyzstan; Lao People's Democratic Republic; Malaysia; Mongolia; Myanmar; Nepal; Russian Federation; Tajikistan; Thailand; Viet Nam.

Population Trend: Decreasing

Habitat and Ecology: The dhole is found in a wide variety of vegetation types, including: primary, secondary and degraded forms of tropical dry and moist deciduous forest; evergreen and semi-evergreen forests; dry thorn forests; grassland–scrub–forest mosaics; and alpine steppe (above 3,000 m). They are not recorded from desert regions.

Major Threat(s): Depletion of prey base: All species of ungulate except muntjacs (*Muntiacus* spp.), pigs (*Sus* spp.) and in some areas southern serow (*Naemorhedus sumatraensis*) are ecologically or fully extinct across extensive parts of the region. Only a few of the largest wildernesses support nearly intact species assemblages and even in these, the larger species (*Bos* spp., *Cervus* spp., hog deer *Axis porcinus*) are very rare.

Habitat loss and transformation: Habitat conversion and fragmentation are proceeding apace. Habitat loss and degradation are also serious threats to dholes in South Asia.

Persecution: In India, such persecution can play a serious role in limiting local populations.

Competition with other species: In many parts of their range, dholes are sympatric with tigers and leopards and so the potential for significant interspecific competition for prey exists, especially if the prey populations are reduced as a result of hunting by people.

Disease and pathogens: Diseases are a significant threat in South Asia and probably in parts of Indonesia.

There is no widespread exploitation for fur or other purposes, though medicinal use should be investigated in China.

Conservation Actions: Included in CITES – Appendix II (2003).

(4) Fishing cat *Prionailurus viverrinus*

Findings: An old skin of the fishing cat was found at the hunter's house in Chonedam village of Pisa area on 16 April, 2009.

IUCN Red List (2009): Fishing cats are widely distributed but concentrated primarily in wetland habitats, which are increasingly being settled, degraded and converted. Over 45% of protected wetlands and 94% of globally significant wetlands in Southeast Asia are considered threatened (Dugan 1993). Threats to wetlands include human settlement, draining for agriculture, pollution, and excessive hunting, wood-cutting and fishing. In addition, clearance of coastal mangroves over the past decade has been rapid. The depletion of fish stocks from over-fishing is prevalent and is likely to be a significant threat.

Range Description: The fishing cat has a broad but discontinuous distribution in Asia, with large gaps - some the result of its association primarily with wetlands, some the result of recent extirpation, and some supposed due to a lack of confirmed records In Southeast Asia, its distribution appears very patchy, ith few recent records (Anak, W. Duckworth and R. Steinmetz, Southeast Asia mammal assessment, 2003).

Countries: Native: Bangladesh; Bhutan; Cambodia; India; Indonesia (Jawa, Sumatera); Lao People's Democratic Republic; Myanmar; Nepal; Sri Lanka; Thailand; Viet Nam.

Population: There is concern about the species status in Southeast Asia where it is very infrequently encountered and believed to be declining (Southeast Asia regional mammal assessment, 2003).

Population Trend: Decreasing

Habitat and Ecology: Fishing cats are strongly associated with wetland. They are typically found in swamps and marshy areas, oxbow lakes, reed beds, tidal creeks and mangrove areas and are more scarce around smaller, fast-moving watercourses. Along watercourses they have been recorded at elevations up to 1,525 m, but most records are from lowland areas. Although fishing cats are widely distributed through a variety of habitat types (including both evergreen and tropical dry forest: Rabinowitz and Walker 1991), their occurrence tends to be highly localized (Nowell and Jackson 1996).

Fishing cats are good swimmers, and unlike most other small cats may prey primarily on fish rather than small mammals

Major Threat(s): Wetland destruction and degradation is the primary threat faced by the species (Nowell and Jackson 1996). Threats to wetlands include human settlement, draining for agriculture, pollution, and excessive hunting, wood-cutting and fishing. Widespread indiscriminate snaring, trapping and poisoning are believed to underlie recent declines in Southeast Asia, where fishing cats have not been found even in seemingly intact wetland habitats (Southeast Asia regional mammal assessment, 2003). Fishing cat skins have been found in illegal trade in India for many years (Sunquist and Sunquist 2002, Anon 2005).

Conservation Actions: Included on CITES Appendix II. Protected by national legislation is over most of its range. Hunting prohibited: Bangladesh, Cambodia, China, India, Indonesia, Myanmar, Nepal, Pakistan, Sri Lanka, and Thailand. Conservation of the species depends on adequate protection of remaining wild wetlands in Asia, and prevention of indiscriminate trapping, snaring and poisoning.

(5) Asian elephant *Elephas maximus*

Findings: In Myitsone area, footprints, dung and destructive signs of Asian Elephant were observed on 10 May, 2009. According to information, a group of three individuals of wild elephant was recorded to be present in the west of Jubilee and a group of nine individuals is also present in the Bone-par mountain, north of Jubilee.

IUCN Red List (2009): It is listed as Endangered (EN), because of a population size reduction inferred to be at least 50% over the last three generations, based on a reduction in its area of occupancy and the quality of its habitat. Although there are few accurate data on historical population size, from what is known about trends in habitat loss/degradation and other threats including poaching, an overall population decline of at least 50% over the last three generations.

Range Description: Asian elephants still occur in isolated populations in 13 states, with a very approximate total range area of 486,800 km^2 (Sukumar 2003; but see Blake and Hedges 2004). The species occurs in Bangladesh, Bhutan, India, Nepal, and Sri Lanka in South Asia and Cambodia, China, Indonesia (Kalimantan and Sumatra) Lao PDR, Malaysia (Peninsular Malaysia and Sabah), Myanmar, Thailand, and Viet Nam in South-east Asia. Feral populations occur on some of the Andaman Islands (India).

The Asian elephant has a wide, but highly fragmented, distribution in Myanmar. The five main areas of elephant abundance are: the Northern Hill Ranges, the Western Hill Ranges, Pegu Yoma (central Myanmar), Tenasserim Yoma (in the south, bordering Thailand), and Shan State or eastern Yoma.

Countries: Native: Bangladesh; Bhutan; Cambodia; China; India; Indonesia (Kalimantan, Sumatera); Lao People's Democratic Republic; Malaysia (Peninsular Malaysia, Sabah); Myanmar; Nepal; Sri Lanka; Thailand; Viet Nam.

The overall population trend of the Asian elephant has been downwards, probably for centuries. This remains the case in most parts of its range, but especially in most of the countries of South-east Asia.

Population Trend: Decreasing

Habitat and Ecology: Asian elephants are generalists and they occur in grassland, tropical evergreen forest, semi-evergreen forest, moist deciduous forest, dry deciduous forested and dry thorn forest, in addition to cultivated and secondary forests and scrublands. Over this range of habitat types elephants are seen from sea level to over 3,000 m asl. Given their requirements for large areas, elephants are regarded as an “umbrella species” because their conservation will also protect a large number of other species occupying the same area. They are also a premier “flagship species” and are sometimes regarded as a “keystone species” because of their important ecological role and impact on the environment.

Major Threat(s): The pre-eminent threats to the Asian elephant today are habitat loss, degradation, and fragmentation (Leimgruber *et al*., 2003; Sukumar, 2003; Hedges, 2006), which are driven by an expanding human population, and lead in turn to increasing conflicts between humans and elephants when elephants eat or trample crops. Hundreds of people and elephants are killed annually as a result of such conflicts.

Poaching is a major threat to elephants in Asia too, although reliable estimates of the number of elephants killed and the quantities of ivory and other body parts collected and traded are scarce (Sukumar *et al*., 1998; Milliken, 2005). It has been argued that poaching is a relatively minor threat to Asian elephant because some males and all females lack tusks (Dawson and Blackburn, 1991). However, the reality is that elephants are poached for a variety of other products (including meat and leather) in addition to ivory, and poaching is now acknowledged as a threat to the long-term survival of some Asian elephant populations (e.g. Kemf and Santiapillai, 2000; Menon, 2002). Moreover, poaching of elephants for ivory is a serious problem in some parts of Asia (Sukumar, 1992; Menon *et al*., 1997). Poaching of elephants is also a major problem in other parts of Asia. Large-scale hunting of elephants for ivory, bushmeat, hides, and other products has reduced their populations significantly over a wide area from Myanmar to Indonesia (Menon *et al*., 1997; Duckworth and Hedges, 1998; Kemf and Santiapillai, 2000; Martin and Stiles, 2002; Menon, 2002; World Wide Fund for Nature, 2002a; Hedges *et al*., 2005).

Conservation Actions: The most important conservation priorities for the Asian elephant are: 1) conservation of the elephant's habitat and maintaining habitat connectivity by securing corridors; 2) the management of human–elephant conflicts as part of an integrated land-use policy that recognizes elephants as economic assets from which local people need to benefit or at least not suffer; 3) better protection to the species through improved legislation and law enforcement, improved and enhanced field patrolling, and regulating/curbing trade in ivory and other elephant products. Monitoring of conservation interventions is also needed to assess the success or failure of the interventions so that adjustments can be made as necessary (i.e. adaptive management). Reliable estimation of population size and trends will be needed as part of this monitoring and adaptive management approach.

4.1.9.2. Vulnerable (VU) species

(1) Bengal slow loris *Nycticebus bengalensis*

Findings: One skin in Myitsone and one in Chibwe area were found. The presence of this species was recorded through interviews in Myitsone, Lasa, Chibwe and Khaunglanghpu areas. In Lasa area, capturing and selling of a live Bengal slow loris was informed in the last three months by the middleman and hunter.

IUCN Red List (2009): It is listed as Vulnerable as, due to loss of habitat and severe pressures from hunting, there is more than 30% reduction in population over three generations. The species is predicted to decline by more than 30% in the next three generations over its entire range due to continuing hunting pressures and loss of habitat.

Range Description: This species occurs in Bangladesh, Cambodia, China (southern Yunnan and possibly southern Guangxi), north-eastern India, Lao PDR, Myanmar (including the Mergui Archipelago), Thailand, and Viet Nam (except the south). It may possibly occur as well in northern Peninsular Malaysia.

Countries: Native: Bangladesh; Cambodia; China; India; Lao People's Democratic Republic; Myanmar; Thailand; Viet Nam.

Population Trend: Decreasing

Habitat and Ecology: This is an arboreal, nocturnal species that inhabits tropical evergreen rainforest, semi-evergreen forest, and moist deciduous forest. It feeds on fruits and gums, but very few insects as compared to slender or pygmy lorises (U. Streicher pers. comm.). This animal's life span is about 15 years, and generation time is 7-8 years. Females give birth to one offspring per litter once every two years in semi-wild conditions (Rowe 1996). In captivity, this rate may be slightly higher (U. Streicher pers. comm.).

Major Threat(s): The major threats that this species' habitat faces include farming, timber removal, human settlement, road building, dams, power lines, fragmentations, soil loss and erosion, and deliberately set fires. They are hunted and traded for food, traditional "medicine," sport, and as pets (Molur *et al*. 2003; Nekaris and Nijman 2007; V. Thanh and U. Streicher pers. comm.). Road kills represent another threat to this species.

Conservation Actions: This species is listed in Bangladesh as Schedule III in the Bangladesh Wildlife (Preservation) (Amendment) Act, 1974. In India, it is listed in Schedule I, part I, under the Indian Wildlife Protection Act, 1972 amended up to 2002. This species is protected in Thailand under the Wildlife Protection of 1992; in China it is Class I, and is given the highest protection in Viet Nam under the Wildlife Protection Law (List IB, Decree 32, 2006) on a par with tigers, elephants and bears. In Cambodia, it is protected under law 359 of the Ministry of Forestry and Fisheries, 1994.

This species is found in a large number of protected areas throughout its range, but possibly at low numbers. Actual surveys rather than anecdotal reports are necessary to determine the true abundance of this species in the wild (Nekaris *et al*. 2008). The species has been recently transfer from Appendix II to Appendix I of CITES (Nekaris and Nijman 2007).

(2) Stump-tailed macaque *Macaca arctoides*

Findings: In Lasa area, a juvenile stamp-tailed macaque reared as pet was found on 9 April. In field surveys, one individual in Chibwe area on 12 May, 2009 and another one in Wusok area on 13 April, 2009 were sighted. Skulls were found in Myitsone, Lasa, Chibwe, Wusok, and Yenam areas. Bloody meat recently hunted by local hunter was seen in Khaunglanghpu area on 25 February, 2009. The species was recorded from interviews in Myitsone, Lasa, and Yenam areas. A group moving of around 10 individuals was informed in Yenam area on 9 March. Many local people indicated this species clearly, noting the feature of its short tail.

IUCN Red List (2009): Listed as Vulnerable as due to reduction in the past and projected decline by at least 30% over the coming 30 years (three generations) due primarily to hunting and continued rates of habitat loss (mainly as a result of logging and timber extraction).

Range Description: This species is found in Cambodia, south-western China (Guangdong, Guangxi, Guizhou, and Yunnan provinces), north-eastern India, Lao PDR, north-western Peninsular Malaysia, northern Myanmar, Thailand, and Viet Nam. It appears to be absent from most of Myanmar and Thailand; records are only from the far north of Myanmar and from the border ranges between the two countries south into the peninsula, with a few dubious records in central and north-western Thailand.

Countries: Native: Cambodia; China; India; Lao People's Democratic Republic; Malaysia; Myanmar; Thailand; Viet Nam.

Population: Populations in South Asia and in Myanmar are few and fragmented (Molur *et al.* 2003; S. Htun pers. Comm.). In China the species is still common in Yunnan, though the populations are thought to be lower in the eastern portions of its range (Zhang *et al.* 2002).

Populations of this species are critically threatened in India, declining in Myanmar, stable in Thailand, and declining rapidly in China and Viet Nam. There are some declines in Lao PDR and Cambodia. Future declines are predicted to be faster in Lao PDR, Viet Nam, India, Myanmar and China due to habitat loss and/or hunting.

Population Trend: Decreasing

Habitat and Ecology: This species ranges from tropical semi-evergreen forest to tropical wet evergreen forest and tropical moist deciduous forest. It prefers dense evergreen forests (Choudhury 2001). Srivastava and Mohnot (2001) report it from lowland semi-evergreen forests to monsoon and montane forests. It occurs between 200 and 2,200 m in Myanmar (Htun pers. comm.), and up to 2,400 m in China (X. Jiang pers. Comm.). It is considered arboreal as well as terrestrial, and is diurnal. It feeds primarily on seeds and fruits.

Major Threat(s): Habitat disturbances affecting this species' survival include selective logging, timber and firewood collection for charcoal, building roads, dams, power lines and fisheries, deliberately set fires, fragmentation, and soil loss/erosion. These animals are hunted and traded for food, sport and traditional "medicine," and accidental mortality due to trapping occurs. There is a local trade for bones, meat for food and the live animals as pets (Molur *et al*. 2003).

In Myanmar, logging and timber extraction are major threats. Commercial rubber plantations, hunting, and trade of animals parts with China are all major threats to this species. In China, hunting and habitat loss have reduced in population of this species, and it is locally extinct in some places.

Conservation Actions: Internationally, this species is listed under Appendix II in CITES. The species is also protected in national wildlife acts of Lao PDR, Viet Nam, Thailand, and Myanmar.

(3) Eastern hoolock gibbon *Hoolock leuconedys*

Findings: Vocalizations of Eastern Hoolock gibbon were recorded in Myitsone, Lasa, Chibwe and Wusok areas. Skulls were found in Lasa area. The gibbon was reported in the interviews in Myitsone, Lasa, Chibwe, Wusok, and Yenam areas.

IUCN Red List (2009): Listed as Vulnerable because it is suspected that a population decline, projected to be more than 30%, would be met over the next three generations (approximately 40 years), inferred from habitat loss and hunting.

Range description: This species is found in southern China (western Yunnan) and northeastern Myanmar (east of the Chindwin River). In China it is found as far east as the Salween River, and north to nearly 26°N (Groves 2001).

The boundary between the two species of hoolock gibbon is uncertain in the Chindwin headwaters in the north, and possibly includes a zone of intermediates or variable population (T. Geissmann pers. comm.). More fieldwork is needed to investigate populations on both sides of the river and in the headwaters of the Chindwin, where there is likely to be one or more hybrid zones or clines (W. Brockelman pers. comm.).

Countries: Native: China (Yunnan); Myanmar.

Population: The total population of *H. leuconedys* in Myanmar is over 10,000 individuals, and perhaps up to 50,000 or so; however, much more survey work is needed. There have been some Wildlife Conservation Society surveys in Hukaung Valley Wildlife Sanctuary, which have approximately two groups/km^2 (Htun pers. comm. 2006). There are approximately two groups/km^2 in Mahamyaing Wildlife Sanctuary based on vocal surveys, with a total population of 4,000–8,100 individual gibbons (about half of which would be adult animals) (Brockelman 2006 unpub. draft).

The species is doing relatively well in Myanmar, but there is no guarantee of continued political protection in the next few decades (W. Brockelman pers. comm.). Political instability is presently slowing down logging (W. Bleisch pers. comm.).

Habitat and Ecology: This gibbon is a forest-dweller that inhabits primary evergreen, scrub and semi-deciduous hill forest, as well as mountainous broadleaf and pine-dominated forest. It ranges up to 2,700 m in elevation, as reported by the Vernay-Cutting expedition (Anthony 1941), in mixed pine/broadleaf forest in northeastern Myanmar.

It is a frugivorous species, with ripe fruits composing a majority of its diet. Individuals also eat a large proportion of figs and some amount of leaves, shoots, and petioles. This diet contributes to a relatively large home range of some populations.

Major Threat(s): Eastern hoolocks are threatened by habitat loss and hunting, both for meat as well as for use in traditional “medicine” (M. Richardson pers. comm.). In Myanmar, commercial logging may eliminate most forest habitats outside of protected areas, but in and around Mahamyiang Sanctuary, selectively logged forests (with dipterocarps removed) still contain many gibbons. The more than 50,000 people settled in the Hukaung Valley Tiger Reserve constitute a threat to all wildlife in the area, and the future of the reserve will depend on the ability of the government as well as international conservation groups to curtail hunting. Gold mining has become a threat to conservation in Kachin State (W. Brockelman pers. comm.).

Conservation Actions: This species is listed on CITES Appendix I. In Myanmar, the Mahamyaing Sanctuary was created in part as a gibbon refuge, and the species occurs as well in the Bumhpabum, Hponkan Razi and Htamanthi Wildlife Sanctuaries, and in the Hukaung Valley Tiger Reserve (W. Brockelman unpub.). Unfortunately, there is no viable protected area in Myanmar between the northern Ayerawady and Salween Rivers, near the borders with Yunnan and Thailand. Gibbons in this zone could be genetically different from those along the Chindwin; therefore, it is critical to save the small numbers that survive west of the Salween River in Yunnan. A project has been implemented by Wildlife Conservation Society to help educate local residents – especially school children – around Mahamyiang Sanctuary, and to urge them not to hunt wildlife. The project also provides some support to the wildlife sanctuary for increased patrols. Such projects need to be implemented in the Hukaung Tiger Reserve as well, in order to reduce hunting pressures. At present tourism is not promoted in the Hukaung Valley because it is a politically sensitive area, but there is great potential for tourism to have a positive impact on local development in the future. In the meantime, alternative sources of income are needed to compensate for the bans on direct resource exploitation (W. Brockelman pers. comm.).

(4) Asian/Himalayan black bear *Ursus thibetanus*

Findings: In Myitsone, Chibwe, Wusok, khaunglanghpu, and Yenam areas, only old skulls were found. A skull, a genital organ, and two claws were found in Lasa area. Information were recorded in six areas except for Pisa. According to the survey it seems that the population of this species has declined greatly in these areas.

IUCN Red List (2009): Widespread illegal killing of bears and trade in parts, combined with loss of habitat indicate that this species is likely declining in most parts of its range, especially in Southeast Asia and China.

Although actual data on population sizes or trends are lacking, it seems likely, given the rate of habitat loss and uncontrolled exploitation that the world population has declined by 30–49% over the past 30 years (3 bear generations) and that this rate will continue during the next 30 years unless abated by the implementation of significant conservation measures.

Range Description: This species occupies a narrow band from southeastern Iran (Gutleb and Ziaie 1999) eastward through Afghanistan and Pakistan, across the foothills of the Himalayas, to Myanmar. It occupies all countries in mainland Southeast Asia except Malaysia. It has a patchy distribution in southern China, and is absent in much of east-central China. Its distribution in parts of China and Myanmar remains very poorly known.

The distribution of the Asiatic black bear roughly coincides with forest distribution in southern and eastern Asia (FAO 2006). This species is replaced by the sloth bear (*Melursus ursinus*), sun bear (*Helarctos malayanus*) and brown bear (*Ursus arctos*) in other countries. However, the Asiatic black bear overlaps the ranges of each of these species, especially the sun bear in a large portion of Southeast Asia.

Countries: Native: Afghanistan; Bangladesh; Bhutan; Cambodia; China; India; Iran, Islamic Republic of; Japan; Korea, Democratic People's Republic of; Korea, Republic of; Lao People's Democratic Republic; Myanmar; Nepal; Pakistan; Russian Federation; Taiwan, Province of China; Thailand; Viet Nam

Population: No rigorous population estimates exist for this species.

Population Trend: ⬇ Decreasing

Habitat and Ecology: Asiatic black bears occupy a variety of forested habitats, both broad-leaved and coniferous, from near sea level to an elevation of 4,300 m (in northeastern India, A. Choudhury, Rhino Foundation for Nature pers. comm.). They also infrequently use open alpine meadows. Individual bears move to different habitats and elevations seasonally (Izumiyama and Shiraishi 2004), tracking changes in food abundance. Foods include succulent vegetation (shoots, forbs and leaves) in spring, turning to insects and a variety of tree and shrub-borne fruits in summer, and finally nuts in autumn (Bromlei 1965, Reid *et al*. 1991, Huygens *et al*. 2003). In some places the diet contains a sizeable portion of meat from mammalian ungulates (which they either kill or scavenge, Hwang *et al*. 2002). Asiatic black bears also use regenerating forests, which may have a high production of berries or young bamboo shoots. They also feed in plantationsand in cultivated areas.

Asiatic black bears generally breed during June–July and give birth during November–March; however, timing of reproduction is not known for all portions of the range. Age of first reproduction is 4–5 years, and they normally produce litters of 1 or 2 cubs every other year (at most). Maximum lifespan is over 30 years, but average lifespan is less in the wild.

Major Threats(s): Habitat loss due to logging, expansion of human settlements, roadway networks, and hydro-power stations, combined with hunting for skins, paws and especially gall bladders are the main threats to this species.

Habitat loss and degradation is most severe in the southern portion of the range. Asiatic black bears survive only in small remnant patches in the east Bangladesh, generally near the Myanmar border. Myanmar, although still well forested (nearly 50%), is fourth in the world in the annual rate of loss of forested area (among countries occupied by all species of bears, it is second only to Indonesia: FAO 2006).

The major threat to bears in China and Southeast Asia is the commercial trade in live bears and bear parts, especially gall bladders (bile). China initiated commercial bear farming in 1984, ostensibly to satisfy the demand for bile by practitioners of Traditional Chinese Medicine (TCM; and also Traditional Korean Medicine, TKM). The bile is periodically drained, so the captive bears do not have to be killed; it was claimed that this practice would thereby reduce the taking of wild bears. However, these farms were initially stocked with wild bears, and although the Chinese farms are purportedly now mainly self-propagating (with some continuing exceptions), there is no evidence that their existence has reduced the killing (poaching) of wild bears.

The market for bear paws also appears to be increasing commensurate with an increasing number of wealthy people who find it within their means to indulge in this very expensive delicacy.

The demand for these bear products has fuelled a growing network of international trade throughout Southeast Asia, and has turned many subsistence hunters into commercial hunters. Most commercial trade routes eventually terminate in China (Saw Htun 2006; C. Shepherd, TRAFFIC SE Asia pers. comm.). However, it is difficult to assess the true extent of this trade because only a small fraction of the parts are confiscated. Moreover, with no reliable population estimates or monitoring system it is not possible to evaluate the actual impacts on populations. Nevertheless, it seems highly probable that this commercially-driven trade in parts is unsustainable and therefore causing populations to decline.

The capture of live bears presents yet another threat to this species. In several Southeast Asian countries Asiatic black bears are routinely confiscated from people attempting to raise them as pets.

Conservation Actions: The most beneficial conservation measure for Asiatic black bears would be to substantially lessen the demand for bear products, and thus reduce hunting and trade. The species is protected under both international and national laws, but often these laws are not enforced. It has been included on CITES Appendix I since 1979.

In most range countries Asiatic black bears are listed as a protected species. Throughout Southeast Asia this species is totally protected in every range country, with the exception of Myanmar, where this species is classified as "normally protected", meaning that it may be killed with a special license (although such licenses are rarely issued; Saw Htun, Wildlife Conservation Society, Myanmar pers. comm.).

Farming bears for bile presents another conservation difficulty that needs to be resolved.

(5) Malayan sun bear *Helarctos malayanus*

Findings: Body remains such as canine teeth (one pair in Myitsone, two pairs in Lasa), skull (two in Lasa, four in Yenam), skin (one in Lasa) and gall-bladder (one in Lasa) were found. Recently captured fresh skull was found in Aliaung village of Yenam area.

IUCN Red List (2009): Given the Sun Bear's dependence on forest, it is clear that the large-scale deforestation that has occurred throughout southeast Asia over the past three decades has dramatically reduced suitable habitat for this species. Although quantitative data on population sizes or trends are lacking, it is suspected that the global population of Sun Bears has declined by > 30% over the past 30 years (3 bear generations). In addition, Sun Bear numbers have been reduced by uncontrolled exploitation for body parts. It is expected that commercial exploitation will continue during the next 30 years unless abated by the implementation of significant anti-poaching measures.

Range Description: Sun bears occur in mainland Southeast Asia. It now occurs very patchily through much of its former range, and has been extirpated from many areas, especially in mainland southeast Asia. Its current distribution in eastern Myanmar and most of Yunnan is unknown.

Countries: Native: Bangladesh; Brunei Darussalam; Cambodia; China; India; Indonesia; Lao People's Democratic Republic; Malaysia; Myanmar; Thailand; Viet Nam

Population: Reliable estimates of sun bear populations are lacking. However, rapid loss of forests throughout their range and an active trade in wild bears and their parts is strong evidence of a declining trend.

Population Trend: Decreasing

Habitat and Ecology: Sun bears rely on tropical forest habitat. Sun bears in mainland Southeast Asia inhabit seasonal ecosystems with a long dry season (3–7 months), during which rainfall is <100 mm per month. Seasonal forest types are usually interspersed in a mosaic that includes semi-evergreen, mixed deciduous, dry dipterocarp (<1,000 m elevation), and montane evergreen forest (>1,000 m). The range of sun bears overlaps that of Asiatic black bears (*Ursus thibetanus*) in this seasonal forest mosaic.

Sun bears are omnivores, feeding primarily on termites, ants, beetle larvae, bee larvae and honey, and a large variety of fruit species, especially figs (*Ficus* spp.), when available (McConkey and Galetti 1999, Wong *et al*. 2002, Augeri 2005, Fredriksson *et al*. 2006).

Major Threats: The two major threats to sun bears are habitat loss and commercial hunting. These threats are not evenly distributed throughout the range of the species. Commercial poaching of bears for the wildlife trade is a considerable threat in most countries (Meijaard 1999, Nea and Nong 2006, Nguyen Xuan Dang 2006, Saw Htun 2006, Tumbelaka and Fredriksson 2006, Wong 2006). Killing bears is illegal in all range countries but is largely uncontrolled.

In Myanmar, Thailand, Lao PDR, Cambodia and Viet Nam, sun bears are commonly poached for their gall bladders (i.e., bile) and bear-paws; the former is used as a Traditional Chinese Medicine, and the latter as an expensive delicacy.

Other motivations for killing bears include: preventing damage to crops (Fredriksson 2005), subsistence use, fear of bears near villages, and capture of cubs for pets (the mother being killed in the process).

Despite significant poaching within extant forest areas, sun bear populations appear to persist longer than some other heavily-exploited large carnivores. For example, tiger (*Panthera tigris*) populations have been severely reduced or extirpated in 12 of 15 protected areas surveyed in Myanmar, whereas sun bears were still encountered relatively frequently in 13 of these areas (Lynam 2003, Saw Htun 2006).

Conservation Actions: Killing of sun bears is strictly prohibited under national wildlife protection laws throughout their range. However, little enforcement of these laws occurs. The sun bear has been listed on CITES Appendix I since 1979.

Reducing the trade in bear parts would be highly beneficial for the survival of the species in mainland Southeast Asia.

Recently, the Bear Specialist Group mapped the current, range-wide distribution of sun bears. Important habitat blocks for long-term survival of sun bears were identified (Bear Conservation Units-BCUs). Anti-poaching efforts within these BCUs should be a high priority. Trends in bear occurrence and relative abundance within BCUs could be monitored using standardized sign surveys and camera trapping. Results of such monitoring could indicate which management or ecological conditions promote successful bear conservation, and which do not, and provide a means to assess the results of conservation efforts (e.g., future range expansion and/or increased bear density being indicative of effective conservation efforts). Additional field studies also would be helpful in this regard; few intensive studies have been conducted on this species.

(6) Red panda *Ailurus fulgens*

Findings: Skins of red panda hunted from icy mountain were found in Chibwe, Pisa, and Yenam areas.

IUCN Red List (2009): This species is listed as Vulnerable because its population is estimated at less than 10,000 mature individuals with a continuing decline of greater than 10% over the next 3 generations (estimated at 30 years).

Range Description: The distribution of *Ailurus fulgens* in the wild is poorly known, but its range is known to include Nepal, India, Bhutan, Myanmar, and southern China, with a disjunct population on the Meghalaya Plateau of northeastern India (Choudhury 2001). It is found from the southern part of the Gaoligong Shan on the Myanmar-China border (25ºN), to Minshan Mountains and upper Min Valley, Sichuan (33ºN) (Ellerman and Morrison-Scott 1966; Macdonald 1984; Corbet and Hill 1992; Choudhury 1997). Pradhan *et al.* (2001) found that this species' preferred altitudinal range in Singhalila

National Park in eastern Himalayas was 2,800 to 3,100 m, and it was relatively more abundant between 2,800 to 3,600 m.

It is believed to have gone extinct from the rest of its historical range in China, e.g. Guizhou, Gansu, Shaanxi, and Qinghai provinces (Wei *et al*. 1999).

In Myanmar it is known only from the northernmost state, Kachin, and is locally distributed even there (Than Zaw *et al*. in prep.).

Countries: Native: Bhutan; China; India; Lao People's Democratic Republic; Myanmar; Nepal

Population: It is estimated to be more common in the eastern part of its range, especially along the Myanmar-Yunnan border, yet it cannot be considered a common species" (Roberts and Gittleman 1984). Observation of this species is difficult due to its shy and secretive nature, and its largely nocturnal habits (Choudhury 2001). Anecdotal evidence based on local villager captures suggests the species may be common in the northernmost parts of Myanmar, especially in the Hkakaborazi National Park, however, recent camera-trapping surveys did not capture any red pandas in the area (Rabinowitz and Khaing, 1998, Than Zaw *et al.* in prep.).

Population Trend: ⬇ Decreasing

Habitat and Ecology: The red panda is found closely associated with temperate forest having bamboo-thicket understories (Roberts and Gittleman 1984). Red panda diet is largely vegetarian, and consists chiefly of young leaves and shoots of bamboo, yet also includes fruit, roots, succulent grasses, acorns, lichens, bird eggs, insects, and grubs (Choudhury 2001). This species is largely arboreal (Choudhury 2001). Pradhan *et a*l. (2001) found 79% of records to be 0 to 100 m from the presence of water bodies, indicating that the presence of water may be an important habitat requisite for this species.

Major Threat(s): The red panda is threatened by habitat loss and fragmentation, poaching, and inbreeding depression (Wei *et al.* 1998). Habitat loss is considered to be the biggest threat to this species (Choudhury 2001), whereas poaching and hunting pose a greater threat in areas of China and Myanmar, particularly in Hkakaborazi and adjacent areas. The ultimate cause of these threats to the red panda is the high growth rate in human populations within the species' range and in surrounding nearby areas (Choudhury 2001). The growth rate of the local human population has almost doubled between 1971 and 1991, causing increased pressure on land for both housing and farming, as well as increased demand for firewood (Choudhury 2001).

The major causes of habitat loss are commercial logging, demand for firewood (especially in the cold Himalaya), clearing for habitation and farming, jhum (slash-and-burn shifting cultivation) by hill tribes, grazing of domestic stock, monoculture forest plantation, and various developmental activities (Choudhury 2001).

Habitat is effectively stable in northernmost Myanmar (Renner *et al*. 2007), but elsewhere in Kachin where the panda might occur there are indications of rapid habitat degradation through deforestation in this area (B.F. King pers. comm. 1998, cited in Collar *et al*. 2001).

Hunting does not appear to be as serious a threat to the red panda as habitat loss, since hunters do not appear to deliberately hunt this species, but rather is shot opportunistically and caught accidentally in snares during hunting for wild pig, deer, goat-antelopes (serow, goral, and takin) and primates (Choudhury 2001).

The species is protected in Myanmar by the Wildlife Act of 1994 and is found in at least one, probably several, protected areas (Than Zaw, *et al*. in prep.).

(7) Marbled cat *Pardofelis marmorata*

Findings: In Chibwe area, four skins were found and a skull was found in Pisa area. The presence of the species was reported in the interviews with locals and forestry staff in Yenam area.

IUCN Red List (2009): The marbled cat is forest-dependent, and its habitat is undergoing the world's fastest regional deforestation rates (over 10% in the past ten years: FAO 2007). It occurs at low densities, and its total effective population size is suspected to be fewer than 10,000 mature individuals, with no single population numbering more than 1,000 (IUCN Cats Red List Workshop 2007).

Range Description: The marbled cat is found in tropical Indomalaya westward along the Himalayan foothills westward into Nepal and eastward into southwest China, and on the islands of Sumatra and Borneo. There are few locality records of this species (Nowell and Jackson, 1996, Sunquist and Sunquist, 2002).

Countries: Native: Bhutan; Brunei Darussalam; Cambodia; China; India; Indonesia (Kalimantan, Sumatera); Lao People's Democratic Republic; Malaysia (Peninsular Malaysia, Sabah, Sarawak); Myanmar; Nepal; Thailand; Viet Nam

Population: The marbled cat appears relatively rare compared to sympatric felids, based on the paucity of historical as well as recent records (Nowell and Jackson 1996, Duckworth *et al.* 1999, Holden 2001, Sunquist and Sunquist 2002, Grassman *et al.* 2005, Azlan and Sharma 2006, Lynam *et al.* 2006, Mishra *et al.* 2006, Yasuda *et al.* 2007).

Habitat and Ecology: The marbled cat is primarily associated with moist and mixed deciduous-evergreen tropical forest (Nowell and Jackson 1996), and may prefer hill forest (Duckworth *et al.* 1999, Holden 2001, Grassman *et al.* 2005). A few sightings have been made in secondary forest or cleared areas near forest, but it is likely forest-dependent (Nowell and Jackson 1996).

Population Trend: Decreasing

Major Threat(s): The marbled cat appears to be forest-dependent, and its habitat in Southeast Asia is undergoing the world's fastest deforestation rate (1.2-1.3% a year since 1990: FAO 2007), due to logging, oil palm and other plantations, and human settlement and agriculture. Although infrequently observed in the illegal Asian wildlife trade (Nowell and Jackson 1996), it is valued for its skin, meat and bones, and indiscriminate snaring is prevalent throughout much of its range and is likely to pose a major threat (IUCN Cats Red List workshop, 2007). They have been reported as poultry pests (Nowell and Jackson 1996, Mishra *et al.* 2006).

Conservation Actions: Included on CITES Appendix I. Hunting of this species is prohibited in Bangladesh, Cambodia, China (Yunnan only), India, Indonesia, Malaysia, Myanmar, Nepal and Thailand. Further research is needed on its ecology, distribution and status (IUCN Cats Red List workshop, 2007).

(8) Clouded leopard *Neofelis nebulosa*

Findings: A skin and teeth intact on jaw in Lasa area, and two skins in Yenam area were found. The presence of this species was recorded through the interviews in Myitsone, Lasa and Yenam areas.

IUCN Red List (2009): The clouded leopard is forest-dependent, and its habitat is undergoing the world's fastest regional deforestation rates (over 10% in the past ten years: FAO 2007). There are high levels of illegal trade in its skin and bones (Nowell 2007). Its total effective population size is suspected to be fewer than 10,000 mature individuals, with no single population numbering more than 1,000 (IUCN Cats Red List Workshop 2007).

Range Description: The clouded leopard is found from the Himalayan foothills in Nepal through mainland Southeast Asia into China (Nowell and Jackson 1996). The clouded leopard historically had a wide distribution in China, south of the Yangtze, but recent records are few, habitat is fast disappearing, illegal hunting of this species has been prolific and its current distribtution in China is poorly known (Wozencraft 2008).

Countries: Native: Bangladesh; Bhutan; Brunei Darussalam; Cambodia; China; India; Indonesia (Kalimantan, Sumatera); Lao People's Democratic Republic; Malaysia (Peninsular Malaysia); Myanmar; Nepal; Thailand; Viet Nam

Population: The clouded leopard is most strongly associated with primary tropical forest which is rapidly disappearing across its range (Nowell and Jackson 1996), and clouded leopard skins have been observed in large numbers in illegal wildlife trade in Southeast Asia (Nowell 2007). Increasing use of camera traps has helped to better document its distribution and recent research efforts should help improve understanding of its population status (Grassman *et al.* 2005, Austin *et al.* 2007).

Population Trend: ↓ Decreasing

Habitat and Ecology: The clouded leopards are strongly associated with forest habitat, particularly primary evergreen tropical rainforest, but there are also records from dry and deciduous forest, as well as secondary and logged forests. They have been recorded in the Himalayas up to 2,500 m and possibly as high as 3,000 m. Less frequently, they have been found in grassland and scrub, dry tropical forests and mangrove swamps (Nowell and Jackson 1996). Radio-tracking studies in Thailand have showed a preference for forest over more open habitats (Austin *et al.* 2007).

A study in Thailand's Phu Khieu National Park found that clouded leopards preyed upon a variety of arboreal and terrestrial prey, including hog deer, slow loris, bush-tailed porcupine, Malayan pangolin and Indochinese ground squirrel (Grassman *et al.* 2005). Clouded leopards are primarily nocturnal, with crepuscular activity peaks (Grassman *et al.* 2005, Austin *et al.* 2007).

Clouded leopards may occur at higher densities where densities of the larger cats, tigers and leopards, are lower (Lynam *et al.* 2001, Grassman *et al.* 2005, Rao *et al.* 2005).

Major Threat(s): Clouded leopards prefer closed forest (Grassman *et al.* 2005, Austin *et al.* 2007), and their habitat in Southeast Asia is undergoing the world's fastest deforestation rate (1.2-1.3% a year since 1990: FAO 2007).

The clouded leopard is hunted for the illegal wildlife trade - large numbers of skins have been seen in market surveys, and there is also trade in bones for medicines, meat for exotic dishes and live animals for the pet trade. Wild animals are likely the primary source, but there is also some illegal trade from captive animals (Nowell 2007).

Conservation Actions: Included on CITES Appendix I and protected by national legislation over most of its range (Nowell and Jackson 1996). Hunting is banned in Bangladesh, Brunei, Cambodia, China, India, Indonesia, Malaysia, Myanmar, Nepal, Taiwan, Thailand, and Viet Nam.

(9) Black muntjac *Muntiacus crinifrons*

Findings: Two skins and six antlers of black muntjac were found at Aliaung village, the last camp of Yenam area, and information from local people were recorded at all surveyed sites of Yenam area.

IUCN Red List (2009): Currently, the name *Muntiacus crinifrons* is only applicable to populations from eastern China (Groves and Grubb 1990).

Recent reports of *M. crinifrons* in northern Myanmar and adjacent parts of China, which lies far from its generally accepted range (see below), result from confusion with *M. gongshanensis* in Ma *et al*. 1990, described from the Gaoligongshan. They stem from a decision, based upon a similarity of analysed portions of mtDNA, to consider *M. gongshanensis* to be indistinguishable from, and therefore a junior synonym of, *M. crinifrons*, rather than any evidence that *M. crinifrons*, and specifically not *M. gongshanensis*, is in these areas. The first report was from northern Myanmar (Rabinowitz *et al*. 1998; Amato *et al*. 1999, 2000), which led to this claim that *M. gongshanensis* is indistinguishable from *M. crinifrons*. But to thereby consider the two as synonymous ignores the cautions and dangers of relying solely upon mtDNA to determine species phylogenies and identifications (Ballard and Whitlock 2004). Specifically, no consideration was given to possibilities that non-conspecific populations might possess very similar, perhaps identical, mtDNA, although there are several reasons why they sometimes do so (Ballard and Whitlock 2004). There are subsequent reports of muntjacs under the name '*M. crinifrons*' from areas of China adjacent to northern Myanmar and some way to the west (Schaller and Rabinowitz 2004; Chen *et al*. 2007). The identification in Chen *et al*. (2007) was based explicitly solely on mtDNA and *M. gongshanensis* may not have been considered (the name *M. gongshanensis* was associated with the name ‘Roosevelt’s Muntjak’ [sic], for which the code ‘Mgon’ was used; yet no result was given anywhere for ‘Mgon’, nor is either species discussed); Schaller and Rabinowitz (2004) took *M. gongshanensis* as a synonym of *M. crinifrons*. Therefore, none of these identifications can be taken as indicative of *M. crinifrons*, if *M. gongshanensis* is considered a distinct species (as it is here).

M. gongshanensis and *M. crinifrons* were maintained as distinct by Grubb (2005): the two differ substantially in morphological characters (Ma *et al*. 1990, Groves and Grubb 1990, R.J. Timmins pers. comm. 2008), reportedly also in karyotype (Huang *et al*. 2006) and even in mtDNA (Lan *et al*. 1995, Wang and Lan 2000).

<u>Justification:</u> Listed as Vulnerable because of a probable serious population decline, estimated to be more than 30% over the last three generations (approximately 18 years), inferred from over-exploitation, shrinkage in distribution, and habitat destruction and degradation. Although there is no direct data available regarding recent declining population rates, the above-mentioned rate of decline seems reasonable based on the high levels of harvesting and habitat loss. It should also be noted that:

1) The last population assessment accounted for only 7,000 to 8,500 individuals living in the wild, in eastern China (Sheng 1998), though the basis for these numbers is not clear.

2) The distribution range of the species is rather limited, and the species appears to slow to colonize new areas (Ohtaishi and Gao 1990, Wu *et al*. 2007).

3) Threats, to the survival of the species, are in all likelihood still present (Ohtaishi and Gao 1990, Wu *et al*. 2007).

Range Description: This species is now restricted to eastern China (in southeastern Anhui, northern Fujian, northeastern Jiangxi, and western Zhejiang (Ohtaishi and Gao 1990, Wu *et al*. 2007), with a few outlying records from eastern Zheijiang. Its range formerly extended from the coastal region of Ningbo at the mouth of the Yangtze River, westward to Guangdong province (Ohtaishi and Gao 1990). Records from Yunnan and Myanmar refer to *Muntiacus gongshanensis*. Animals are restricted to altitudes of 200-1,000 m asl.

Countries: Native: China

Population: This species is endemic to China. In 1989 the total Chinese population was estimated around 5,000-6,000 individuals by Ohtaishi and Gao (1990); Sheng (1998) estimated the population to number approximately 7,000 to 8,500. However, the basis for these population estimates is not known. Hunting and habitat destruction have negatively affected its geographic distribution and abundance (Sheng, 1998). A possible decrease in numbers during the late eighties was inferred by Ohtaishi and Gao (1990). Among the three main distribution centers of this species in eastern China there has developed a degree of genetic differentiation that Wu *et al*. (2006) attributed to the reduction of female-mediated gene flow stemming from habitat fragmentation. Although Wu *et al*. (2007) found a comfortingly large degree of nuclear genetic diversity; they nevertheless confirmed the earlier conclusions of Wu *et al*. (2005, 2006) based on mtDNA that the species had been fragmented into subpopulations. The species is believed to be in decline because of hunting and habitat loss.

Population Trend: Decreasing

Habitat and Ecology: This species occurs mostly in heavily forested mountain areas, with abundant undergrowth (Ohtaishi and Gao 1990), as well as mixed forest and scrub (Sheng Helin and Zhang Endi, East China Normal University pers. comm.). The species appears to be a generalist browser/frugivore, its diet includes a wide variety of tree leaves and twigs, forbs, grasses, and fruits. Zheng *et al*. (2006) found that most sign of *M. crinifrons* in a study area in Suichang county, Zhejiang province was found in mixed forests, although conifer forests increased in importance during winter. *M. crinifrons* seemed to prefer relatively high tree canopy cover in relatively high elevation (> 800 m) zones with little human disturbance. They apparently display rather limited dispersal capability (Wu *et al*. 2005, 2006, 2007).

The reproductive cycle is aseasonal, and some females conceive new litters while still lactating. Young are born throughout the year. Gestation is 210 days, and mothers give birth to single fawns. Sexual maturity is reached at one year (Sheng and Ohtaishi 1993).

Major Threat(s): Numbers of this species continue to decline due to deforestation, expanding agriculture, hunting, and other human disturbances. The species is hunted for venison and skin. Ohtaishi and Gao (1990) reported that 500 animals were being killed annually for skins which were sold to local markets during the 1980s. Sheng (1998) reported that yearly harvest may have exceeded this figure. There are no current data available regarding human predation on the species, but considering the chronic nature of the poaching problem in China there is no reason to assume that the species is not affected by it.

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Conservation Actions: *M. crinifrons* is listed on Appendix I of CITES. On the Chinese Red List this species is termed Endangered A2bcd (Smith and Xie 2008), and it protected by the 1988 Chinese National Wildlife Law under category I. It presumably exists in some protected areas, but no active conservation measures are currently in place for this species. Recommended conservation actions include initiation of research to determine status and threats throughout the species' range. Activities should include field reconnaissance, population censuses, demographic surveys, ecological studies and investigations into human use of the animals. The highest priority is to conserve the forest habitat of this species, and to bring poaching under strict control.

(10) Sambar *Rusa unicolor*

Findings: One and 18 antlers were found in Chibwe and Lasa areas respectively. In Lasa area, footprints were observed in the field survey and killed flesh and blooded skull of a sample were seen on 27 May, and also recorded through interviews with local people.

IUCN Red List (2009): Sambar is listed as VU through sustained declines across its range. These vary in severity between regions, and in some areas considerably exceed the threshold for VU. In the last three generations (taken to be 24–30 years), declines in mainland South-east Asia (Viet Nam, Lao PDR, Thailand, Cambodia, Myanmar, Malaysia), Bangladesh, and possibly Borneo and Sumatra have exceeded 50%, probably by a substantial margin. Current trends of wild meat and antler marketing in South-east Asia and China suggest declines might even speed up.

Sambar has not previously been listed as threatened or even as Near-Threatened. This reflects poor collation and processing of information in the 1980s and 1990s, because major declines have been in place during these decades. It may also reflect a tendency to infer from places like Khao Yai National Park, Thailand, where (around the reasonably well-secured headquarters) herds are large, visible, and clearly not at all threatened, that the species must therefore be secure.

Range Description: It occurs in Bangladesh, throughout mainland South-east Asia (Myanmar, Thailand, Lao PDR, Cambodia, Viet Nam, West Malaysia) and many of the main islands of the Greater Sundas (excepting Java): Sumatra, Siberut, Sipora, Pagi and Nias islands (all Indonesia), and Borneo (Malaysia, Indonesia, and Brunei) (Grubb 2005). The Sambar has been introduced widely outside its native range, e.g.: San Luis Obispo Country, California; the Gulf Prairies and Edwards Plateau regions of Texas (Ables and Ramsey 1974); the St. Vincent Islands, Franklin Country, Florida (Lewis *et al*. 1990); Australia (Slee 1984; Freeland 1990); New Zealand (Kelton and Skipworth 1987); and Western Cape Province, South Africa (Lever 1985).

Countries: Native: Bangladesh; Bhutan; Brunei Darussalam; Cambodia; China (Guangxi, Guizhou, Hainan, Hunan, Jiangxi, Sichuan, Yunnan); India; Indonesia (Sumatera); Lao People's Democratic Republic; Malaysia; Myanmar; Nepal; Sri Lanka; Taiwan, Province of China; Thailand; Viet Nam

Population: In Myanmar, Sambar was detected at 12 of 15 camera-trapped Tiger sites during 1999–2002, indicating that it is still widespread (Lynam 2003). The Myanmar Forest Department and Wildlife Conservation Society have jointly now (as of May 2008) camera-trapped 21 survey areas (including the earlier 15) and found Sambar in 13 (Saw Htun pers. comm. 2008). This lower ratio of proven presence indicates how the areas selected for Tiger survey were above average for prey and may indicate increasing local-level extinctions. For example, in a multi-method study of one area not expected to hold Tiger, hunted animals showed that Sambar still occurred in Naungmung and Machanbaw (south of Hkakaborazi National Park, Kachin state), but it was so scarce that it was not detected by substantial amounts of either camera trapping or sign surveys (Rao *et al*. 2005). Even within these best areas, large declines are suspected and overall national population losses of about 50% over the last 25–30 years and in the following such period are likely (Than Zaw pers. comm. 2006; Saw Htun pers. comm. 2008).

Population Trend: Decreasing

Habitat and Ecology: In Myanmar, recent camera-trap photographs spanned the range of 0–2,150 m asl (Saw Htun pers. comm. 2008). Sambar is largely restricted to hilly terrain in the Terai Arc Landscape (Johnsingh *et al*. 2004), although how much this reflects real habitat selection and how much it is an artificial pattern produced by human effects (habitat conversion and hunting) is unclear. Kushwaha *et al*. (2004) found that in Kumaon Himalaya (India), Sambar usage was greater of the higher than the lower altitude area. However, it makes wide use of plains areas elsewhere, where these have not been destroyed, e.g. the Hukaung Valley in Myanmar (J.W. Duckworth pers. comm. 2008). In Borneo, while Payne *et al*. (1985) considered Sambar "most common in secondary forests of gently-sloping terrain" they also knew of occurrence in "tall dipterocarp forests on steep terrain and in swamp forests". In Thung Yai, Thailand, Sambar signs were twice as abundant in lowland forest as in montane forest, although this difference was not statistically significant (Steinmetz *et al*. 2008).

In Southeast Asian regions of dense evergreen closed-canopy forest, Sambar is highly tolerant of forest degradation: indeed, much higher numbers are found in encroached stands than in pristine forests, if hunting is under control (Rijksen 1978; Heydon 1994; Stuebing 1995; Davies *et al*. 2001).

Sambar regularly visits salt licks (e.g. Matsubayashi *et al*. 2007), perhaps especially when growing new antlers. This predictability exposes it to high levels of hunting, where this is not effectively controlled. It seems that within an area, not all sort of licks are visited.

Major Threat(s): Habitat encroachment and hunting are both widespread in the Sundaic region and in much of the rest of Sambar's range. There are major, ongoing, declines in at least Viet Nam, Lao PDR, Cambodia, Thailand, Malaysia, Myanmar, Bangladesh and Nepal, and probably Sri Lanka and Indonesia (see Populations) which can plausibly only be driven by hunting, because suitable habitat for Sambar is abundant in these countries but is almost or actually bereft of the species.

Eld's Deer *Rucervus eldii* and Hog Deer *Axis porcinus* (extinct across most of their former range through former steep declines) does indeed suggest a broad applicability of a conclusion that Sambar is somewhat less rapidly reduced by hunting than are other sympatric deer, excepting muntjacs *Munitacus* spp.

Deer are hunted in India using snares, dogs, and guns (Jathanna *et al*. 2003; Kumara and Singh 2004) and these methods are general across their range. Some hunting is for village consumption of meat, but most (at least in South-east Asia) is probably sold commercially, to the affluent urban classes (e.g. Duckworth *et al*. 1999; Walston 2001; Kumara and Singh 2004), and to itinerant labourers, such as logging crews in at least Sarawak (Bennett and Gunal 2001) and gold-diggers and rattan-cutters in Myanmar (J.W. Duckworth pers. comm. 2008). Such commercially-driven hunting causes major declines (e.g. Steinmetz *et al*. 2008) because the market is limitless. Adult males suffer additionally because antlers are widely displayed as trophies and are used in traditional medicine (e.g. Martin 1992, Baird 1995).

Conservation Actions: The Sambar is found in many protected areas throughout its range, although in most of these areas this legal status has not stemmed declines and local extinctions from hunting. Similarly, although it is protected from hunting by legislation, even outside protected areas, in most or all range states, these laws are challenging to enforce, given the trade demand for meat and antlers (GMA Indonesia Workshop).

In South-east Asia, Sambar declines have lagged behind those of other sympatric deer (excepting muntjacs). There is no doubt that within a decade or two Sambar will be, like Hog Deer and Eld's Deer are already, almost absent from South-east Asia unless effective protection from trade-driven hunting is instituted.

As the majority of the Sambar population is in South Asia, conservation activities are important there. It is also important that populations are maintained at least in several areas in Southeast Asia, to maintain Sambar presence through its historical range, to preserve Sambar genetic diversity and through its importance to the ecosystems within which it lives. Given the regional pattern of threats and current successes to date, implementing effective conservation interventions is considerably more challenging, and therefore a higher priority in the Southeast Asian region.

In Myanmar the Hukaung Valley is an exceptional area of lowland plains forest, grassland, and wetlands. Part lies within the Wildlife Sanctuary and some of the rest of the outstanding plains habitat is within an enormous proposed extension. Through its size and mostly little-encroached condition, this is the most outstanding remaining landscape-level floodplains habitat for very large mammals remaining in tropical Asia, and although wildlife populations are highly depleted, warrants the strongest effort to conserve it. It faces a number of daunting challenges (J.W. Duckworth pers. comm. 2008).

(11) Gaur *Bos gaurus*

Findings: Horns, four in Myitsone, two in Lasa and another two in Chibwe area were found. In Myitsone, selling of fresh meat was seen on 18 January, and footprints and disturbed signs of soil of group of gaur were observed on 1, 4 and 19 February. This species was also recorded from interviews in Myitsone and Lasa areas.

IUCN Red List (2009): The population decline in parts of the species' range especially Indochina and Malaysia, perhaps also Myanmar and China, is likely to be well over 70% over the last three generations. This reflects that in the various reasonably well-protected areas, population trends are stable, and in a few areas which have been neglected but are the focus of improved protection, populations are rebuilding. Weighting these by population size gives an overall decline of at least 30% over the last three generations. Similar reductions are projected, largely because the causative factors (especially wild meat hunting and hunting for the trade in horns in Southeast Asia) are still operative.

Range Description: Gaur historically occurred throughout mainland south and southeast Asia and Sri Lanka. It currently occurs in scattered areas in the following range states: Bhutan, Cambodia, China, India, Lao PDR, Malaysia (Peninsular Malaysia only), Myanmar, Nepal, Thailand, and Viet Nam, but is extinct in Sri Lanka and also, as a resident, apparently in Bangladesh (Grubb 2005; Md Anwarul Islam in litt. 2008; Hedges in prep.). The species is now seriously fragmented within its range, and the mapped distribution is generalised, especially in India, Myanmar, China and Malaysia.

The domesticated form of Gaur, considered by IUCN a separate species (*Bos frontalis*; Mythun, Mithan or Gayal), occurs in parts of India, China, and Myanmar as feral, semiferal, and domestic animals. This animal is excluded from the red-listing considerations for Gaur.

Countries: Native: Bangladesh; Bhutan; Cambodia; China; India; Lao People's Democratic Republic; Malaysia (Peninsular Malaysia); Myanmar; Nepal; Thailand; Viet Nam

Regionally extinct: Sri Lanka

Population: The global population is estimated to lie within 13,000–30,000 animals. In Myanmar, the status of Gaur is poorly known (J.W. Duckworth and Than Zaw pers. comm. 2006). A March 1994 survey of Taminthi Wildlife Sanctuary, Myanmar's largest protected area, guessed that 100–200 Gaur remained, and that they were in danger of being extirpated from the area if current levels of poaching continued (Rabinowitz *et al*. 1995). A national Tiger survey camera-trapped Gaur in 11 of 15 camera-trapped sites, commonly in several (Lynam 2003); these sites were selected for their chances of holding Tigers, so, because the two species face similar threats, it may present the most positive picture of Gaur occurrence in the country.

Habitat and Ecology: The Gaur occurs from sea level up to at least 2,800 m asl (Wood 1937; Wharton 1968; Choudhury 2002). Despite the many reports that call it an animal of hill-country, low-lying areas seem to comprise optimal habitat (Choudhury 2002). Similarly, in the Tenasserim–Dawna mountains, Thailand, signs of Gaur were more abundant in the lowlands than in the hills, noting that this was the opposite of the patterns that would be predicted if hunting (itself concentrated heavily in the lowlands) was the chief determinant of population densities, although solitary animals were found mainly in the hills (Steinmetz *et al*. 2008). Gaur can persist in fragmented areas with some habitat disturbance and hunting, including in landscapes dominated by plantations (such as on parts of the Valparai plateau, south India), but in Southeast Asia it has been too heavily hunted in such areas to survive in them.

Gaur both grazes and browses, reportedly eating mostly young green grasses but also leaves, fruit, twigs, and bark of various woody species, as well as coarse dry grasses, and bamboo. It seems able to maintain good condition on relatively low quality feed. In undisturbed areas, Gaur is mainly diurnal, but in areas of high human disturbance, it is reported to become mainly nocturnal.

Systems: Terrestrial

Major Threat(s): The set of threats and the gravity of each threat to Gaur differs greatly between south and central India, and Southeast Asia; China and most of northeast India are more similar to Southeast Asia in this respect (Farshid Ahrestani pers. comm. 2008), and are so treated in the following discussion.

In Indochina, Myanmar, and northeast India, hunting is the major problem, compounded by loss of suitable habitat: large tracts of suitable habitat hold few or no Guar. Ongoing habitat degradation and conversion is continually reducing the potential population, should hunting be brought under control (Duckworth *et al*. 1999; Duckworth and Hedges 1998; Timmins and Ou 2001; Choudhury 2002; Steinmetz 2004; Than Zaw pers. comm. 2006; R.J Timmins pers. comm. 2008; Farshid Ahrestani pers. comm. 2008). Hunting is often for meat and a variety of methods is used (Choudhury 2002). There is also a flourishing international trade in Gaur parts, both horns (decorative) and internal organs (for medicinal purposes). Given the small size of the remaining Southeast Asian subpopulations and the number of trophies found for sale in Cambodia, Lao PDR, Thailand, and Myanmar during essentially opportunistic surveys, trade is clearly a major threat (Srikosamatara *et al*. 1992; Baird 1993;

Srikosamatara and Suteethorn 1994, 1995; Martin and Phipps 1996; Srifa La-Ong *et al*. 1997; Duckworth *et al*. 1999).

Gaur occurs mainly in protected areas in Southeast Asia, although Cambodia and Myanmar may both have large populations outside them and some may persist is such areas in Lao PDR (Duckworth 1996; Hansel 2004).

A large captive population exists of wild-type Gaur (as well as of Mythun); given the complexity of field conservation of large ungulates, particularly in South-east Asia, it is clearly in resolving issues of hunting, trade, and protected area effectiveness that conservation interventions must focus.

(12) Takin *Budocas taxicolor*

Findings: The horns of Takin hunted from icy mountain were found in Wusok, Pisa, Khaunglanghpu, and Yenam areas.

IUCN Red List (2009): The species is listed as Vulnerable based on a probable decline of at least 30% over the last three generations (estimated at 24 years) due to over-hunting and habitat loss.

Range Description: This species occurs in Bhutan, China (southeastern Gansu, Sichuan, Shaanxi, southeast Tibet, and northwestern Yunnan), and northeast India (Arunachal Pradesh and Sikkim; Singh 2002) and northern Myanmar (Salter 1997).

Budorcas taxicolor taxicolor

In Myanmar, it occupies the high mountain slopes above 2,750 m in Kachin State, northern Myanmar, to the border with China (Blower, 1985, Salter 1997). However, there is no recent distribution data. The geographic boundary between *B. t. taxicolor* and *B. t. whitei* is evidently uncertain.

Countries: Native: Bhutan; China; India; Myanmar

Budorcas taxicolor taxicolor

No rigorous estimate has been made of the total population in China, but Wang (1998) estimated about 3,500, mostly in Tibet. In Myanmar populations are decreasing because of hunting for bushmeat (by trapping and crossbow), and is now rare (Than Zaw pers comm. 2006).

Population Trend: ↓ Decreasing

Habitat and Ecology: This species is found in eastern Himalayan pine shrub, subtropical forest, and possibly temperate forest in Myanmar (Than Zaw pers. comm. 2006). *Budorcas taxicolor whitei* inhabits sub-tropical to subalpine forests, mainly between 2,000 and 3,500 m, but sometimes entering as low as 1,500 m, or moving up to areas above the timberline. In summer, Takin feed in alpine meadows up to 4,000 m. In winter they descend into the valleys and forests to as low as 1,000 m. They feed on a variety of grasses, bamboo shoots, forbs and leaves of shrubs and trees. Takin forage in early morning and late afternoon, and regularly visit salt-licks which renders them very vulnerable to poachers who lay in ambush. Takins seasonally migrate to preferred habitats. During spring and early summer months, they begin to gather in large herds of up to 100 animals at the uppermost limits of treeline. During cooler autumn months, when food is less plentiful at higher elevations, herds disband into smaller groups of up to 20 individuals, and move to forested valleys at lower elevations. Groups mainly comprise females, subadults, young and some adult males. Older males usually remain solitary throughout most of the year, but gather with females during the rutting season.

Sexually mature at about 3.5 years of age. Rutting occurs in late summer, followed by a gestation of 200 to 220 days. Single young are born in March or April. Longevity is about 16-18 years.

Major Threat(s): *Budorcas taxicolor taxicolor*

In Tibet, China, hunting is the main threat, but habitat destruction caused by deforestation is also serious (Wang *et al*. 1997, Wang 1998). In Myanmar populations are threatened by for bushmeat (by trapping and crossbow; Salter 1997).

Conservation Actions: In China, all subspecies are protected from direct exploitation by their inclusion under Category I of the National Wildlife Law of 1988, although a small number are taken yearly in trophy hunts. They are not legally hunted in India or Bhutan. Their legal status in Myanmar is uncertain. The species is listed on Appendix II of CITES.

Budorcas taxicolor taxicolor

It occurs mainly within protected areas in Myanmar, (Than Zaw pers comm. 2006). Conservation measures proposed are: 1) complete a population census of the Mishmi takin, beginning in the Nujiang Nature Reserve, before moving to other parts of its range; 2) develop a co-operative program between Chinese and Myanmar authorities to strictly forbid hunting of this animal; and 3) locate potential protected areas.

(13) Red goral *Naemorhedus baileyi*

Findings: Two skins and one horn of red goral were found at Pannandim of Yenam area.

IUCN Red List (2009): Listed as Endangered because its population size is estimated to number fewer than 10,000 mature individuals, there is probably continuing decline in the number of mature individuals due to over hunting, and no subpopulation is likely to contain more than 1,000 mature individuals.

Range Description: This species is found in northern Myanmar, China (southeast Tibet and Yunnan), and northeast India (Arunachal Pradesh) (Grubb, 2005, Singh, 2002, Mishra, 2006). This species is found at higher elevations than most gorals, between altitudes of 2,000-4,500 m (Zhang 1987; Rabinowitz 1999; Smith and Xie 2008).

According to Shackelton (1997), this species, sometimes referred to as *N. cranbrooki*, has a narrow distribution, and inhabits the largest remaining native coniferous forests up to 4,000 m in the eastern Himalayas of southeastern Tibet. In Myanmar the species is confined to the northernmost part of the country, and in India it is restricted to Arunachal Pradesh, near the Chinese and Myanmar borders.

Countries: Native: China; India; Myanmar

Population: Wang (1998) suggested that total numbers in China were less than 1,500. The species is rare in Myanmar because of a naturally restricted range, compounded by the effects of trade-driven hunting (Than Zaw and W. Duckworth pers. comm., 2006). There is little information on its status in India. Given its small range, the total population size is probably less than 10,000 mature individuals.

Population Trend: Decreasing

Habitat and Ecology: The red goral inhabits forest, ragged crags, scrub and meadows from 2,000 m up to 4,500 m in summer (Smith and Xie 2008). The elevation and range where red goral is found supports one of the largest tracts of primary coniferous woodland in Asia, which along with its rocky outcrops, form the species' primary habitat (Zhang, 1987; Wang 1998; Sheng *et al*., 1999). Red gorals migrate seasonally, moving in the winter (typically, November through to March) to lower-elevation mixed deciduous and coniferous forests or glades and thickets below the snow line (Zhang, 1987; Wang 1998; Sheng *et al*., 1999; Rabinowitz, 1999). Gorals are diurnal, and are most active in the early morning and late evening, but can be active throughout on overcast days (Sheng *et al*., 1999). This species is typically solitary, but occasionally the animals are seen in small groups of 2-3, typically a female and her offspring, sometimes accompanied with a male, or a female with her offspring from the previous two years (Zhang, 1987; Sheng *et al*., 1999).

<u>Systems:</u> Terrestrial

<u>Major Threat(s):</u> Hunting and habitat loss caused by rapid forestry expansion are the major threats. Since the opening up of and the economic reforms in Tibet, hunting has had a major negative impact on the population of red goral. This is due primarily to the increasing number of immigrants and modern hunting weapons. It was said that in the three provinces of Pelung, Dingjiu and Bayu in the Linzhi county, only about 150 individuals of this species had been hunted annually before the early 1980s. Although a hunting ban was in effect over the last five years, poaching is still common and takes place most often when animals move down to their winter ranges (Zhang, 1991). Hunting is the major threat to the species in Myanmar, reflecting the same factors as listed above for China (Than Zaw pers. comm. 2006). It is valued when found (W. Duckworth pers. comm. 2006). Horns are valued medicinally in China (Than Zaw pers. comm. 2006).

<u>Conservation Actions:</u> The red goral is listed on Appendix I of CITES, and as a Class I Protected Species in China.

This species is largely or perhaps entirely within protected areas in Myanmar (Than Zaw pers. comm. 2006), notably the Hpoganranzi Wildlife Sanctuary and the Hkakaborazi National Park.

The taxonomic validity of this species, and its relationship to other species in the genus *Naemorhedus* needs to be assessed.

Table 4.1.1. List of mammal team in all survey areas

Myitsone area (I)	Lasa area (II)	Chibwe Area (III)	Wusok Area (IV)	Pisa Area (V)	Khaunglanhpu Area (VI)	Yenam Area (VII)
16-1-09 to 28-1-09	**6-4-09 to 30-4-09**	**3-4-09 to 12-5-09**	**6-4-09 to 13-5-09**	**15-4-09 to 18-4-09**	**20-2-09 to 29-3-09**	**20-2-09 to 29-3-09**
Swe Swe Aung	Swe Swe Aung	Aung Soe Than	Aung Soe Than	Aung Soe Than	Aung Soe Than	Swe Swe Aung
May Thu Tun	May Thu Tun	Thida Nyein	Kyaw Naing Oo		Thida Nyein	May Thu Tun
Thidar Win	Myo Min Tun	Thandar Win	Thida Nyein		Thandar Win	
		Kyaw Naing Oo	Thandar Win			
30-1-09 to 12-2-09						
Aung Soe Than						
Swe Swe Aung						
May Thu Tun						
17-2-09 to 21-2-09						
Myo Min Tun						
Kyaw Naing Oo						
6-5-09 to 13-5-09						
Myo Min Tun						
May Thu Tun						
18-5-09 to 27-5-09						

Table 4.1.2. Study areas of mammal team

Study sites in Myitsone area

Study area		Site	Location	Altitude (m)	Place	Date	Forest Type
I	a	Myitsone	N 25˚ 42' 30.5" E 97˚ 29' 48.1"	132	Junction of MK & MLK	15-27 Jan 09	Secondary forest, Mixed-evergreen forest, Cultivation land, Bamboo forest, Riverbed
I	b	Tiangzup	N 25˚ 58' 21.0" E 97˚ 32' 02.3"	151	Malihka	24-Jan-09	Primary and Second forest, Bamboo, Riverbed
I	c	Bantbane	N 25˚ 42' 03.2" E 97˚ 54' 50.6"	224	Mayhka	31 Jan to 5 Feb 09 7-12 May 09	Secondary forest, Primary forest, Bamboo, Riverbed, Plantation, Degraded forest and Cultivation
I	d	Thewaing	N 25˚ 41' 56.7" E 97˚ 36' 52.8"	295	Mayhka	7-11 Feb 09	Secondary forest, Primary forest, Bamboo, Riverbed, Plantation, Degraded and Cultivation land
I	e	Chaung-sone	N 25˚ 35' 71.1" E 97˚ 48' 82"	175	Mayhka	18-20 Feb 09	Secondary forest, Bamboo, Riverbed

Study sites in Lasa area

Study area	Site		Location	Altitude (m)	Place	Date	Forest Type
II	a	SumPiyan	N 26˚ 52' 33.4" E 97˚ 38' 56.0"	359	Village	8-Apr-09	Tropical Wet Evergreen
		In Gi Yang	N 26˚ 53' 47.4" E 97˚ 39' 34.2"	343	Village & forest	9-Apr-09	Tropical Wet Evergreen
II		Hpa Wun	N 26˚ 53' 39.3" E 97˚ 42' 42.7"	349	Village & forest	11,13,14-Apr-09	Tropical Wet Evergreen
	b	Khaut Hka	N 26˚ 53' 39.9" E 97˚ 43' 26.1"	304	Along stream & forest	11-Apr-09	Tropical Wet Evergreen
II		Lone Kar Hka	N 26˚ 53' 54.8" E 97˚ 42' 28.1"	349	Stream & forest	12-Apr-09	Tropical Wet Evergreen
	c	Zi Di Yang	N 26˚ 43' 43.8" E 97˚ 39' 53.7"	319	Village & forest	16,18-Apr-09	Tropical Wet Evergreen
		Hpung Ing Yang	N 26˚ 45' 05.8" E 97˚ 38' 40. 8"	526	Forest	17-Apr-09	Tropical Wet Evergreen
II		Shi Rang Hka	N 26˚ 35' 40.5" E 97˚ 40' 38.2"	253	Along stream & forest	21-Apr-09	Tropical Wet Evergreen
		Lot Mai Yang	N 26˚ 35' 52.2" E 97˚ 44' 03.3"	242	Village	22-Apr-09	Tropical Wet Evergreen
II		In Htan Sut	N 26˚ 35' 51. 8" E 97˚ 44' 13.7"	260	Village	23-Apr-09	Tropical Wet Evergreen
	d	Lone Hka	N 26˚ 33' 05.5" E 97˚ 41' 41.3"	259	Forest	24-Apr-09	Tropical Wet Evergreen
II		Lot Kon	N 26˚ 31' 06.8" E 97˚ 42' 54.7"	375	Village & forest	25-Apr-09	Tropical Wet Evergreen
		Ja Ra Yang	N 26˚ 34' 23.4" E 97˚ 42' 03.2"	251	Village	26-Apr-09	Tropical Wet Evergreen
II		Maliyan	N 26˚ 34' 40. 4" E 97˚ 41' 20.6"	271	Village	27,28-Apr-09	Tropical Wet Evergreen

Study sites in Chibwe area

Study area	Site	Location	Altitude (m)	Place	Date	Forest Type

III	a	Kyihtam	N 26˚ 16' 13.6" E 98˚ 18' 41.4"	514		8-9 Apr-09	Secondary forest, Mixed-evergreen forest, Cultivation land, Riverbed
III	b	Majhon			Junction of Mayhka & Ngaw Chan Hka	26-Apr-09	Secondary forest, Degrated and Riverbed
III	c	21 mile	N 26˚ 06' 37.3" E 98˚ 12' 52.2"	317	Mayhka	8-May-09	Secondary forest, Bamboo, Riverbed, Plantation, Degraded and Cultivation land
III	d	Phala	N 26˚ 01' 55.9" E 98˚ 10' 42.1"	321	Mayhka	1-12 May	Secondary forest, Bamboo, Riverbed, Plantation, Degraded and Cultivation land
III	e	Kaungla	N 26˚ 00' 04.1" E 98˚ 10' 59.2"	379	Mayhka	2-3 May 09	Secondary forest, Bamboo, Riverbed, Plantation, Degraded and Cultivation land
III	f	Mondon	N 25˚ 57' 38.2" E 98˚ 09'23.4"	317	Mayhka	10-May-09	Secondary forest, Degrated and Riverbed
III	g	Longphine	N 26˚ 08' 27.9" E 98˚ 10'51.1 "	421	Mayhka	8-May-09	Secondary forest, Bamboo, Riverbed
III	h	Phonphine	N 25˚ 59' 20.7" E 98˚ 09'56.2	276	Mayhka	7-May-09	Secondary forest, Bamboo, Riverbed
III	i	Larorzu	N 26˚ 04' 39.4" E 98˚ 11'55.5"	294	Mayhka	11-May-09	Secondary forest, Bamboo, Riverbed
III	j	Ngamyawzu	N 26˚ 09' 38.4" E 98˚14' 17.2"	397	Mayhka	12-May-09	Secondary forest, Bamboo, Riverbed

Study sites in Wusok area

Study area		Site	Location	Altitude (m)	Place	Date	Forest Type
IV	a	Pashe	N 26˚ 28' 10.0" E 98˚ 17' 43.5"	509	Mayhka	12-Apr-09	Secondary forest, Mixed-evergreen forest, Cultivation land, Riverbed
IV	b	Pashe and Warup	N 26˚ 48' 43.0" E 98˚ 29' 38.7"	555	Mayhka	16-Apr-09	Secondary forest, Degrated and Riverbed
IV	c	Warup	N 26˚ 31' 32.5" E 98˚ 18' 42.1"	760	Mayhka	12-Apr-09	Secondary forest, Bamboo, Riverbed, Plantation, Degraded and Cultivation land
IV	d	Phung Ja	N 26˚ 33' 21.7" E 98˚ 21' 08.1"	985	Mayhka	13-Apr-09	Secondary forest, Bamboo, Riverbed, Plantation, Degraded and Cultivation land
IV	e	Htaw Lang	N 26˚ 28' 17.5" E 98˚ 22' 39.6"	1082	Mayhka	14-Apr-09	Secondary forest, Bamboo, Riverbed, Plantation, Degraded and Cultivation land

Study sites in Pisa area

Study area		Site	Location	Altitude (m)	Place	Date	Forest Type
V	a	Nga Yar	N 26˚ 40' 07.1" E 98˚ 22' 56.5"	1370	Mayhka	15-Apr-09	Secondary forest, Mixed-evergreen forest, Cultivation land, Riverbed
V	b	Chone Dan	N 26˚ 42' 28.2" E 98˚ 23' 07.3"	1146	Mayhka	16-Apr-09	Secondary forest, Degrated and Riverbed
V	c	Ga Ran	N 26˚ 35' 37.5" E 98˚ 22' 05.2"	1240	Mayhka	19-Apr-09	Secondary forest, Bamboo, Riverbed, Plantation, Degraded and Cultivation land

Study sites in Khaunglanhpu area

Study area	Site	Location	Altitude (m)	Place	Date	Forest Type

VI	a	Ridam	N 27° 12' 03.8" E 98° 14'20.2"	758	Mayhka	1,20 March 09	Secondary forest, Mixed-evergreen forest, Cultivation land, Riverbed
VI	b	Khaung Lan Hpu	N 27° 12' 45.2" E 98° 13'14.9"	725	Mayhka	3-15 March 09	Secondary forest, Bamboo, Riverbed, Plantation, Degraded and Cultivation land
VI	c	Wunning	N 27° 01' 03.6" E 98° 21' 51.8"	1149	Mayhka	7,8 March 09	Secondary forest, Bamboo, Riverbed, Plantation, Degraded and Cultivation land
VI	d	Chaungsone	N 27° 02' 21.6" E 98° 22' 05.4"	996	Mayhka	9,11,12,13 15 March 09	Secondary forest, Bamboo, Riverbed, Plantation, Degraded and Cultivation land

Study sites in Yenam area

Study area		Site	Location	Altitude (m)	Place	Date	Forest Type
VII	a	Panandim	N 27° 43' 34.3" E 97° 52' 18.7"	1019	Nam Tamai river	27/28-2-09 & 18-3-09	Secondary forest, Mixed-evergreen forest, Cultivation land, Bamboo forest, Riverbed
VII	b	West Mandon	N 27° 43' 37.9" E 97° 56' 27.1"	972	Nam Tamai river	2/3-3-09	Secondary forest, Bamboo forest, Riverbed
VII	c	West Yenam	N 27° 42' 04.8" E 98° 02' 21.9"	1019	Junction of Nam Tamai & Trone Wan rivers	5 to 9-3-09	Secondary forest, Bamboo forest, Riverbed
VII	d	Aliaung	N 27° 42' 08.1" E 98° 07' 44.3"	989	Trone Wan river	11 to 13-3-09	Secondary forest, Primary forest, Bamboo forest, Riverbed, Degraded and Cultivation land

Table 4.1.3. Numbers of species in orders in all seven survey areas

Orders	I	II	III	IV	V	VI	VII	All
Pholidota	1	1	1	—	—	—	1	1
Insectivora	1	—	1	1	1	—	1	2
Chiroptera	7	1	—	3	—	2	3	7
Primates	6	6	5	4	2	3	4	6
Carnivora	11	12	6	4	3	4	13	17
Proboscida	1	—	—	—	—	—	—	1
Artiodactyla	4	6	7	7	6	7	6	12
Rodentia	6	9	8	3	4	3	4	15

I = Myitsone, II = Lasa, III =Chibwe, IV = Wusok, V = Pisa, VI = Khaunglanhpu, VII = Yenam, All = All survey areas

Table 4.1.4. Mammal species frequency and per cent showing in conservation status of IUCN Red List Data

IUCN Red List Data, 2009	I		II		III		IV		V		VI		VII		All	
	species	per cent	species	per cent	species	per cent	species	per cent	species	per cent	species	per cent	species	per cent	species	per cent

Endangered (EN)	4	36.67	3	31.43	1	30.00	1	31.82	1	18.75	1	26.32	2	37.50	5	29.51
Vulnerable (VU)	7		8		8		6		2		4		10		13	
Near Threatened (NT)	4	13.33	5	14.3	6	20	3	13.6	3	18.8	3	15.8	3	9.38	7	11.5
Least Concern (LC)	14	46.67	18	51.4	11	36.7	8	36.4	8	50	9	47.4	15	46.9	29	47.5
Data Deficient (DD)	–	–	–	–	1	3.33	2	9.09	1	6.25	2	10.5	1	3.13	3	4.92
Unknown Status	1	3.33	1	2.86	1	3.33	2	9.09	1	6.25	0	0	1	3.13	4	6.56

I = Myitsone, II = Lasa, III = Chibwe, IV = Wusok, V = Pisa, VI = Khaunglanhpu, VII = Yenam, All = All survey areas

Table 4.1.5. Summary of information on mammal species recorded in the seven study areas

Information	I	II	III	IV	V	VI	VII	ALL
Elevation (range)	132-295	242-526	276-514	509-1082	1146-1370	725-1149	972-1019	–
Elevation (mean)	213.5	384	395	795.5	1258	937	995.5	–
Observed days	43	21	35	34	11	21	15	179
Order	7	6	6	6	5	5	7	8
Species	30	35	28	22	16	19	32	61
Species in per cent	41.92	57.38	45.9	36.06	26.23	31.15	52.46	–
Endangered (EN)	4	3	1	1	1	1	2	5
Vulnerable (VU)	7	8	8	6	2	4	10	13
Near Threathened (NT)	4	5	6	3	3	3	3	7
Least Concerned (LC)	14	18	11	8	8	9	15	29
Data Deficient (DD)	–	–	1	2	1	2	1	3
Appendix I	7	7	8	5	3	4	6	12
Appendix II	9	9	7	5	4	5	11	13
Appendix III	5	5	1	–	1	1	3	5

I = Myitsone, II = Lasa, III = Chipwi, IV = Wusot, V = Pisa, VI = Khaunglanphu, VII = Renam, All = All survey areas

4.2. REPTILE AND AMPHIBIAN (HERPETOFAUNA)

Itinerary: The detailed itinerary was listed in Tables 4.2.1 and 4.2.2.The study sites of herpetofauna team were shown in Figures 4.2.1 to 4.2.7.

A total of 115 species of amphibians and reptiles was recorded out of which 46 species were frogs, one caecilian, 25 species were lizards, 34 species were snakes and 6 species were turtles. Out of 34 species of snakes, five were venomous viz Malayan krait *Bungarus candidus*, monocellate cobra *Naja kaouthia*, king cobra *Ophiophagus hannah*, mountain pit viper *Ovophis monticola* and white-lipped pit-viper *Trimeresurus albolabris*. All the turtles were recorded as terrestrial and fresh water turtles.

Species abundance: A total of 115 amphibians and reptiles species were recorded. Nineteen families of Bufonidae (4 species), Hylidae (1 species), Megophryidae (9 species), Microhylidae (3 species), Ranidae (17 species), Rhacophoridae (13 species), Ichthyophiidae (1 species), Agamidae (9 species), Gekkonidae (6 species), Scincidae (8 species),Varanidae (2 species), Anguidae (1 species), Colubridae (26 species), Elapidae (3 species), Pythonidae (1 species), Typhlopidae (2 species), Viperridae (2 species), Xenopeltidae (1 species) Emydidae (6 species) were included (Figures 4.2.8 to 4.2.15; Table 4.2.3 and Appendix 4.2.1). The greatest species richness (26 species) was recorded in the family Colubridae and the least number of species (1 species) was found in the families Hylidae, Ichthyophiidae, Pythonidae and Xenopeltidae.

Species abundance in relation to observation days and the elevation ranges of study areas are shown in Figure 4.2.16. The highest altitude was found in Khaunglanphu, study area VI, and the lowest altitude in Myitsone, study area I. The greatest abundant of species (52) was recorded in Study area I, which was observed for the greatest number of days (40) as shown in Table 4.2.4.

Conservation status: According to the conservation status of 2009 IUCN Red list Data, two species are listed as Endangered (EN), one species is listed as Vulnerable (VU), two species are listed as Near Threatened (NT), 17 species are listed as Least Concern (LC) and three species are listed as Data Deficient (DD) from survey areas (Table. 4.2.4 and Appendix 4.2.1). Five and one recorded species were also included in 2009 CITES Appendices II and III respectively.

Within records of endangered species (EN + VU), Keeled box turtle *Pyxidea mouhotii*, Myanmar roofed turtle *Kachuga trivittata* are catergorized as Endangered (EN) and Giant Asian pond turtle Heosemys grandis is also catergorized as Vulnerable (VU) in IUCN Red List Data, 2009 (Appendix 4.2.1).

A total of 31 hertofauna species was recorded more by Chinese researchers (it means they found and identified these 31 spp. in greater numbers and these are that non-Chinese did not find at all), shown in Appendix. 4.2.9. Seventeen species of amphibians and 14 species of reptiles (included 12 species of snake) were recorded. Within recorded species, Yunnan spiny frog *Paa yannanensis* is listed as Endangered (EN), Xizhang warty treefrog *Theloderma moloch* is listed as Vulnerable (VU) and Gongshan flying frog *Polypedates gongshanensis* is listed as Near Threatened (NT) in 2009 IUCN Red List Data. Six species of Least Concerned (LC) and two species of Data Deficient (DD) are also catergorized.

4.2.1. Myitsone, study area I

Species abundance: A total of 51 amphibians and reptiles species were recorded. Sixteen families of Bufonidae (2 species), Megophryidae (1 species), Microhylidae (3 species), Ranidae (9 species), Rhacophoridae (3 species), Agamidae (4 species), Gekkonidae (5 species), Scincidae (5 species),Varanidae (2 species), Colubridae (7 species), Elapidae (8 species), Pythonidae (1 species), Typhlopidae (2 species), Viperidae (1 species), Xenopeltidae (1 species) and Emydidae (4 species) were included (Table 4.2.3 and Appendix 4.2.2). The greatest species richness (9 species) was recorded in the family Ranidae. Three venomous snakes were recorded viz, Malayan krait *Bungarus candidus*, king cobra *Ophiophagus hannah* and white-lipped pit-viper *Trimeresurus albolabris.*

Species abundance in relation to observation days and the elevation ranges of study areas are shown in Figure 4.2.16. The lowest altitude was found in Myitsone, study area I. The greatest abundant of species (51) was recorded in Study area I, which was observed for the greatest number of days (40) as shown in Table 4.2.4.

Herpetofauna species (total numbers collected) were recorded in or on or near or around the following microhabitats in the percentages indicated in brackets: water (39.2); vegetation (31.4); wood/log/soil/hole (13.7), road/trail and roof/hut (7.8) (Table 4.2.5).

Snakes were killed by the local people (KIA) especially for meat and the skins were traded to China. Turtles were captured and traded. Turtle shells were found. Boa was found killed by local people 3 days ago and they had grilled its meat. Boa pancreases (2) were also found. Boa was bought by Chinese people at Jubilee village.

Threats: Habitat for herpetofauna species was degraded by logging and gold dredging. Logging was noted in Bam-bane village and especially found in Jubilee. Much illegal logging has resulted in the forest being totally destroyed. Gold mining was also found. The original forest is degraded into secondary forest and cultivation lands. The local people usually hunt them for food and for trade. Snake especially python, boia and turtles were sold alive and trade market is present in Jubilee market. They also have a traditional believe to kill the snakes.

Conservation status: According to the conservation status of 2009 IUCN Red list Data, two species are listed as Endangered (EN), two species are listed as Near Threatened (NT) and nine species are listed as Least Concern (LC) from survey areas (Table. 4.2.4 and Appendix 4.2.2). Four and one species are also included in 2009 CITES Appendices II and III respectively.

Within records of endangered species (EN + VU), Keeled box turtle *Pyxidea mouhotii*, Myanmar roofed turtle *Kachuga trivittata* are categorized as Endangered (EN) and No species is categorized as Vulnerable (VU) in IUCN Red List Data, 2009 (Appendix 4.2.2).

Conclusions and Discussion: Sixteen families, including 51 species of herpetofauna were recorded in Myitsone, study area I. The greatest number of species was listed in the family Ranidae and the least, only one species was found in Megophryidae, Pythonidae, Typhlopidae, Viperidae and Xenopeltidae.

Two Endangered (EN) species and two Near Threatened (NT) species were recorded, viz Keeled box turtle *Pyxidea mouhotii*, Myanmar roofed turtle *Kachuga trivittata* and Burmese python *Python molurus,* Indian black turtle *Melanochelys trijuga* are found as threatened species in Myitsone area. Nine species were also recorded Least Concerned (LC) in conservation status (Appendix 4.2.2).

The herpetofauna species were observed most abundantly near/around watercourses microhabitats. The most of the days (40) of observation was done in this area. The reason for species being are abundant might be the large plain areas surrounding watercourses.

4.2.2. Lasa, study area II

Species abundance: A total of 31 amphibians and reptiles species were recorded. Thirteen families of Bufonidae (2 species), Ranidae (6 species), Rhacophoridae (1 species), Ichthyophiidae (1 species), Agamidae (1 species), Gekkonidae (3 species), Scincidae (3 species),Varanidae (1 species), Colubridae (6 species), Pythonidae (1 species), Typhlopidae (2 species), Xenopeltidae (1 species) and Emydidae (4 species) were included (Table 4.2.3 and Appendix 4.2.3). The greatest species richness (6 species) was recorded in the family Ranidae and Colubridae. No venomous snake was recorded.

Species abundance in relation to observation days and the elevation ranges of study areas are shown in Figure 4.2.16.

Herpetofauna species (total numbers collected) were recorded in or on or near or around the following microhabitats in the percentages indicated in brackets: vegetation (41.9); watercourses (35.5), wood/log/soil/hole (12.9), and roof/hut (9.7) (Table 4.2.5).

Threats: Habitat for herpetofauna species was degraded by logging and gold dredging. Gold mining was also found. The original forest is degraded into secondary forest and cultivation lands. Much more findings of dynamite fishing and gold mining were observed in this area. Hunters capture whatever herpetofauna available for food and for trade.

Conservation status: According to the conservation status of 2009 IUCN Red list Data, one species is listed as Endangered (EN), one species is listed as Vulnerable (VU), two species are listed as Near Threatened (NT), six species are listed as Least Concern (LC) and two species are listed as Data Deficient (DD) from survey areas (Table. 4.2.4 and Appendix 4.2.3). Only one species is also included in 2009 CITES Appendices II.

Within records of endangered species (EN + VU), Keeled box turtle *Pyxidea mouhotii*, is categorized as Endangered (EN) and giant Asian pond turtle *Heosemys grandis* is categorized as Vulnerable (VU) in IUCN Red List Data, 2009 (Appendix 4.2.3). It is also in Appendix II in CITES 2009.

Conclusions and Discussion: thirteen families, including 31 species of herpetofauna were recorded in Lasa, study area II. The greatest number of species was listed in the family Ranidae and Colubridae. The least number of species were found in Rhacophoridae, Ichthyophiidae, Agamidae, Varanidae, Pythonidae and Xenopeltidae.

One Endangered (EN), One Vulnerable (VU) two Near Threatened (NT) species were recorded, viz Keeled box turtle *Pyxidea mouhotii* as EN, giant Asian pond turtle *Heosemys grandis* as VU and Burmese python *Python molurus,* Indian black turtle *Melanochelys trijuga* as NT threatened species in Lasa area. Five species are also recorded as Least Concerned (LC) and two species are recorded as Data Deficient (DD) in conservation status (Appendix 4.2.3).

The herpetofauna species were observed most abundantly near/around vegetation/forest microhabitats. A total of only eight observation days was done in this area.

4.2.3. Chibwe, study area III

Species abundance: A total of 44 amphibians and reptiles species were recorded. Ten families of Bufonidae (2 species), Hylidae (1 species), Megophryidae (6 species), Ranidae (10 species), Rhacophoridae (10 species), Agamidae (2 species), Gekkonidae (1 species), Scincidae (2 species), Colubridae (8 species) and Elapidae (1 species) were included (Table 4.2.3 and Appendix 4.2.4). The greatest species richness (10 species) was recorded in the family Ranidae and Rhacophoridae. One venomous snake, monocellate cobra *Naja kaouthia* was recorded.

Species abundance in relation to observation days and the elevation ranges of study areas are shown in Figure 4.2.16. The second greatest abundance of species (44) was recorded in Chibwe study area III, which was observed for the second greatest number of days (20) as shown in Table 4.2.4.

Herpetofauna species (total numbers collected) were recorded in or on or near or around the following microhabitats in the percentages indicated in brackets: water (45.5); vegetation (40.9); wood/log/soil/hole (9.1), road/trail (4.5) (Table 4.2.5).

Three new findings (confirmed by Awan Khwi Shein, former California Academy of Science (CAS) investigation member) of herpetofauna species, viz *Megophry* sp.6, *Limnonectes* sp.1 and *Rhacophorus* sp1. were recorded in Chibwe study area. Snakes were more found from Chibwe to Sawlaw village. Limbless lizard *Ophisaurus gracilis*, King cobra *Ophiophagus hannah* and cobra spp. were captured in this area.

Threats: Habitat for herpetofauna species was degraded. The original forest is degraded into secondary forest by logging and doing cultivation especially lands beside River Mai Hka. The local people made fire and there were many patches of slash and burn even on the top of the hill. Hunters are present and usually set up traps and capture wildlife. Wildlife are captured for trade to China and for food.

Conservation status: According to the conservation status of 2009 IUCN Red list Data, no species are listed as Endangered (EN), Vulnerable (VU) and Near Threatened (NT). Nine species are listed as Least Concern (LC) and one species is listed as Data Deficient (DD) from survey areas (Table. 4.2.4 and Appendix 4.2.4). One species is also included in 2009 CITES Appendices II.

Conclusions and Discussion: Ten families, including 44 species of herpetofauna were recorded in Chibwe, study area III. The greatest number of species was listed in the family Ranidae and Rhacophoridae. Only one species was found in Hylidae, Gekkonidae, Anguidae and Elapidae.

No endangered species are found. Nine species were also recorded as Least Concerned (LC) and one as Data Deficient (DD) in conservation status (Appendix 4.2.2).

The herpetofauna species were observed most abundantly near/around watercourses microhabitats. The second most of the days of observation (20) was done in this area.

4.2.4. Wusok, study area IV

Species abundance: A total of 20 amphibians and reptiles species were recorded. Seven families of Bufonidae (1 species), Megophryidae (1 species), Ranidae (4 species), Rhacophoridae (2 species), Agamidae (3 species), Scincidae (2 species) and Colubridae (8 species) were included (Table 4.2.3 and Appendix 4.2.5). The greatest species richness (4 species) was recorded in the family Ranidae. No venomous snake was found.

Species abundance in relation to observation days and the elevation ranges of study areas are shown in Figure 4.2.16.

Herpetofauna species (total numbers collected) were recorded in or on or near or around the following microhabitats in the percentages indicated in brackets: vegetation (55); water (30), road/trail (10) and wood/log/soil/hole (5) (Table 4.2.5).

Threats: The original forest is degraded into secondary forest and cultivation lands, not much found compared to Myitsone, Lasa, Chibwe areas. More hunters were found and they hunt them for trading. There's a route leading to the China border being located.

Conservation status: According to the conservation status of 2009 IUCN Red list Data, no species are listed as threatened species. Two species are recorded as Data Deficient (DD) from survey areas (Table. 4.2.4 and Appendix 4.2.5). No species are also included in 2009 CITES.

Conclusions and Discussion: Seven families, including 20 species of herpetofauna were recorded in Wusok, study area IV. The greatest number of species was listed in the family Ranidae and only one species was found in Bufonidae and Megophryidae.

The herpetofauna species were observed most abundantly near/around vegetation microhabitats. Eight observation days (8) were done in this area.

4.2.5. Pisa, study area V

Species abundance: A total of six amphibians and reptiles species were recorded. Four families of Rhacophoridae (1 species), Scincidae (2 species), Colubridae (2 species) and Elapidae (1 species) were included (Table 4.2.3 and Appendix 4.2.6). The greatest species richness (2 species) was recorded in the family Scincidae and Colubridae. Only one venomous snake is recorded viz, king cobra *Ophiophagus hannah.*

Species abundance in relation to observation days and the elevation ranges of study areas are shown in Figure 4.2.16. The lowest abundant of species (6) was recorded in Study area IV, which was observed for the lowest number of days (1) as shown in Table 4.2.4.

Herpetofauna species (total numbers collected) were recorded in or on or near or around the following microhabitats in the percentages indicated in brackets: vegetation (66.7); wood/log/soil/hole (16.7) and road/trail (16.7) (Table 4.2.5).

Threats: The original forest is degraded into secondary forest and cultivation lands, not much found compared with Myitsone, Lasa, Chibwe areas. The hunters found more and they hunt them for trading. The place is nearer to China and there's a way to China border.

Conservation status: According to the conservation status of 2009 IUCN Red list Data, no species are listed as threatened species. One species is also included in 2009 CITES Appendices II.

Conclusions and Discussion: Sixteen families, including six species of herpetofauna were recorded in Pisa, study area I. The greatest number of species was listed in the family Scincidae and Colubridae.

Two threatened species were found (Appendix 4.2.6).

The herpetofauna species were observed most abundantly near/around vegetation/forest microhabitats. The most observation days (1) were done in this area.

4.2.6. Khaunglanphu, study area VI

Species abundance: A total of 15 amphibians and reptiles species were recorded. Seven families of Bufonidae (1 species), Megophryidae (1 species), Ranidae (1 species), Rhacophoridae (3 species), Agamidae (4 species), Scincidae (2 species) and Colubridae (3 species) were included (Table 4.2.3 and Appendix 4.2.7). The greatest species richness (4 species) was recorded in the family Agamidae. No venomous snake was recorded.

Species abundance in relation to observation days and the elevation ranges of study areas are shown in Figure 4.2.16. The highest altitude was found in Khaunglanphu, study area VI. The second lowest abundant of species (15) was recorded in Study area VI as shown in Table 4.2.4.

Herpetofauna species (total numbers collected) were recorded in or on or near or around the following microhabitats in the percentages indicated in brackets: vegetation (60); water (26.7) and cultivation (13.3) (Table 4.2.5).

Threats: The original forest is degraded into secondary forest and cultivation lands, not much found compared to Myitsone, Lasa, Chibwe areas. The hunters found more and they hunt them for trading. The place is nearer to China and there's a way to China border.

Conservation status: According to the conservation status of 2009 IUCN Red list Data, Two species are listed as Least Concern (LC) and one species is listed as Data deficient (DD) from survey areas (Table. 4.2.4 and Appendix 4.2.7). No endangered species is recorded. No species is included in 2009 CITES Appendices.

Conclusions and Discussion: Seven families, including 15 species of herpetofauna were recorded in Khaunglanphu, study area VI. The greatest number of species was listed in the family Agamidae and the least, one species were found in Bufonidae, Megophryidae and Ranidae.

In this area, four species were recorded as Least Concerned (LC) in conservation status (Appendix 4.2.7).

The herpetofauna species were observed most abundantly near/around vegetation microhabitats. An observation of 13 days was done in this area.

4.2.7. Yenam, study area VII

Species abundance: A total of 16 amphibians and reptiles species were recorded. Six families of Ranidae (4 species), Rhacophoridae (4 species), Scincidae (3 species), Colubridae (3 species), Viperidae (1 species) and Emydidae (1 species) were included (Table 4.2.3 and Appendix 4.2.8). The greatest species richness (4 species) was recorded in the family Ranidae and Rhacophoridae. One venomous snake, mountain pit-viper was recorded.

Species abundance in relation to observation days and the elevation ranges of study areas are shown in Figure 4.2.16. The second highest altitude was found in Yenam, study area VII as shown in Table 4.2.4.

Herpetofauna species (total numbers collected) were recorded in or on or near or around the following microhabitats in the percentages indicated in brackets: vegetation (62.5); water (31.3) and road/trail (6.3) (Table 4.2.5).

King cobra was killed by the local people. The skins of cobra were kept for sale, fetching 10,000-15,000 Kyats per skin.

Threats: The original forest is degraded into secondary forest and cultivation lands, not much found compared to Myitsone, Lasa, Chibwe areas. The hunters found more and they hunt them for trading. The place is nearer to China and there's a way to China border.

Conservation status: According to the conservation status of 2009 IUCN Red list Data, one species is listed as Endangered (EN) and Keeled box turtle *Pyxidea mouhotii* is categorized as Endangered (EN). Four species are listed as Least Concern (LC) (Table. 4.2.4 and Appendix 4.2.8). No species is included in 2009 CITES.

Conclusions and Discussion: Six families, including 16 species of herpetofauna were recorded in Yenam, study area VII. The greatest number of species was listed in the family Ranidae and Rhacophoridae. Only one species was found in Viperidae and Emydidae.

One Endangered (EN) – keeled box turtle *Pyxidea mouhotii* and four Least Concerned (LC) species were recorded in conservation status (Appendix 4.2.8).

The herpetofauna species were observed most abundantly near/around vegetation/forest microhabitats. The observation days (12) were done in this area.

4.2.8. Overall Conclusions and Discussion

The diversity of herpetofaunas within the proposed dams of inundated areas included 19 families of herpetofauna comprising 115 species, demonstrating strongly the great importance of this taxon in the survey area.

California Academy of Science (CAS) recorded a total of about 360 species in amphibians and reptiles in Myanmar. There are three new findings of herpetofauna species, viz *Megophry* sp.1, *Limnonectes* sp.1 and *Rhacophorus* sp.1 were recorded in Chibwe study area (Awan Khwi Shein from CAS comm.).

In comparing the species richness among the seven study areas, it is noteworthy that numbers of species are roughly inversely proportional to elevation (Figure 4.2.16). Myitsone (I), the lowest study area, has the highest species richness (51 species), followed by Chibwe (III) with 44 species, while Khaunglanphu (VI), the highest study area, had only 15 species. The herpetofauna species richness in the seven study sites is ranked as Myitsone (I), Chibwe (III), Lasa (II), Wusok (IV), Yenam (VII), Khaunglanphu (VI) and Pisa (V) in order of number of species recorded (Table 4.2.4).

In addition to species abundance, it was highly significant in observed day specificity. For example, 51 species were only found in the most of the days of observed (39) of Myitsone area and 6 species were only recorded in the least observed days (6) of Pisa.

A further important consideration from the conservation point of view is the occurrence of species classified as Endangered (EN) species among the various study areas (Table 4.2.6). A total of two species of herpetofauna were recorded in the proposed dams of study areas, two of them at Myitsone (I), one at Lasa (II) and one at Yenam (VII) (Table 4.2.6). Significantly, no EN species were recorded at the four remaining sites. The occurrence of species also classified as Vulnerable (VU) species among the various study areas as shown in Table 4.2.6. Only one species of herpetofauna was recorded in Lasa among all study areas. As shown in Appendix 4.2.9, Chinese researchers also recorded more herpetofauna species, one Endangered (EN), one Vulnerable (VU) and one Near Threatened (NT) species. Yunnan spiny frog *Paa yunnanensis* (EN) found in Myitsone and Lasa areas. Xizhang warty treefrog *Theloderma moloch* (VU) and Gongshan flying-frog *Polypedates gongshanensis* (NT) are recorded in Khaunglaphu area. Again, careful consideration needs to be given to these threatened species that are of global importance when planning conservation measures**.**

Within a total of six turtles, keeled box turtle *Pyxidea mouhotii* and Myanmar roofed turtle *Kachuga trivittata* are listed as Endangered (EN), giant Asian pond turtle Heosemys grandis is listed as Vulnerable (VU) and Indian black turtle *Melanochelys* *trijuga* is listed as Near Threatened (NT) in 2009 IUCN Red List of Threatened Species. A single snake species Burmese python *Pythin molurus* is listed in Near Threatened (NT).

The Burmese roofed turtle *K. trivittata* is an aquatic fresh water turtle, endemic to Myanmar and a sensitive species in regard to environmental degradation and human exploitation. Captive breeding of Burmese roofed turtles had been implemented by Wildlife Conservation Society (WCS) in 2007 for the survival of this species.

Its conservation status was Critically Endangered (CR) (Das, 1997; Kuchling 2002). There were no records of this turtle from Myanmar since 1935. Formerly it was only known from Ayeyarwaddy, Chindwin, Salween and Sittang rivers (Iverson, 1993, Dijk *et al.*, in press). Historically it was abundant in the lower Ayeyarwaddy and Sittang rivers; large numbers of females congregated on nesting beaches at the mouth of Ayeyarwaddy river about 100 years ago (Maxwell,1911), and Smith (1931) stated that the species was "fairly common" in the river as far north as Bhamo. Less is known about its population in the Chindwin River, although Morris (1936) collected several females in the upper beaches in the upper reaches during a 1935 expedition (Vernay, 1935).

Thorbjrnarson *et al.* (1999) concluded that *K.tirvittata* was extirpated in the lower Ayeyarwady Delta and Dijk *et al*. (in press) stated that extant populations no longer occurred in the Salween River along the Thai border. Platt *et al.* (2005) found no evidence of the continued persistence of *K.trivittata* in the Ayeyarwady River downstream from Bhamo, but located a remnant population in the Dokhtawady River (also known as the Myitnge or Namthu River) near Mandalay. This population was also threatened by Yeywa dam construction.

An additional population was located by Kuchling *et al.* (2006) along the upper Chindwin between Htamanthi and Khamti. Although villagers continue to collect eggs for local consumption, *K.trivittata* has persisted in this region owing to village-level prohibitions against killing adult turtles (Kuchling *et al.*, 2006). Eggs collected from nesting beaches along the upper Chindwin were incubated successfully and these hatchlings, together with several wild-caught adults, form the nucleus of a captive assurance colony at the Yadanabon zoological Gardens in Mandalay (Win Ko Ko *et al*., 2006).

Widespread population declines of *K.trivittata* throughout its historic range in Myanmar are generally attributed to chronic over-harvesting of eggs and adults, the incidental capture of turtles in fishing gear, and conversion of nesting beaches to agricultural fields (Platt, 2001; *et al.*, 2005; Dijk *et al.*, in press, Kuchling *et al.*, 2006).

An examination of the distribution of herpetofauna species in relation to the various microhabitats of each study area shows significant correlations. Approximately 41.9, 55, 66.7, 60 and 62.5 per cent of them were recorded near/around *natural* habitats, viz vegetation/forest at Lasa, Wusok, Pisa, Khaunglanphu and Yenam areas. Approximately 39.2 and 45.5 per cent of them were recorded near/around water courses. Conversely, only a very small percentage was found in close proximity to human activities, viz cultivation, wood/log/soil/hole, road/trail, roof at hut. Thus the disturbance/destruction of water (rivers) and forest habitats by the proposed dam constructions will pose a huge threat to a large majority of herpetofauna species, with the possibility of some of them going extinct locally due to habitat loss.

The main threats are opportunistic huntings (illegal), habitat loss and temporary immigrants in the inundated areas of dam constructions. The traders on wildlife especially turtles are present. The worst is in the areas of Myitsone, Lasa and Chibwe in where we found many temporary immigrants. This project is responsible for the fate of this endangered species. Now it is quite clear that the habitat of these species habitat especially nesting sites of the turtles will be destroyed by the dam constructions. Opportunistic collection on turtles were also done by the local people and exported to China. Ecological information will be needed to draft a long term conservation strategy for the endangered species. Due to the threats for the species, recommendations should need to save this endangered species. There is thus need for conservation measures with respect to this taxon at ALL of the proposed dam sites.

4.2.9. Threatened species (EN, VU and NT)

By using of 2009 IUCN Red List of Threatened Species, Version 2009.1 in <www.iucnredlist.org>, the range, population, habitat and ecology, threats, and conservation actions of the recorded on the endangered species (EN and VU) are as follows with findings:

4.2.9.1. Endangered (EN) species

(1) Yunnan spiny frog *Paa yunnanensis*

Yunan spiny frog was encountered by Chinese researcher at Myitsone and Lasa area.

Year Assessed: 2004

Justification: Listed as Endangered because of an observed population decline, estimated to be more than 50% over the last three generations, inferred from over-harvesting, observed shrinkage in distribution, and ongoing habitat destruction and degradation. The generation length is estimated to be five years.

Range Description: This species is known from south-western and central China in Sichuan, Yunnan, Guizhou, Hunan and possibly also Hubei Provinces. The only reasonably reliable records from mainland Southeast Asia are from Sa Pa (Bourret 1942, as *Rana yunnanensis* and *R. phrynoides*). Records from the Kakhien Hills of Myanmar may be a consequence of Bourret (1942) considering *Paa feae* a synonym. However, *P. yunnanensis* is recorded from most of Yunnan Province adjoining eastern Myanmar (Fei and Ye 1999). It probably occurs more widely than current records suggest. In China it is known from elevations of 1,500-2,950m asl, and in Viet Nam from 800-1,000m asl (Bourret 1942).

Countries: Native: China; Viet Nam

Presence uncertain: Lao People's Democratic Republic; Myanmar

Population: Although there are no available data on the population status of Southeast Asian populations, in China it is a common species (though it has declined significantly).

Population Trend: Decreasing

Habitat and Ecology: It has been recorded from rocky streams in high mountains in closed-canopy forest and grassland, and has also been found in ditches. The eggs are laid under stones in streams.

Systems: Terrestrial; Freshwater

Major Threat(s): *Over-collecting for human consumption is the major threat to this species. It is also threatened by habitat destruction and degradation (caused by agricultural expansion), and water pollution.*

Conservation Actions: It is present in several protected areas in China. The two localities in Viet Nam are within Hoang Lien Son National Park and Tam Dao National Park. Studies of the intensity of harvesting of this species are required, and there is a need to ensure that the offtake of this species from the wild for human consumption is managed sustainably. Further survey work is needed to determine the population status of populations in Southeast Asia, and there is also a need for further taxonomic work to clarify the taxonomic status of frogs in the genus present in mainland Southeast Asia and the Himalayan foothills.

(2) Keeled box turtle *Pyxides mouhotii*

This species was observed and collected alive and shells. These were encountered in Jubilee and Nannin Hka villages at Myitsone area; Phawang, Sarand Hka and Lotmaiyang villages at Lasa area; and Aliaung village at Yenam area.

Year Assessed: 2000

Countries: Native: China; India; Lao People's Democratic Republic; Myanmar; Viet Nam

Systems: Terrestrial; Freshwater

(3) Myanmar roofed turtle *Kachuga trivittata*

A shell of Myanmar roofed turtle was found at Thewaing village in Myitsone area.

Year Assessed: 2000

Justification: *Kachuga trivittata* is possibly Critically Endangered or even Extinct.

Countries: Native: Myanmar

Habitat and Ecology: Deep flowing rivers with terrestrial nest sites.

Systems: Terrestrial; Freshwater

Major Threat(s): Could possibly be extinct considering that no animals have been reliably recorded since 1935 despite mass trade of riverine turtles from Myanmar to China.

4.2.9.2. Vulnerable (VU) species

(1) Xizhang warty treefrog *Theloderma moloch*

Xizhang warty treefrog was found by Chinese researcher at Khaunglanhpu area.

Year Assessed: 2004

Justification: Listed as Vulnerable because its Extent of Occurrence is less than 20,000 km2, it is known from fewer than ten locations, and there is continuing decline in the extent and quality of its habitat inin northeastern India.

Range Description: This species has a fragmented range in Arunachal Pradesh and Assam, India. It probably occurs somewhat more widely, and might be present in Bhutan, although this requires confirmation. It has been recorded at elevations of 300-1,500m asl.

Countries: Native: India

Presence uncertain: Bhutan; China

Population: It is a rare species.

Population Trend: Decreasing

Habitat and Ecology: It is an arboreal species associated with tropical forest and shrubland. Breeding is believed to take place in ponds surrounded by shrubs.

Systems: Terrestrial; Freshwater

Major Threat(s): Subsistence wood collection is a threat to the species' habitat.

Conservation Actions: The species has been recorded from Dibang Wildlife Sanctuary and Mouling National Park in Assam, and Nameri National Park in Arunachal Pradesh.

(2) Giant Asian pond turtle *Heosemys grandis*

Three shells of giant Asian pond turtle were found in Khinduyang, Ranhka and Jayayang villages at Lasa area.

Year Assessed: **2000**

Justification: *Heosemys grandis* is considered VU A1d+2d in Cambodia, Lao and Viet Nam; it is considered VU A2cd in Malaysia; the limited data for Myanmar and Thailand (currently not listed - OEPP 1997) suggest at least VU A1d.

Countries: Native: Cambodia; Lao People's Democratic Republic; Malaysia; Myanmar; Thailand; Viet Nam

Habitat and Ecology: Semi-aquatic

Systems: Terrestrial; Freshwater

4.2.9.3. Lower Risk/near threatened (NT) species

(1) Gongshan flying-frog *Polypedates gongshanensis*

Gongshan flying-frog was encountered by Chinese researcher at Khaunglanhpu.

Year Assessed: 2004

Justification: Listed as Near Threatened because its Extent of Occurrence is probably not much greater than 20,000km2, and the extent and quality of its habitat is probably declining, thus making the species close to qualifying for Vulnerable.

Range Description: This species is known from the western slope and southern part of Gaoligongshan (Gongshan, Tengchong and Baoshan Counties), in western Yunnan Province, China, and it has also recently been recorded from Puliebadze, in Nagaland, India. It is also likely to occur in Myanmar, but it has not yet been recorded from there.

Countries: Native: China; India

Presence uncertain: Myanmar

Population: It is a common species.

Population Trend: Decreasing

Habitat and Ecology: It inhabits agricultural land in hilly areas, and often occurs near streams, ponds and pools, and in the surrounding bamboo clumps, trees, shrubs and grasses. It lays eggs on leaves above water, and the larvae then develop in the water below.

Systems: Terrestrial; Freshwater

Major Threat(s): The major threat to this species is habitat loss due to agricultural development and subsistence wood collecting.

Conservation Actions: Gaoligongshan National Nature Reserve is within the range of this species.

(2) Burmese python *Python Molurus*

Two skins of Burmese python were encountered in Jubilee village at Myitsone and another one at Maliyan in Lasa area. One alive specimen of this species was also collected in Myitsone area**.**

Year Assessed: 1996

Annotations: Needs updating

Countries: Native: Bangladesh; Cambodia; China; Hong Kong; India; Indonesia; Lao People's Democratic Republic; Myanmar; Nepal; Pakistan; Sri Lanka; Thailand; Viet Nam

Systems: Terrestrial

(3) Indian black turtle *Melanochelys trijuga*

A shell of Indian black turtle in Myitsone and another one in Maliyan village at Lasa area were observed.

Year Assessed: 2000

Justification: Considered Enadangered in Bangladesh (*M. t. indopeninsularis*). The population in Myanmar (*M. t. edeniana*) is presumed to be Vulnerable or Endangered. The species is common in India and Nepal. Although no data were available for Sri Lanka, overall the species was considered fairly secure.

Countries: Native: Bangladesh; British Indian Ocean Territory; India; Maldives; Myanmar; Nepal; Sri Lanka

Systems: Terrestrial; Freshwater

Table 4.2.1. List of herpetofauna team in all survey areas

Myitsone area (I) 16-1-09 to 28-1-09	**Lasa area (II) 6-4-09 to 30-4-09**	**ChibweArea (III) 3-4-09 to 12-5-09**	**WusokArea (IV) 6-4-09 to 13-5-09**	**Pisa Area (V) 15-4-09 to 18-4-09**	**Khaunglanhpu Area (VI) 20-2-09 to 29-3-09**	**Yenam Area (VII) 20-2-09 to 29-3-09**
Yan Naing Hein	Nay Myo Win	Awan Khwi Shein	Awan Khwi Shein	Awan Khwi Shein	Awan Khwi Shein	Yan Naing Hein
Kyaw Swa Aung	Myint Kyaw Thuya	Thaw Zin	Thaw Zin		Kyaw Swa Aung	Thaw Zin
Nay Myo Win	Min Thein Htet		Aung Ko Ko		Nay Myo Win	Min Thein Htet
30-1-09 to 12-2-09						
Yan Naing Hein						
Nay Myo Win						
17-2-09 to 21-2-09						
Myint Kyaw Thuya						
Aung Ko Ko						
6-5-09 to 13-5-09						
Myint Kyaw Thuya						

Nay Myo Win
12-5-09 to 14-5 09

Min Thein Htet
18-5-09 to 27-5-09
Myint Kyaw Thuya

Thaw Zin

Nay Myo Win

Aung Ko Ko

Table 4.2.2. Study areas of herpetofauna team

study sites in Myitsone area

Study area		Site	Location N	Location E	Altitude (m)	Date	Forest type
I	a	Myitsone	25º 40' 30.5"	97º 29' 48.1"	132	16.1-26.1.09	Secondary forest,degraded forest,bamboo forest
I	b	Teyunzup	25º 58' 21"	97º 32' 02.3"	151	30.1-6.2.09	Secondary forest,degraded forest,bamboo forest
I	c	Bambane	25º 42' 03.2"	97º 54' 50.6"	224	7-8.2.09	Secondary forest,degraded forest,bamboo forest
I	d	Thewai	25º 41' 56.7"	97º 36' 52.8"	295	9-11.2.09	Secondary forest,degraded forest,bamboo forest
I	e	Chaung sone	25º 34' 58.1"	97º 48' 39.2"	175	18-20.2.09	Secondary forest,degraded forest,bamboo forest
I	f	Jubilee	25º 43' 21.3"	97º 51'52.6"	226	7-10.5.09	Secondary forest,degraded forest,bamboo forest
I	g	Myit sone village	25º 42' 48.2"	97º 30' 03.3"	206	12-13&18-25.5.09	Secondary forest,degraded forest,bamboo forest

Study sites in Lasa area

Study area		Site	Location N	Location E	Altitude (m)	Date	Forest type
II	a	Sum pi yaung	26º 52' 15.6"	97º 39' 05.9"	336	8-9.4.09	Secondary forest,semi-primary forest,degraded forest,cultivation
II	b	Hpaw wang	26º 53' 40.2"	97º 43' 26.1"	268	11-13.4.09	Secondary forest,semi-primary forest,degraded forest,cultivation
II	c	Hpung in yaung	26º 45' 05.3"	97º 38' 18.5"	479	16.4.09	Secondary forest,semi-primary forest,degraded forest,cultivation
II	d	Ma li yaung	26º 35' 31.7"	97º 40' 21.7"	266	21-26.4.09	Secondary forest,semi-primary forest,degraded forest,cultivation

Study sites in Chibwe area

Study area		Site	Location N	Location E	Altitude (m)	Date	Forest type

III	a	Manton	25º 57' 52.1"	98º 09' 37.6"	286	3-5.4.09	Secondary forest,cultivation land,bamboo forest,degraded forest
III	b	Phala	26º 01' 53.0"	98 10' 58.8"	340	4-7.5.09	Secondary forest,cultivation land,bamboo forest,degraded forest
III	c	19 miles	26º 18' 20.3"	98º 13' 05.2"	435	27-28.4.09	Secondary forest,cultivation land,bamboo forest,degraded forest
III	d	Tsawlaw	26º 09' 17.9"	98º 16' 13.6"	1459	6/26.4.09	Secondary forest,cultivation land,bamboo forest,degraded forest
III	e	Kyihtam	26º 16' 11.8"	98º 18' 41.3"	491	7-9/25.4.09	Secondary forest,cultivation land,bamboo forest,degraded forest
III	f	Man kyi	26º 16' 47.7"	98º 18' 46.7"	627	10-11.4.09	Secondary forest,cultivation land,bamboo forest,degraded forest
III	g	Chaung sone	26º 18' 51.0"	98º 17' 28.1"	416	22-24.4.09	Secondary forest,cultivation land,bamboo forest,degraded forest

Study sites in Wusok area

Study area	Site		Location		Altitude (m)	Date	Forest type
			N	E			
IV	a	Wusok	26º 24' 38.5"	98º 17' 31.1"	421	13-14.4.09	Secondary forest,cultivation land,bamboo forest
IV	b	Hpaung ja	26º 25' 57.2"	98º 17' 35.2"	458	16.4.09	Secondary forest,cultivation land,bamboo forest
IV	c	Pashe	26º 28' 13.8"	98º 17' 30"	555	15/20-22.4.09	Secondary forest,cultivation land,bamboo forest
IV	d	Warup	26º 31' 34.8"	98º 18' 21.8"	731	24.4.09	Secondary forest,cultivation land,bamboo forest

Study sites in Pisa area

Study area	Site		Location		Altitude (m)	Date	Forest type
			N	E			
V	a	Chone dam	26º 44' 10.8"	98º 22' 35.3"	544	17.4.09	Secondary forest,degraded forest,bamboo forest

Study sites in Khaunglanhpu area

Study area	Site		Location		Altitude (m)	Date	Forest type
			N	E			
VI	a	Ridam	27º 12' 05.9"	98º 14' 06.4"	1492	2-3/19.3.09	Secondary forest,cultivation land,bamboo forest
VI	b	Phan htone	27º 03' 59.1"	98º 20' 22.4"	1287	6-9.3.09	Secondary forest,cultivation land,bamboo forest
VI	c	Near htan kha	27º 02' 09.8"	98º 21' 31.2"	996	10-11.3.09	Secondary forest,cultivation land,bamboo forest
VI	d	San pone	27º 01' 09.1"	98º 20' 54.5"	1085	12-13.3.09	Secondary forest,cultivation land,bamboo forest
VI	e	Chaung sone	27º 01' 09.1"	98º 20' 54.5"	1085	14-15.3.09	Secondary forest,cultivation land,bamboo forest

Study sites in Yenam area

Study area	Site	Location		Altitude (m)	Date	Forest type
		N	E			

VII	a	Panandim	27º 43' 46.6"	97º 52' 48.5"	985	27-28.2.09	Secondary forest, Evergreen forest, Cultivation land, Bamboo forest
VII	b	West man ton	27º 43' 33.6"	97º 56' 33.8"	887	2-3.3.09	Secondary forest, Evergreen forest, Cultivation land, Bamboo forest
VII	c	Yenam	27º 42' 08.1"	98º 02' 11.1"	953	5-9.3.09	Secondary forest, Evergreen forest, Cultivation land, Bamboo forest
VII	d	Aleaung	27º 42' 25.2"	98º 07' 10.7"	955	11-13.3.09	Primary forest, Secondary forest, Bamboo, Cultivation land

Table 4.2.3. List of herpetofauna families and respective number of species in all survey areas

Family	I	II	III	IV	V	VI	VII	ALL
Bufonidae	2	2	2	1		1		4
Hylidae			1					1
Megophryidae	1		6	1				9
Microhylidae	3							3
Ranidae	9	6	10	4		1	4	17
Rhacophoridae	3	1	10	2	1	3	4	13
Ichthyophiidae		1						1
Agamidae	4	1	2	3		4		9
Gekkonidae	5	3	1					6
Scincidae	5	3	2	2	2	2	3	8
Varanidae	2	1						2
Anguidae			1					1
Colubridae	7	6	8	8	2	3	3	26
Elapidae	2		1		1			3
Pythonidae	1	1						1
Typhlopidae	1	2						2
Viperidae	1						1	2
Xenopeltidae	1	1						1
Emydidae	4	4					1	6

I=Myitsone, II=Lasa, III=Chibwe, IV=Wusok, V=Pisa, VI=Khaunglanphu, VII=Yenam, All=7 survey areas

Table 4.2.4. Summary of information on herpetofauna species recorded in different study areas

Fact	I	II	III	IV	V	VI	VII	ALL
Elevation (range)	132-295	266-479	286-1459	421-731	544	996-1492	887-985	−
Elevation (mean)	213.5	372.5	872.5	576	544	1244	936	−
Observed days	40	8	20	8	1	13	12	102
Family	16	13	10	7	4	7	6	19
Species	51	31	44	20	6	15	16	115
Species in per cent	44.3	27	38.3	17.4	5.2	13	13.9	−
Endangered (EN)	2	1	−	−	−	−	1	4
Vulnerable (VU)	−	1	−	−	−	−	−	1
Near Threathened (NT)	2	2	−	−	−	−	−	4
Least Concerned (LC)	9	6	9	−	−	2	4	30
Data Deficient (DD)	−	2	1	2	−	1	−	6
Appendix II	4	1	1	−	1	−	−	7
Appendix III	1	−	−	−	−	−	−	−

I=Myitsone, II=Lasa, III=Chibwe, IV=Wusok, V=Pisa, VI=Khaunglanphu, VII=Yenam, All=7 survey areas

Table 4.2.5. Distribution of total numbers of herpetofauna recorded among microhabitats in each survey area (figures given as percentages of total in that area)

Microhabitat	I	II	III	IV	V	VI	VII
near/around watercourses	39.2	35.5	45.5	30	−	26.7	31.3
vegetation/forest	31.4	41.9	40.9	55	66.7	60	62.5
cultivatiion	−	−	−	−	−	13.3	−
wood/log/soil/hole	13.7	12.9	9.1	5	16.7	−	−
road/trail	7.8	−	4.5	10	16.7	−	6.3
roof at hut	7.8	9.7	−	−	−	−	−

I=Myitsone, II=Lasa, III=Chibwe, IV=Wusok, V=Pisa, VI=Khaunglanphu, VII=Yenam

Table 4.2.6. Conservation status of herpetofauna species recorded in all proposed dams' study areas

Conservation Status	I	II	III	IV	V	VI	VII	All
Endangered (EN)	2	1					1	2
Vulnerable (VU)		1						1
Near Threatened (NT)	2	2						2
Least Concerned (LC)	9	6	9			2	4	17
Data Deficient (DD)		2	1	2		1		3
Appendix II	3	2	1		1			5
Appendix III	1							1

I=Myitsone, II=Lasa, III=Chibwe, IV=Wusok, V=Pisa, VI=Khaunglanphu, VII=Yenam, All=7 survey areas

4.3. INSECT (BUTTERFLY)

Itinerary:The detailed itinerary is listed in Table 4.3.1 and Table 4.3.2.The study sites of insect team were shown in Figures 4.3.1 to 4.3.7.

Species abundance: A total of 345 butterfly species under the order Lepidoptera were recorded. Ten families of Papilionidae (36 species), Pieridae (32 species), Danaidae (14 species), Satyridae (46 species), Nymphalidae (93 species), Amathusiidae (6 species), Libytheidae (2 species), Riodinidae (8 species), Lycaenidae (73 species) and Hesperiidae (35 species) were included (Figures 4.3.8 to 4.3.13; Table 4.3.3, Appendix 4.3.1). The greatest species richness (93 species) was recorded in the family Nymphalidae and the least (2 species) was found in the family Libytheidae. Species abundance in relation to observation days and the elevation ranges of study areas are shown in Figure 4.3.14. The highest altitude was found in Khaunglanhpu, study area VI, and the lowest altitude in Myitsone, study area I. The greatest abundant of species was recorded in Study area I, which was observed for the greatest number of days.

Relative species abundance, according to Kenyon 2004, was: two species found as very common (VC), 75 species found as common (C), six species found as rare (R) and 262 species found as status unknown (SU). The six rare species are *Atrophaneura aidoneus, Papilio bianor, Papilio nephelus, Euploea Sylvester, Euploea diocletianus and Thaumantis diores.* One species of locally common (LC) and 87 species of uncommon (UC) are included in SU (Table 4.3.4).

Butterfly species (total numbers collected) were recorded in or on or near or around the following microhabitats in the percentages indicated in brackets: water (41.25);

vegetation/forest (28.23); trails/roads (17.89); cultivation (8.95); in flight – is not a real habitat (2.49); dung/scats (1.09) and village (1.00) (Table 4.3.5 and Figure 4.3.15).

4.3.1. Myitsone, study area I

Species abundance: A total of 192 butterfly species under the order Lepidoptera were recorded. Ten families of Papilionidae (21 species), Pieridae (24 species), Danaidae (13 species), Satyridae (27 species), Nymphalidae (56 species), Amathusiidae (3 species), Libytheidae (1 species), Riodinidae (4 species), Lycaenidae (33 species) and Hesperiidae (10 species) were included (Table 4.3.3, Appendix 4.3.2). The greatest species richness (56 species) was recorded in the family Nymphalidae and the least (one species) was found in family Libytheidae (Table 4.3.3, Appendix 4.3.2).

Species abundance according to the reference Kenyon 2004, showed two species found as very common (VC), 72 species found as common (C), four species found as rare (R) and 114 species found as status unknown (SU). *Papilio nephelus, Euploea Sylvester, Euploea diocletianus and Thaumantis diores* are recorded as rare species (Table 4.3.4).

Butterfly species (total numbers collected) were recorded in or on or near or around the following microhabitats in the percentages indicated in brackets: vegetation (45.61); water (36.82); in flight – not a real habitat (7.43); cultivation (6.76); trails/roads (2.36); dung/scats (0.68) and village (0.34) (Table 4.3.5).

Threats: Habitat for butterfly species was degraded by logging and gold dredging. Logging was noted in Bam-bane village and especially found in Jubilee. Much illegal logging has resulted in the forest being totally destroyed. Gold mining was also found. The original forest is degraded into secondary forest and cultivation lands.

Conservation Status: No IUCN Red list data is recorded.

Conclusions and Discussion: Ten families, including 114 species of butterfly were recorded in Myitsone, study area I. The greatest number of species was listed in the family Nymphalidae and the least in Libytheidae. Four rare species (Kenyon 2004) were recorded, viz *Papilio nephelus* was very commonly observed in the survey and the others, *Euploea Sylvester, Euploea diocletianus and Thaumantis diores* were found as common in Myitsone area. The butterfly species were observed most abundantly around vegetation/forest microhabitats. Most of the days of observation (39) were done in this area. Different types of butterfly species were observed between Myitsone and Lasa, more findings in Myitsone, Jubilee site. The species are abundant even when their habitats are degraded.

4.3.2. Lasa, study area II

Species abundance: A total of 92 butterfly species under the order Lepidoptera were recorded under ten families,viz Papilionidae (13 species), Pieridae (9 species), Danaidae (7 species), Satyridae (10 species), Nymphalidae (27 species), Amathusiidae (1 species), Libytheidae (2 species), Riodinidae (2 species), Lycaenidae (14 species), and Hesperiidae (7 species) (Table 4.3.3, Appendix 4.3.3). The greatest species richness (27 species) was recorded in the family Nymphalidae and the least (one species) was found in family Amathusiidae (Table 4.3.3).

Species abundance according to the reference Kenyon 2004, showed one species found as very common (VC), 33 species found as common (C), three species found as rare (R) and 55 species found as status unknown (SU).). *Papilio nephelus, Euploea Sylvester* and *Euploea diocletianus* are the ones recorded as rare species (Table 4.3.4).

Butterfly species (total numbers collected) were recorded in or on or near or around the following microhabitats in the percentages indicated in brackets: water (77.14) and vegetation/forest (22.86) (Table 4.3.5).

Threats: Habitat for butterfly species was degraded by logging and gold dredging. Some areas are still forested but most former forests are degraded. Slash and burn cultivation was observed. Compared to Myitsone area, logging is observed more in Lasa. Logging companies were found. Gold minings were also found in Lasa. In the gold mining season, Chinese people carry out gold mining in the river using rafts more than mining at the riverside banks. Gold mining started in October and ended in May.

Conservation status: No IUCN Red List data is found.

Conclusions and Discussion: Ten families, including 92 species of butterfly, were recorded in Lasa study area II, The most number of species were listed in Nymphalidae and the least number of species in Amathusiidae. Species listed as rare by Kenyon 2004, viz *Papilio nephelus*, *Euploea Sylvester* and *Euploea diocletianus,* were found to be common in Lasa. The butterfly species were observed to be most abundant near/around water microhabitats. Different types of butterfly species were observed between Myitsone and Lasa but more were found in Myitsone. The species are abundant even when their habitats are degraded.

4.3.3. Chibwe, study area III

Species abundance: A total of 189 butterfly species under the order Lepidoptera were recorded, under ten families, viz Papilionidae (20 species), Pieridae (20 species), Danaidae (6 species), Satyridae (22 species), Nymphalidae (53 species), Amathusiidae (4 species), Libytheidae (2 species), Riodinidae (6 species), Lycaenidae (42 species) and Hesperiidae (14 species) (Table 4.3.3, Appendix 4.3.4). The greatest species richness (53 species) was recorded in the family of Nymphalidae and the least (2 species) was found in the family of Libytheidae (Table 4.3.3).

Species abundance according to the reference Kenyon 2004 was as follows: two species very common (VC), 50 species common (C), three species rare (R) and 134 species status unknown (SU). As shown in Table 4.3.4, *Papilio bianor, Papilio nephelus* and *Thaumantis diores* were the species recorded as rare.

Butterfly species (total numbers collected) were recorded in or on or near or around the following microhabitats in the percentages indicated in brackets: water (51); trails/roads (46); vegetation/forest (33); cultivation (7); dung/scats (2.5) and in flight – not a real microhabitat (0.5) (Table 4.3.5).

Threats: Habitat for butterfly species was degraded by logging. Chinese people from China take out logs by truck every day. Fire caused by slash and burn cultivation was usually observed. Some areas were deforested. . The forest is very productive except around Chibwe town.

Conservation Status: No IUCN Red list data is recorded.

Conclusions and Discussion: Ten families including 189 species of butterfly were recorded in Chibwe, study area III. The greatest number of species was in Nymphalidae and the least in Libytheidae. Three species stated to be rare by Kenyon 2004, (*Papilio bianor, Papilio nephelus* and *Thaumantis diores*) were observed as common in Chibwe area. The butterfly species were observed most abundantly near/around water microhabitats. The species are abundanant even when their habitats are degraded. Butterfly species were abundant in Tsawlaw and Kyihtam villages, which seemed to be plentiful in flowering plants. Also they were abundant in the entrance of Kaungla village, at the stream side.

4.3.4. Wusok, study area IV

Species abundance: A total of 102 butterfly species under the order Lepidoptera were recorded under nine families as follows: Papilionidae (17 species), Pieridae (7 species), Danaidae (2 species), Satyridae (14 species), Nymphalidae (29 species), Amathusiidae (2 species), Riodinidae (5 species), Lycaenidae (15 species) and Hesperiidae (11 species) were included. (Table 4.3.3, Appendix 4.3.5). The greatest species richness (29 species) was recorded in the family of Nymphalidae and the least, (two species) was found in the families of Danaidae and Amathusiidae (Table 4.3.3).

Species abundance according to the reference Kenyon 2004, was: 29 species common (C), two species rare (R) and 70 species status unknown (SU). *Atrophaneura aidoneus* and *Papilio nephelus* were the two species listed as rare by Kenyon 2004 (Table 4.3.4).

Butterfly species (total numbers collected) were recorded in or on or near or around the following microhabitats in the percentages indicated in brackets: water (38.51); trails/roads (37.84); cultivation (16.86) and vegetation/forest (6.76) (Table 4.3.5).

Threats: No threats were observed.

Conservation status: No IUCN Red list data is found.

Conclusions and Discussion: Nine families, including 102 species of butterfly, were recorded in Wusok, study area IV. The greatest number of species was in Nymphalidae and the least in Amathusiidae. No Libytheidae species was recorded. According to Kenyon's (2004) classification, there was no rare species in Wusok area. The butterfly species were observed most abundantly near/around water microhabitats. Butterfly species were abundant even during only 10 days of observation in the survey area. The area was recognized as very dirty. On entering Wusok from Chibwe study area, there were plenty of butterflies. The weather was fine with sunshine and some cloud.

4.3.5. Pisa, study area V

Species abundance: A total of 40 butterfly species under the order Lepidoptera were recorded. under nine families as follows: Papilionidae (8 species), Pieridae (3 species), Danaidae (2 species), Satyridae (8 species), Nymphalidae (4 species), Amathusiidae (1 species), Riodinidae (4 species), Lycaenidae (9 species), and Hesperiidae (5 species) . (Table 4.3.3, Appendix 4.3.6). The greatest species richness (9 species) was recorded in the family of Lycaenidae and the least, (one species) was found in the family of Amathusiidae (Table 4.3.3).

According to the classification of Kenyon 2004, ten of the species found were common (C) and 30 species found of status unknown (SU). There were no rare species according to Kenyon, 2004 (Table 4.3.4).

Butterfly species (total numbers collected) were recorded in or on or near or around the following microhabitats in the percentages indicated in brackets: water (45.24); trails/roads (45.24); dung/scats (7.14); vegetation/forest (2.38) (Table 4.3.5).

Threats: No threats were observed.

Conservation status: No IUCN Red list data is found.

Conclusions and Discussion: Nine families including 40 species of butterfly were recorded in Pisa, study area V. The greatest number of species was in Lycaenidae and the smallest number of species in Amathusiidae and Hesperiidae. No Libytheidae species was recorded. According to Kenyon 2004, there was no ‘rare’ species in Pisa area. The butterfly species were observed most abundantly near/around trail/road. This area was very difficult to survey due to the presence of deep river valleys with very steep mountainous hillsides. The fewest observation days (3) were carried out in this area.

4.3.6. Khaunglanhpu, study area VI

Species abundance: A total of 64 butterfly species under the order Lepidoptera were recorded. Eight families of Papilionidae (5 species), Pieridae (8 species), Danaidae (2 species), Satyridae (7 species), Nymphalidae (17 species), Riodinidae (5 species), Lycaenidae (14 species) and Hesperiidae (6 species) were included. (Table 4.3.3, Appendix 4.3.7). The greatest species richness (17 species) was recorded in the family of Nymphalidae and the least (two species) was found in family of Danaidae (Table 4.3.3).

Species abundance according to the reference Kenyon 2004, showed one species found as very common (VC), 21 species found as common (C) and 42 species found as status unknown (SU). No rare species according to Kenyon, 2004 (Table 4.3.4).

Butterfly species (total numbers collected) were recorded in or on or near or around the following microhabitats in the percentages indicated in brackets: water (32.56); vegetation/forest (32.56); cultivation (32.56); trails/road (1.16) and dung/scats (1.16) (Table 4.3.5).

Threats: No threats were observed.

Conservation status: No IUCN Red list data is found.

Conclusions and Discussion: Eight families including 64 species of butterfly were recorded in Khaunglanhpu, study area VI. The greastest number of species was listed in the family Nymphalidae and the least in Danaidae. No Amathusiidae and Libytheidae species were recorded. According to Kenyon 2004, there was no rare species in Khaunglanhpu area. The butterfly species were observed mostly abundant near/around vegetation/forest and cultivation lands. This area was difficult to survey due to the presence of deep river valleys within steep, mountainous hillsides. This area was observed for 16 days. Plentiful culture lands and good habitats for butterfly were seen.

4.3.7. Yenam, study area VII

Species abundance: A total of 34 butterfly species under the order Lepidoptera were recorded. Seven families of Papilionidae (4 species), Pieridae (5 species), Satyridae (6 species), Nymphalidae (9 species), Riodinidae (3 species), Lycaenidae (5 species) and Hesperiidae (2 species) were included (Table 4.3.3, Appendix 4.3.8). The greatest species richness (9 species) was recorded in the family of Nymphalidae and the least (two species) was found in family of Hesperiidae (Table 4.3.3).

Species abundance according to the reference Kenyon 2004, showed 12 species found as common (C), 22 species found as rare (R) and 262 species found as status unknown (SU). No rare species according to Kenyon, 2004 (Table 4.3.4).

Butterfly species (total numbers collected) were recorded in or on or near or around the following microhabitats in the percentages indicated in brackets: vegetation/forest (40.82); water (38.78); trails/roads (10.2); cultivation (6.12) and in flight – not a real microhabitat (04.08) (Table 4.3.5).

Threats: Local people depend on taungya cultivation. No other threats were observed.

Conservation status: No IUCN Red list data is found.

Conclusions and Discussion: Seven families including 34 species of butterfly were recorded in Yenam, study area VII. The greatest number of species was listed in the family Nymphalidae and the least in Hesperiidae. No Danaidae, Amathusiidae and Libytheidae species were recorded. According to Kenyon 2004, there was no rare species in Yenam area. The butterfly species were observed mostly abundant near/around vegetation/forest. This area was difficult to survey due to the presence of deep river valleys within steep, mountainous hillsides. This area was observed for 14 days.

4.3.8. Overall Conclusions and Discussion

The diversity of insects within the inundated areas of proposed dams included ten families of butterflies, comprising 345 species, demonstrating very strongly the great importance of this taxon in the survey area.

In comparing the species richness among the seven study areas, it is noteworthy that numbers of species are roughly inversely proportional to elevation (Fig.4.3.1). Exceptions to this are Lasa (II) and Pisa (V), both of which are lower than expected but this may be because the number of days of observation was below average at these two sites. Myitsone (I), the lowest study area, has the highest species richness (192 species), followed by Chibwe (III) with 189 species, while Khaunglanhpu (VI), the highest study area, had only 64 species. The butterfly species richness in the seven study sites is ranked as Myitsone (I), Chibwe (III), Wusok (IV), Lasa (II), Khaunglanhpu (VI), Pisa (V) and Yenam (VII) in order of number of species recorded (Table 4.3.4). In addition to species abundance, there was highly significant elevation specificity. For example, 68 species were only found in the lowest altitude of Myitsone area and 8 species were only recorded in the highest altitude of Khaunglanhpu.There is thus need for conservation measures with respect to this taxon at ALL of the proposed dam sites.

A further important consideration from the conservation point of view is the occurrence of species classified as 'rare' among the various study areas (Table 4.3.6)

A total of six rare species of butterfly were recorded in the study areas of proposed dams, four of them at Myitsone (I), three at Lasa (II), three at Chibwe (III) and two at Wusok (IV).4.3.6).Significantly, no rare species were recorded at the three remaining sites. Again, careful consideration needs to be given to these rare species that are of global importance when planning conservation measures.

An examination of the distribution of butterflies in relation to the various microhabitats shows significant correlations, in that approximately 70 per cent of them were recorded near/around *natural* habitats, viz water (41.25%) or vegetation/forest (28.23%). Conversely, only a very small percentage was found in close proximity to human activities, viz 'village' habitat (1.0 %). Thus the disturbance/destruction of water (rivers) and forest habitats by the proposed dam constructions will pose a huge threat to a large majority of butterfly species, with the possibility of some of them going extinct locally due to habitat loss.

4.3.9. Conservation Status for *Triodes aeacus* (Golden Birdwing), Lepidoptera species

No IUCN Red List data is recorded. According to the reference of http://en.wikipedia.org/wiki/Troides_aeacus, the status of *Triodes aeacus* (Golden Birdwing) is generally common and not threatened though it is classified as Vulnerable. It is uncommon in Sumatra, may require protection in peninsular Malaya (Bingham, 1907; Collins and Morris, 1985).

It is a beautiful and large butterfly belonging to the Swallowtail (Papilionidae family) and closely resembles *Triodes helena cerebrus*. It is found in Northern India, Nepal, Myanmar (Burma), China, Thailand, Laos, Vietnam, Taiwan, Cambodia, Peninsular Malaysia and Indonesia.

The Birdwings *Troides* genus comprises of large and beautiful butterflies found in Asia. They are much sought after by collectors and depicted as a highlight to be seen during butterfly-tours of the region. They are of such great economic value that they are cultivated through a people's participative community insect farming initiative in Papua and New Guinea. The genus has a large number of endemic species and its presence in an area is a good indicator of the value of the biodiversity of the region on a worldwide basis.

Table 4.3.1. List of insect team in all survey areas

Myitsone area (I)	Lasa area (II)	ChibweArea (III)	Wusok Area (IV)	Pisa Area (V)	Khaunglanhpu Area (VI)	Yenam Area (VII)
16-28 Jan 09	**6-30 April 09**	**3April-12May 09**	**6April – 13 May 09**	**15-18 April 09**	**20Feb-29Mar 09**	**20Feb-29 Mar 09**
Khin Mar Lwin	Naing Naing Win	Aung Moe	Aung Moe	Aung Moe	Aung Moe	Khin Mar Lwin
Naing Naing Win	Than Than Htay	San Wai Tint	San Wai Tint		Naing Naing Win	Phyoe Thida
Khin Sandar Hlaing		Khin Sandar Hlaing	Khin Sandar Hlaing		San Wai Tint	Nay Myo Aung
30-1-09 to 12-2-09						
Aung Moe						
Naing Naing Win						
Khin Sandar Hlaing						
17-2-09 to 21-2-09						
Than Than Htay						
Khin Sandar Hlaing						
6-5-09 to 13-5-09						
Naing Naing Win						
ThanThan Htay						
18-5-09 to 27-5-09						
Aung Moe						

Table 4.3.2. Study areas of insect team

Study sites on Myitsone area

		Study site	Coordination	Altitude (m)	Place	Date	Forest Type
I	a	Myitsone	N 25˚ 42' 30.5" E 97˚ 29' 48.1"	132	Conflence of May Hka and Mali Hka	15-27.1.09, 19/20/21/25/26.5.09	Secondary forest, semi-evergreen forest, cultivation, bamboo forest
I	b	Tiangzup	N 25˚ 58' 21" E 97˚ 32' 02.3"	151	Mali Hka	24.1.09	Primary and second forest, bamboo forest
I	c	Bantbane	N 25˚ 42' 03.2" E 97˚ 54' 50.6"	224	May Hka	31.1.09, 6.2.09	Secondary forest, primary forest, bamboo forest, orange plantation, degraded forest and cultivation
I	d	Thewaing	N 25˚ 41' 56.7" E 97˚ 36' 52.8"	295	May Hka	7-11.2.09, 19.5.09	Secondary forest, primary forest, bamboo forest, degraded and cultivation
I	e	Chaung sone	N 25˚ 35' 71.1" E 97˚ 48' 82"	175	May Hka	18-20.2.09	Secondary forest, bamboo forest
I	f	Myitsone village	N 25˚ 42' 41.3' E 97˚ 30' 52.4" '	164	Confluence of May Hka and Mali Hka	19/23.5.09	Secondary and degraded forest, cultivation
I	g	Hpung-in-hka	N 25˚ 47' 58.0" E 97˚ 29' 33.0"	147	Confluence of Mali Hka and Phone In Hka	21.5.09	Secondary and degraded forest, cultivation
I	h	Tan Phe	N 25˚ 42' 53.8" E 97˚ 29' 26.8"	191	Confluence of May Hka and Mali Hka	22/24.5.09	Secondary and degraded forest, cultivation
I	i	Jubilee	N 25˚ 42' 58.3" E 97˚ 51' 37.4"	210	May Hka	7/8.5.09	Secondary and degraded forest
I	j	Sut Ja	N 25˚ 41' 06.6" E 97˚ 51' 29.8"	262	May Hka	9.5.09	Secondary and degraded forest
I	k	Nga Nan Chaung	N 25˚ 42' 59.0" E 97˚ 51' 37.1"	213	May Hka	10.5.09	Secondary and degraded forest

Study sites on Lasa area

		Study site	Location	Altitude (m)	Place	Date	Forest type
II	a	Son Pi Yang	N 26˚ 52' 33.4" E 97˚ 38' 56.1"	359	May Hka	8/10.4.09	Secondary forest, Degraded forest, Mixedevergreen forest
II	b	Pha Wan	N 26˚ 52' 33.4" E 97˚ 38' 56.0"	359	May Hka	11/13.4. 09	Secondary forest, Degraded forest, Mixedevergreen forest
II	c	Hpung Ing Yang	N 26˚ 43' 42.5" E 97˚ 38' 15.1"	349	May Hka	14/17.4.09	Secondary forest, Degraded forest, Mixedevergreen forest
II	d	Maliyan	N 26˚ 34' 40.4" E 97˚ 41' 20.6"	271	May Hka	21/26.4.09	Secondary forest, Degraded forest, Mixedevergreen forest

Study sites on Chibwe area

		Study site	Location	Altitude (m)	Place	Date	Forest Type
III	a	Manton	N 25˚ 57' 52.1" E 98˚ 09' 37.6"	286	May Hka	5.5.09	Secondary and evergreen forest, cultivation, bamboo forest
III	b	Kaung Hla	N 26˚ 00' 13.6" E 98˚ 10' 41.8"	375	May Hka	4.5.09	Secondary and evergreen forest, cultivation, bamboo forest
III	c	Phala	N 26˚ 01' 53.0" E 98˚ 10' 58.9"	340	May Hka	5/9.5.09	Secondary and evergreen forest, cultivation, bamboo forest
III	d	Than De	N 26˚ 03' 27.4" E 98˚ 11' 38.8"	333	May Hka	1.5.09	Secondary and evergreen forest, cultivation, bamboo forest
III	e	19 mile	N 26˚ 06' 20.3" E 98˚ 13' 05.2"		May Hka	30.4.09	Secondary and evergreen forest, cultivation, bamboo forest

III	f	Kyihtam	N 26˚ 16' 31.1" E 98˚ 18' 38.6"	552	Ngaw Chan Hka	9/22/23/24/28.4.09	Secondary and evergreen forest, cultivation, bamboo forest
III	g	Han Kum	N 26˚ 15' 56.5" E 98˚ 17' 18.6"	732	May Hka	27.4.09	Secondary and evergreen forest, cultivation, bamboo forest
III	h	Mit Gyo	N 26˚ 18' 01.7' 'E 98˚ 17' 37.5"	1040	May Hka	25.4.09	Secondary and evergreen forest, cultivation, bamboo forest
III	i	Chaung Sone	N 26˚ 18' 51.0" E 98˚ 17' 28.1"	416	Confluence of May Hka & Ngaw Chan Hka	26.4.09	Secondary and evergreen forest, cultivation, bamboo forest
III	j	Gyaw Maw	N 26˚ 19' 32.7" E 98˚ 20' 31.0"	1080	May Hka	10/24.4.09	Secondary and evergreen forest, cultivation, bamboo forest
III	k	West bank of Man Tone	N 25˚ 59' 21.2" E 98˚ 09' 57.0"	313	May Hka	7.5.09	Secondary and evergreen forest, cultivation, bamboo forest
III	l	Phone Phai	N 26˚ 01' 10.8" E 98˚ 10' 35.5"	317	May Hka	7.5.09	Secondary and evergreen forest, cultivation, bamboo forest
III	m	Laung Phai	N 26˚ 03' 28.2" E 98˚ 10' 51.5"	444	May Hka	8/10.5.09	Secondary and evergreen forest, cultivation, bamboo forest
III	n	Nga Myaw Zut	N 26˚ 09' 38.0" E 98˚ 14' 16.7"	358	May Hka	11.5.09	Secondary and evergreen forest, cultivation, bamboo forest
III	o	North of Nga Myaw Zut	N 26˚ 11' 10.9" E 98˚ 14' 43.4"	512	May Hka	12.5.09	Secondary and evergreen forest, cultivation, bamboo forest

Study sites on Wusok area

Study site			Location	Altitude (m)	Place	Date	Forest Type
IV	a	Wusok	N 26˚ 24' 36.0" E 98˚ 17' 45.3"	419	May Hka	11/20.4.09	Secondary forest, semi-evergreen forest, cultivation, bamboo forest
IV	b	Pashe	N 26˚ 28.191' E 98˚ 17.705'	537	May Hka	16/18/20.4.09	Secondary forest, semi-evergreen forest, cultivation, bamboo forest
IV	c	Warup	N 26˚ 31' 33.1" E 98˚ 18' 42.8"	784	May Hka	12/19.4.09	Secondary forest, semi-evergreen forest, cultivation, bamboo forest
IV	d	Hpaung Ja	N 26˚ 33' 20.9" E 98˚ 21' 08.6"	987	May Hka	13.4.09	Secondary forest, semi-evergreen forest, cultivation, bamboo forest
IV	e	Htawt Lan	N 26˚ 38' 17.6" E 98˚ 22' 39.7"	1074	May Hka	14/18.4.09	Secondary forest, semi-evergreen forest, cultivation, bamboo forest

Study sites on Pisa area

Study site			Location	Altitude (m)	Place	Date	Forest Type
V	a	Chone Dam	N 26˚ 42' 26.7" E 98˚ 23' 06.4"	1151	May Hka	15.4.09	Secondary forest, semi-evergreen forest, cultivation, bamboo forest
V	b	Chaung Sone	N 26˚ 44' 09.0" E 98˚ 22' 50.5"	572	May Hka	16/17.4.09	Secondary forest, semi-evergreen forest, cultivation, bamboo forest

Study sites on Khaunglanhpu area

Study site			Location	Altitude (m)	Place	Date	Forest Type
VI	a	Ridam	N 27˚ 12' 07.7" E 98˚ 14' 20.3"	774	May Hka	1/2/18/19.3.09	Secondary forest, Evergreen forest, Cultivation land, Bamboo forest, Riverbed
VI	b	Hta-la-law	N 27˚ 3' 29.9" E 98˚ 21' 52.3"	1492	May Hka	17.3.09	Secondary forest, Evergreen forest, Cultivation land, Bamboo forest, Riverbed
VI	c	Tre-wan-gaung			May Hka	14.3.09	Secondary forest, Evergreen forest, Cultivation land, Bamboo forest, Riverbed
VI	d	Ah-chan-hka	N 27˚ 04' 00.6" E 98˚ 22' 50.5"	1287	May Hka	5/8/10/13/16.3.09	Secondary forest, Evergreen forest, Cultivation land, Bamboo forest, Riverbed
VI	e	Chaung-sone	N 27˚ 02' 21.6" E 98˚ 22' 05.4"	996	May Hka	9/11/15.3.09	Secondary forest, Evergreen forest, Cultivation land, Bamboo forest, Riverbed
VI	f	Wuning	N 27˚ 01' 04.7" E 98˚ 21' 52.2"	1170	May Hka	13/14.3.09	Secondary forest, Evergreen forest, Cultivation land, Bamboo forest, Riverbed

Study sites on Yenam area

Study site			Location	Altitude (m)	Place	Date	Forest Type
VII	a	Panandim	N 27˚ 43' 46.6" E 97˚ 52' 48.5"	985	Nantamil stream	27/28.2.09, 17/18.3.09	Secondary and semi-evergreen forest, Cultivation, bamboo forest
VII	b	West Man Ton	N 27˚ 43' 33.6" E 97˚ 56' 33.8"	887	Nantamil stream	2/3.3.09	Secondary and semi-evergreen forest, Cultivation, bamboo forest
VII	c	Yenam	N 27˚ 42' 08.1" E 98˚ 02' 11.1"	953	Junction of Nantamil & Tronwun stream	5-9.3.09	Secondary and semi-evergreen forest, Cultivation, bamboo forest
VII	d	Aleaung	N 27˚ 42' 25.2" E 98˚ 07' 10.7"	955	Tronwun Stream	11-13.3.09	Secondary and semi-evergreen forest, Cultivation, bamboo forest

Table 4.3.3. List of butterfly families and respective numbers of species in all survey areas

FAMILY	I	II	III	IV	V	VI	VII	ALL
Papilionidae	10.94	14.13	10.58	16.67	20	7.81	11.76	10.43
Pieridae	12.5	9.78	10.58	6.86	7.5	12.5	14.71	9.28
Danaidae	6.78	7.61	3.17	1.96	5	3.13	–	4.06
Satyridae	14.06	10.87	11.64	13.73	20	10.94	17.65	13.33
Nymphalidae	29.17	29.35	28.04	28.43	10	26.56	26.47	26.96
Amathusiidae	1.56	1.09	2.12	1.96	2.5	–	–	1.74
Libytheidae	0.52	2.17	1.06	–	–	–	–	0.58
Riodinidae	2.08	2.17	3.17	4.9	10	7.81	8.82	2.32
Lycaenidae	17.19	15.22	22.22	14.71	22.5	21.88	14.71	21.16
Hesperiidae	5.21	7.61	7.41	10.78	2.5	9.38	5.88	10.14

I=Myitsone, II=Lasa, III=Chibwe, IV=Wusok, V=Pisa, VI=Khaunglanhpu, VII=Yenam, All=7 survey areas

Table 4.3.4. Summary of information on butterfly species recorded in the seven study areas

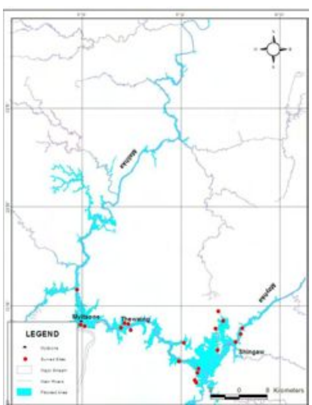
Information	I	II	III	IV	V	VI	VII	ALL
Elevation (range)	132-262	271-359	286-1080	419-1074	572-1151	774-1492	887-985	–
Elevation (mean)	197	315	683	746.5	861.5	1133	936	–
Observed days	39	8	22	10	3	16	14	112
Family	10	10	10	9	9	8	7	10
Species	192	92	189	102	40	64	34	345
Species in per cent	26.9	12.9	26.5	14.3	5.6	8.9	4.8	–
Very Common (VC) species	2	1	2	0	0	1	0	2
Common (C) species	72	33	50	29	10	21	12	75
Rare (R) species	4	3	3	3	0	0	0	6
Status Unknown (SU)	114	55	134	70	30	42	22	262

I=Myitsone, II=Lasa, III=Chibwe, IV=Wusok, V=Pisa, VI=Khaunglanhpu, VII=Yenam, All=7 survey areas

Table 4.3.5. Distribution of total numbers of butterflies recorded among microhabitats in each survey area (figures given as percentages of total in that area)

Microhabitat	I	II	III	IV	V	VI	VII	All
near/around water	36.82	77.14	51	38.51	45.24	32.56	38.78	41.25
flight	7.43	–	0.5	–	–	–	4.08	2.49
trail/road	2.36	–	46	37.84	45.24	1.16	10.2	17.89
dung/scat	0.68	–	2.5	–	7.14	1.16	–	1.09
vegetation/forest	45.61	22.86	33	6.76	2.38	32.56	40.82	28.23
cultivation	6.76	–	7	16.86	–	32.56	6.12	8.95
village	0.34	–	–	–	–	–	–	1

I=Myitsone, II=Lasa, III=Chibwe, IV=Wusok, V=Pisa, VI=Khaunglanhpu, VII=Yenam, All=7 survey areas"in flight" is not a real microhabitat



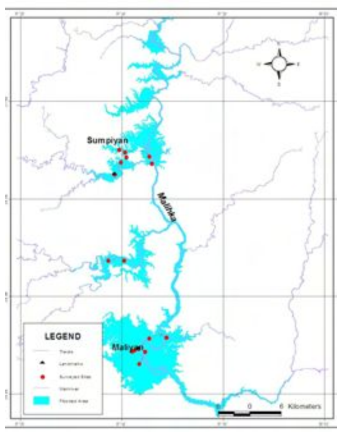
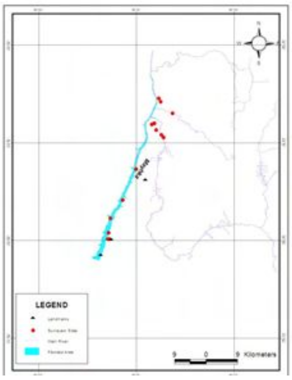


Figure 4.1.1 Map of the study sites of mammal team at Myitsone flooded area

Figure 4.1.2 Map of the study sites of mammal team at Lasa flooded area



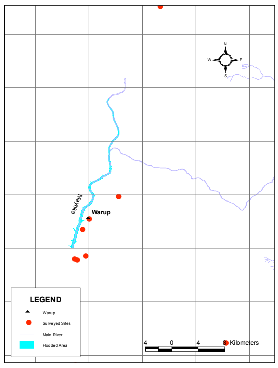


Figure 4.1.3 Map of the study sites of mammal team at Chibwe flooded area.

Figure 4.1.4 Map of the study sites of mammal team at Wusok flooded area.

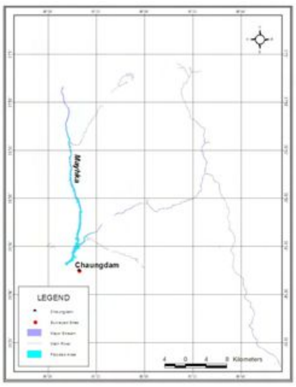


Figure 4.1.5 Map of the study sites of mammal team at Pisa flooded area.

Figure 4.1.6 Map of the study sites of mammal team at Khaunglanhpu flooded area.

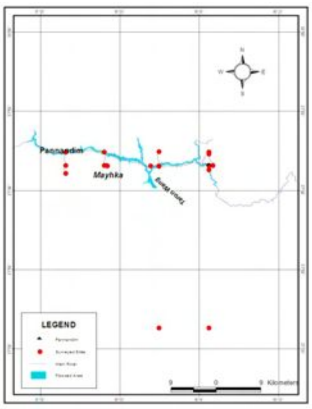


Figure 4.1.7 Map of the study sites of mammal team at Yenam flooded area.

Figure 4.1.8 Horns of Gaur *Bos gaurus* hanging on a hunter's house at Myitsone

Figure 4.1.9 Skin of Large Indian civet *Viverra zibetha* drying in the sun at Lasa

Figure 4.1.10 Skin of dhole *Cuon alpinus* observed at Lasa

Figure 4.1.11 Anderson's squirrel *Callosciurus quinquestriatus* found in Chibwe

Figure 4.1.12 Skin of Clouded leopard *Neofelis nebulosa* observed in Yenam

Figure 4.1.13 Skin of marbled cat *Pardofelis marmorata* observed in Chibwe

Figure 4.1.14 Skin of fishing cat *Prionailurus viverrinus* seen at Chibwe

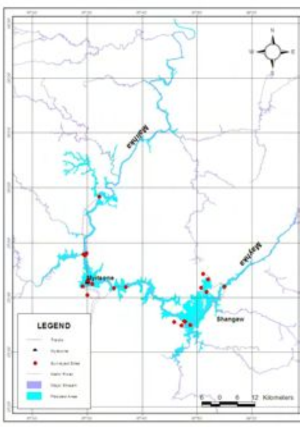
Figure 4.1.15 Assam macaque *Macaca assamensis* captured by camera trap at Wusok (Courtesy He Bing, Chinese researcher)

Figure 4.1.16 Shortridge's langur *Trachypithecus shortridgei* found in Lasa

Figure 4.1.17. Skin of Black muntjac *Muntiacus crinifrons* found in Yenam

Figure 4.1.18 Dung of Asian elephant *Elephas maximus* observed in Myitsone

Figure 4.1.19 Scales of Chinese pangolin *Manis pentadactyla* observed in Chibwe area



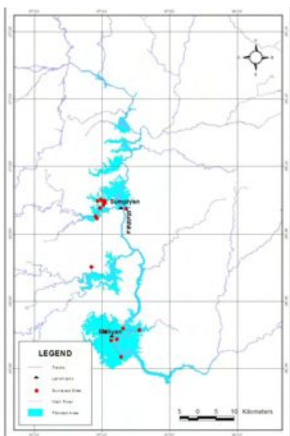
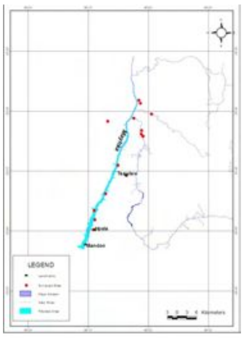


Figure 4.2.1 Herpetofauna survey sites of Myintsone flooded area.

Figure 4.2.2 Herpetofauna survey sites of Lasa flooded area.



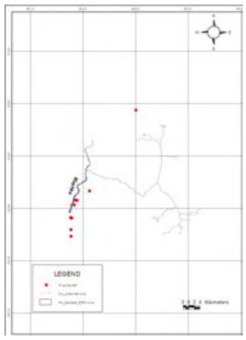


Figure 4.2.3 Herpetofauna survey sites of Chibwe flooded area.

Figure 4.2.4 Herpetofauna survey sites of Wusok flooded area.

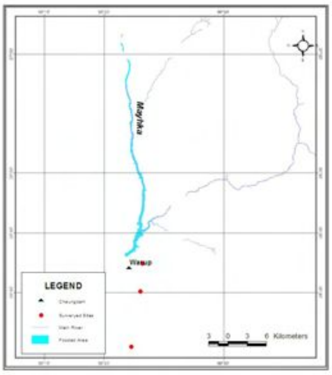


Figure 4.2.5 Herpetofauna survey sites of Pisa flooded area.

Figure 4.2.6 Herpetofauna survey sites of Khaunglanhpu flooded area.

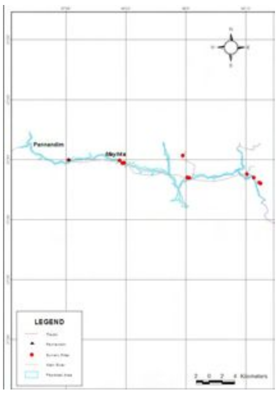


Figure 4.2.7 Herpetofauna survey sites of Yenam flooded area

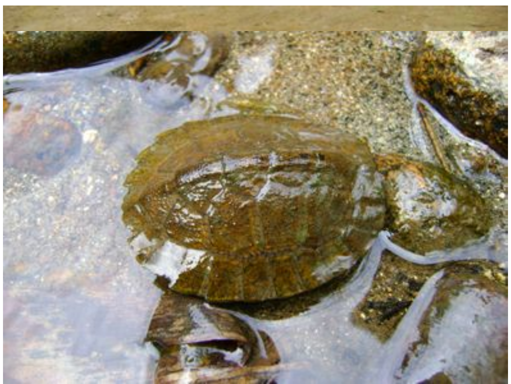


Figure 4.2.8 White-lipped Pitviper *Trimeresurus albolabris* found in Myitsone

Figure 4.2.9 Limbless lizard *Ophisaurus gracilis* in Chibwe

Figure 4.2.10 *Rhacophorus* sp.1 found in Chibwe

Figure 4.2.11 *Megophry* sp.6 found in Chibwe

Figure 4.2.12 Monocellate cobra *Naja kaouthia* found in Chibwe

Figure 4.2.13 *Limnonectes* sp.1 found in Chibwe

Figure 4.2.14 Keeled box turtle *Pyxidea mouhotii* found in Lasa.

Figure 4.2.15 Fea's horned frog *Brachytarsophrys feae* found in Khaunglanhpu

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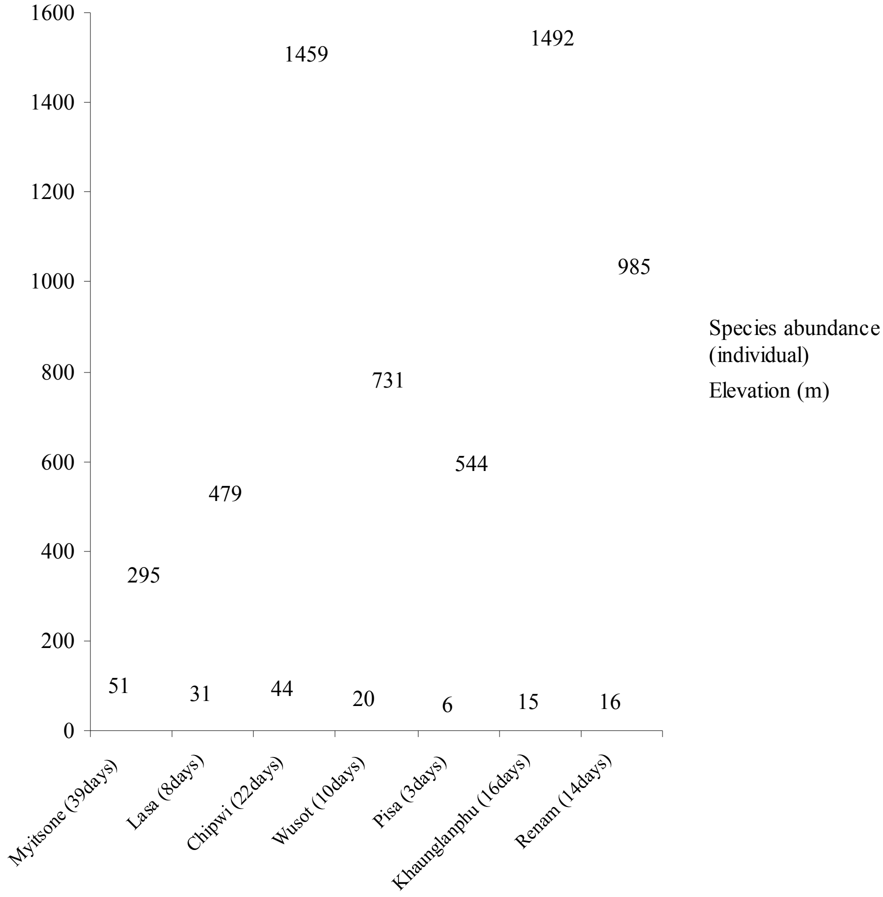
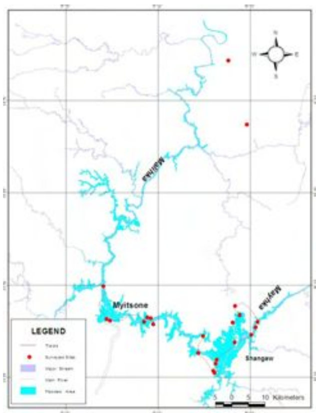


Figure 4.2.16 The relationship between herpetofauna species abundance and elevations of study areas (days of observation shown in brackets against place names)



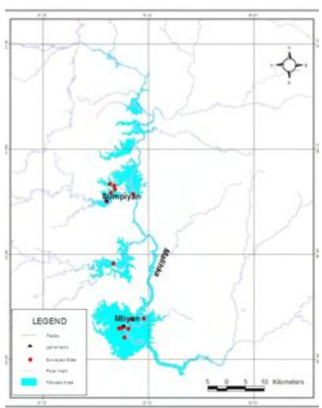
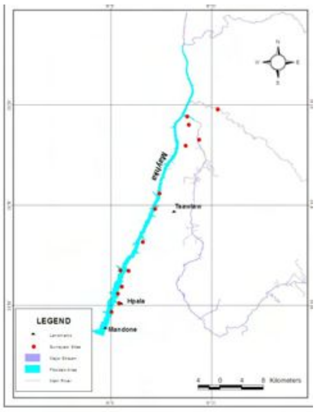


Figure 4.3.1 Insect (Butterfly) survey sites of Myitsone flooded area.

Figure 4.3.2 Insect (Butterfly) survey sites of Lasa flooded area.



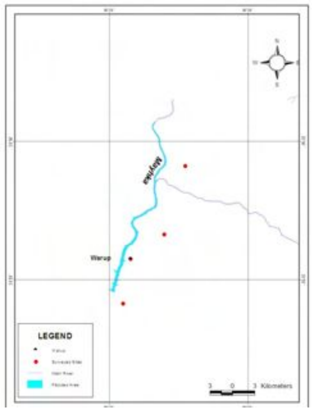


Figure 4.3.3 Insect (Butterfly) survey sites of Chibwe flooded area.

Figure 4.3.4 Insect (Butterfly) survey sites of Wusok flooded area.

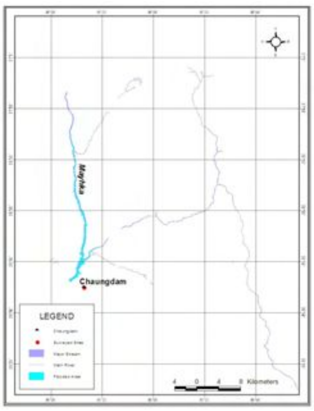


Figure 4.3.5 Insect (Butterfly) survey sites of Pisa flooded area.

Figure 4.3.6 Insect (Butterfly) survey sites of Khaunglanhpu flooded area.

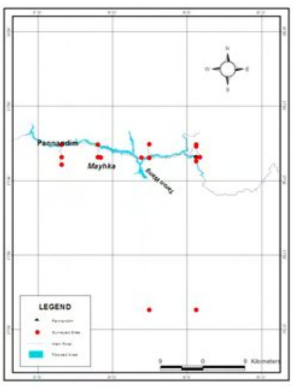


Figure 4.3.7 Insect (Butterfly) survey sites of Yenam flooded area.


Figure 4.3.8 *Papilio paris* observed in Lasa.


Figure 4.3.9 *Euploea diocletianus* found in Lasa.


Figure 4.3.10 *Graphium antiphates* found in Lasa.


Figure 4.3.11 *Triodes aeacus* found in Chibwe.


Figure 4.3.12 *Choaspes xanthopogon* found in Khanunglanhpu.


Figure 4.3.13 *Dodona dipoea* found in Khaunglanhpu.

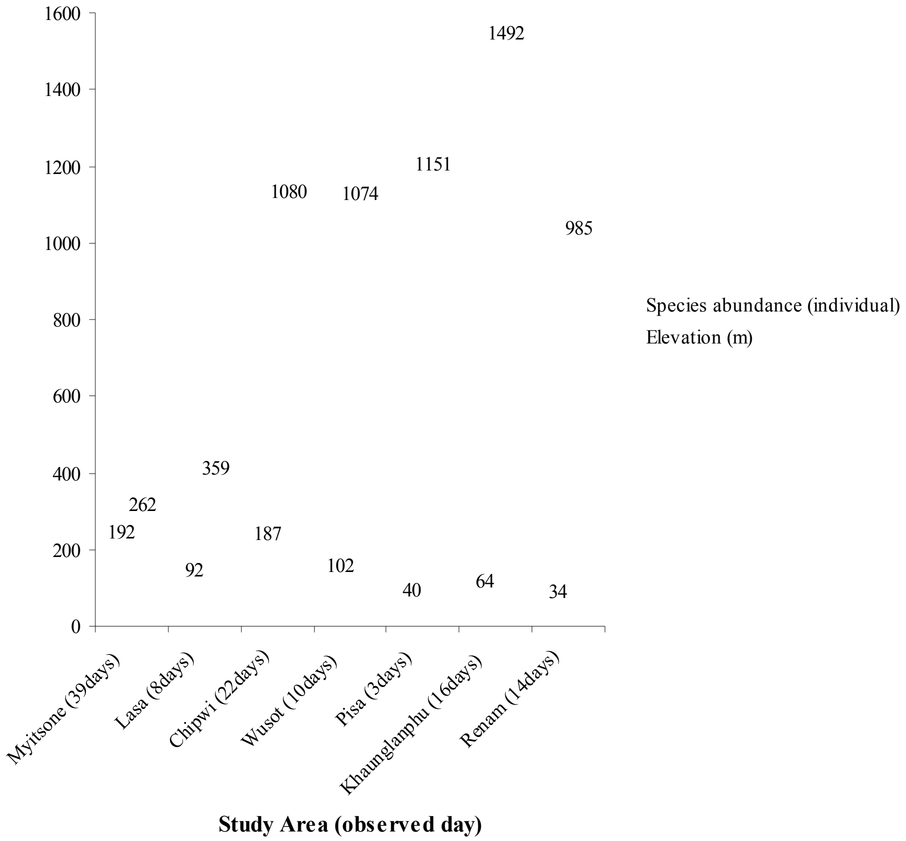


Figure 4.3.14 The relationship between butterfly species abundance and elevations (max) of study areas (days of observation shown in brackets against place names).

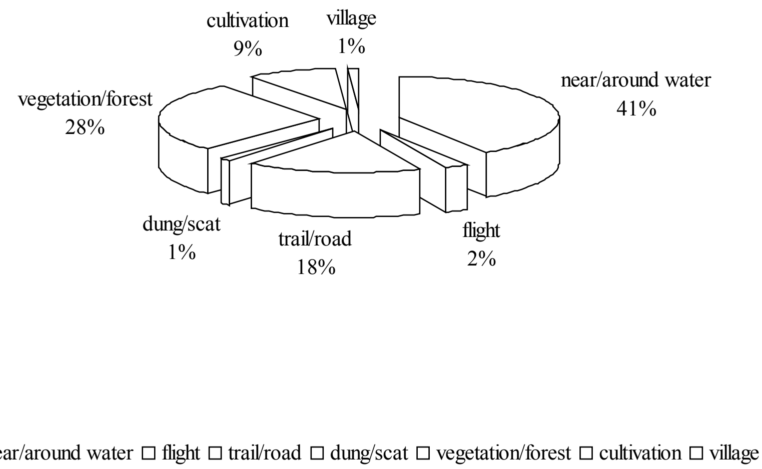


Figure 4.3.15 Distribution of total number of butterflies observed during the survey among various microhabitats (as percentages of total observed).

CHAPTER 5

5. CONCLUSIONS AND DISCUSSION

5.1. Habitat observed: Secondary forest is the most frequently found forest type in all survey areas. Habitats are much degraded in Jubilee at Myitsone, Lasa, southern part of Chibwe, and also degraded in Khaunglanhpu and Yenam areas. The topography is flat plain in Myitsone. A few mountains are present in Lasa and the northern part of Chibwe is mountainous. Wusok, Pisa, Khaunglanhpu and Yenam are the most mountainous places and Pisa is very difficult for travel with deep hillsides. Khaunglanhpu is the highest place (1492 m) among the areas surveyed, with permanent ice present in the cold season. Habitats readily accessible to people are already very degraded and undisturbed habitats for wild fauna are greatly reduced.

5.2. Animal species abundance: A total of 61 species of mammal, 115 species of herpetofauna and 345 species of butterfly was identified in all seven study areas of the proposed dam sites.

5.2.1. The Conservation status of animal species observed Within the mammal species, five, 13 and seven species are categorized as Endangered (EN), Vulnerable (VU) and Near Threatened (NT) respectively in the 2009 IUCN Red List Data. Thus 18 (29.51 per cent) of mammals observed are threatened species (EN and VU). Six species of mammal were recorded more (non-Chinese did not find at all) by Chinese researchers and none of them were threatened species. Of (115, total no. found) herpetofauna species, two, one and two species are listed as EN, VU and NT respectively. Thirty-one species of herpetofauna were recorded more (non-Chinese did not find at all) by Chinese researchers and two of these (one EN and one VU) are catergorized as threatened in 2009 IUCN Red List. A total of five (3.42 per cent) recorded species of herpetofauna (three EN and two VU) are classified as threatened. No threatened species were encountered in the butterflies observed.

According to the record of observed mammal species, Chinese pangolin *Manis pentadactyla*, Shortridge's langur *Trachypithecus shortridge*, dhole *Cuon alpinus*, fishing cat *Prionailurus viverrinus* and Asian elephant *Elephas maximus* are categorized as EN in 2009 IUCN Red List Data. Bengal slow loris *Nycticebus bengalensis*, stumped-tailed macaque *Macaca arctoides*, eastern hoolock gibbon *Hoolock leuconedys*, Asiatic black bear *Ursus thibetanus*, sun bear *Helarctos malayanus*, red panda *Ailurus fulgens*, marbled cat *Pardofelis marmorata*, clouded leopard *Neofelis nebulosa*, black muntjac *Mutiacus crinifrons*, sambar *Rusa unicolor*, Gaur *Bos gaurus*, takin *Budorcas taxicolor* and red goral *Naemorhedus baileyi* are categorized as VU in 2009 IUCN Red List Data.

Leaf muntjac *Muntiacus putaoensis*, Fea's Muntjac *Muntiacus feae* and Gongshan muntjac *Muntiacus gongshanensis* are classified as DD (Data Deficient) in 2009 IUCN Red List Data. Their distribution and other ecological data need to be monitored in order to obtain fuller information on their precise conservation status.

Within herpetofauna species, one frog (Yunnan spiny frog *Paa yunnanensis*) and two turtles (Keel box turtle *Pyxidea mouhotii* and Myanmar roofed turtle *Kachuga trivittata*) are listed as EN. Xizhang warty treefrog *Theloderma moloch* and giant Asian pond turtle *Heosemys grandis* are catergorized as VU in 2009 IUCN Red List Data.

In the butterflies *Triodes aeacus*, belonging to the swallowtail (Papilionidae family), is generally common and not threatened though it is classified as Vulnerable in Wikipedia, the free encyclopedia.

5.2.2. Animal species distribution: Tiger was found within the last 15 years at Chibwe. Otters were abundant in the last 3 years at Chibwe and Wusok even though none were observed in this survey. Signs of Asian elephant were recorded in Myitsone. Gibbon, muntjac, pangolin are still abundant in Chibwe and Wusok. It seems most threatened species were more abundant in previous times, indicating that they have declined in recent years and require urgent conservation attention if they are to be saved from extinction in the areas surveyed.

Turtles were found through the evidence of captive specimens and turtle shells from dead individuals. Malayan soft shell turtle was also found through the evidence of sales of this species to a middleman. King cobra *Ophiophagus hannah* and sunbeam snake *Xenpeltis unicolor* were also encountered as captive specimens, even though the other snakes were encountered in the wild. Export trade in turtles and snakes to China is very easy in these border areas.

Butterfly species were abundant in all survey areas, with greatest numbers in Jubilee at Myitsone and Chibwe areas. Many of these species were observed in or on, or near or around the water microhabitat, comprising 41.25 of the total.

5.3. Main threats: Three main threats to the survival of wildlife were found during the survey, viz hunting, habitat loss, human encroachment/ human activities. These threats destroy components of the fauna both directly and indirectly. Hunting destroys animals, especially vertebrates, directly and the other two, habitat loss and human encroachment/ human activities act indirectly over time to destroy animals of a great variety of different taxa, including both vertebrates and invertebrates.

5.3.1. Hunting: The hunting activities recorded by the survey include subsistence hunting of wildlife for meat and hunting related to trade in wildlife parts (remains). Both forms of hunting directly destroy components of the vertebrate fauna in all areas surveyed. Local people are opportunistic hunters killing whatever wildlife is available. Wildlife remains, resulting from recent hunting, were encountered in all survey areas. Most of the species identified by the evidence of wildlife remains were mammals. Primates, squirrels, bats, and rodents were most commonly sighted. In addition to present-day hunting, there is also strong evidence of much hunting of wildlife in years gone by. Most of the local people have guns (tumee) and are able to shoot wildlife freely. Snares and traps (snap/jaw traps) are also set up all the time in the forest. Du-lay and arrow with poison (locally made) are also used for hunting, [particularly in Khaunglanhpu. Local people widely use wildlife meat. Many heads and skeletons of monkeys were hung and displayed in the local peoples' houses (huts), especially at Khaunglanhpu. Some baby wildlife (Assam macaque, Aderson's squirrel) were captured and kept as pets in Chibwe.

A greater amount of hunting of wildlife was found in Myitsone, Lasa and Yenam among all survey areas. Wildlife trade is much more in Yenam than in other areas. Khaunglanhpu and Yenam are near to the Myanmar- China border and much of the wildlife trade is with China. Khaunglanhpu is nearer to China than Yenam. Wildlife are still relatively abundant in Wusok, Pisa, Khaunglanhpu and Yenam because of the productive forest. But the days of observation on wildlife were less in these areas than elsewhere.

5.3.2. Habitat loss: Both the local people and non- local immigrants use bioresources and entirely depend on them. Logging, gold mining, and slash and burn, and taungya (terrace) cultivation are occured widely, seriously destroying the habitats of the wild fauna.

Gold mining and dredging are the most critical threats and were observed in Myitsone and Lasa, especially in Lasa. Most of the gold mining is done by Chinese people and KIA people in Lasa (90% of Chinese people and10% of Myanmar people do gold mining. These days the Chinese are doing gold mining in the river using rafts. Logging is carried out illegally and much logging was observed at Jubilee in Myitsone area. Logging companies were found in Lasa. Much logging was also found in Lasa and Chibwe, also in Khaunglanhpu and Yenam, near to China.

Taungya cutting is also a major threat to the forest. Most local people depend heavily on taungya or terrace cultivations, using the slash and burn method. Cultivation was particularly extensive in Lasa Chibwe, Khaunglanhou and Yenam, greatly destroying the habitats of forest-dwelling fauna in those areas.

5.3.3. Human encroachments and human activities: KIA and NDAK insurgents (as local people) mostly govern all survey areas. Many Chinese people come to carry out logging and gold mining temporarily on a seasonal basis. There are many human activities in these areas, including development works such as road and dam construction. Roads are present from Chibwe, Khaunglanhpu, Yenam to the China border, facilitating easy crossing to and from China. Chinese people (non local immigrants) are thus able to come freely to work in Myanmar. More people were seen and more forest was degraded in these border areas than among all other areas surveyed. Another destructive human activity was dynamite fishing found in many rivers, especially in Lasa. Ngaw-chan-hka, one of the tributaries of Mayhka River, was found to be extremely polluted around Kyeetan village at Chibwe; yet another form of habitat damage resulting from human activity.

<u>Negative Impacts on the Region</u>

1. Many local people will be relocated.
2. Local people's life or their economy will be changed when they are relocated from their lands
3. Culture, morale and spirit will be changed by encroachment of non local immigrants
4. GThere will be an increase in illegal wildlife trade and illegal logging
5. Economy of non local immigrants will become dominant
6. Habitats for wild fauna will shrunk even further than at present
7. There will be an increase of butterfly and bird collection from Kachin State by foreigners which will destroy their populations
8. Myitsone is a nature heritage site and it will be forever lost by dam construction, permanently removing an important part of Myanmar's heritage
9. Myitsone is at the confluence of Mayhka and Malihka rivers that will be polluted by the dam construction, seriously degrading natural aquatic habitat
10. Nature bioresources are plentiful in Kachin State and many of them will be lost by dam construction

Table 5.2.1a Conservation status of mammal species in each survey area

Sr. No.	Cons. status	Common Name	Species Name	I	II	III	IV	V	VI	VII
1	**EN**	Chinese pangolin	*Manis pentadactyla*	√	√	√				√
2		Shortridge's langur	*Trachypithecus shortridgei*	√	√		√			
3		Dhole	*Cuon alpinus*	√	√				√	√
4		Fishing Cat	*Prionailurus viverrinus*					√		
5		Asian Elephant	*Elephas maximus*	√						
1	**VU**	Bengal slow loris	*Nycticebus bengalensis*	√	√	√			√	
2		Stump-tailed macaque	*Macaca arctoides*	√	√	√	√		√	√
3		Eastern hoolock gibbon	*Hoolock leuconedys*	√	√	√	√			√
4		Asiatic black bear	*Ursus thibetanus*	√	√	√	√		√	√
5		Sun bear	*Helarctos malayanus*	√	√		√			√
6		Red penda	*Ailurus fulgens*			√		√		√
7		Marbled cat	*Pardofelis marmorata*			√	√			√
8		Clouded leopard	*Neofelis nebulosa*	√	√					√
9		Black muntjac	*Muntiacus crinifrons*							√
10		Sambar	*Rusa unicolor*		√	√				
11		Gaur	*Bos gaurus*	√	√	√				
12		Takin	*Budorcas taxicolor*				√	√	√	√
13		Red goral	*Naemorhedus baileyi*							√
1	**NT**	Assam macaque	*Macaca assamensis*	√	√	√	√	√	√	√
2		Large Indian civet	*Viverra zibetha*	√	√					
3		Asian golden cat	*Pardofelis temminckii*			√				√
4		South west China serow	*Capricornis milneedwardsii*		√	√	√	√	√	√
5		Red serow	*Capricornis rubidus*	√	√	√	√	√	√	
6		Black giant squirrel	*Ratufa bicolor*	√	√	√	√			
7		Anderson's squirrel	*Callosciurus quinquestriatus*			√				
1	**DD**	Leaf muntjac	*Muntiacus putaoensis*						√	
2		Fea's muntjac	*Muntiacus feae*			√	√	√	√	√
3		Gongshan muntjac	*Muntiacus gongshanensis*						√	

I = Myitsone, II = Lasa, III = Chibwe, IV = Wusok, V = Pisa, VI = Khaunglanhpu, VII = Yenam

Table 5.2.1b Conservation status of herpetofauna species in each survey area

Sr. No.	Cons. status	CommonName	Species Name	I	II	III	IV	V	VI	VII
1	**EN**	Yunnan spiny frog	*Paa yunnanensis*	√	√					
2		Keeled box turtle	*Pyxidea mouhotii*	√	√					
3		Myanmar roofed turtle	*Kachuga trivittata*	√						
1	**VU**	Xizhang warty treefrog	*Theloderma moloch*						√	
2		Giant Asian pond turtle	*Heosemys grandis*		√					
1	**NT**	Gongshan flying frog	*Polypedates gongshanensis*						√	
2		Burmese python	*Python molurus*	√	√					
3		Indian black turtle	*Melonochelys trijuga*	√	√					

I = Myitsone, II = Lasa, III = Chibwe, IV = Wusok, V = Pisa, VI = Khaunglanhpu, VII = Yenam

CHAPTER 6

6. CONSERVATION MEASURES REQUIRED

The following species specific conservation measures are urgently required in order to protect the many valuable faunal elements of the north-eastern region of Kachin State that is to be the focus of the proposed dam constructions. Unless these measures are rapidly implemented and carefully maintained many of the species listed will almost certainly disappear from the area as a result of the widespread environmental disturbances that the construction of the seven dams will bring about. In some cases more data needs to be collected before precise details of the conservation required can be drawn up. In others, the main requirement is the enforcement of existing conservation legislation that is designed to protect wildlife from destructive hunting practices and destruction of their habitats. All these measures require considerable funding and this should be provided within the overall budget of the dam construction works. For budgeting purposes, most cases will require a time-based conservation plan to be drawn up by appropriate experts and costs calculated accordingly. In this regard it should be noted that the protection of some of these species can be carried out simultaneously, e.g. by strengthened law enforcement in an area, and will not require a separate programme for that species alone. The budget would be a large one and the constructors should bear all expenses because they are the one who will bring all the biodiversity damages to that area.

Pangolins: Development and enforcement of effective hunting and trade controls for both species of pangolin.

Shortridge's langur: It is one of the small group of species considered for conservation priority among Asian primates; this species requires immediate and complete protection from subsistence hunting.

Gibbons: All species require complete protection from subsistence hunting.

Canids: Very large areas are required to support viable populations of dholes. More information is required on the status and abundance of this species. It should be completely protected from hunting.

Bears: The most urgent conservation need is development and enforcement of appropriate controls on hunting and on trade on bear and bear parts.

Otters: It is considered to have high priority for conservation action. All species require complete protection from subsistence hunting and trading.

Civets: Civets are important food items and meat and skins are traded in adjacent parts of China; the extent to which species of conservation significance are involved needs to be determined and appropriate conservation measures developed.

Felids: Complete protection of all of the large cats (tiger, leopard and clouded leopard) from hunting and trade, as well as conservation of very large areas of habitat and maintenance of adequate prey populations; development of hunting and trade controls for all remaining species in this family.

Elephants: Elephant populations are most threatened; establishment of managed elephant ranges; enforcement of existing legal restrictions on the sale of ivory and other elephant products.

Cervids: The distribution of these species needs to be further documented.

Bovids: Development and implementation of appropriate trade controls; to develop effective conservation measures, including hunting and trade controls.

Squirrels: Protection from hunting for black giant squirrel; monitoring of trade in all species; conservation of adequate areas of habitat.

Flying squirrels: Seasonal protection from hunting, monitoring of trade level, and conservation of adequate areas of habitat.

Porcupines: Monitoring of trade levels and imposition of controls as necessary

Snakes: Enforcement on hunting of pythons and imposition of appropriate controls on trade.

Turtles: Monitoring and control of trade

Frogs: These presumably are mostly abundant species occurring in common habitats; need to be evaluated in order to identify potential conservation concerns.

CHAPTER 7

7. GENERAL RECOMMENDATIONS

In addition to the above requirements of specific conservation measures, there are a number of general recommendations that are essential to ensure improved environmental management for the entire region. It will be noted that a number of these provide a supporting framework for the species-oriented conservation already proposed in chapter 6 above. Again, it must be pointed out that much detailed planning, including costing, will be needed in order for these recommendations to be implemented. It is assumed that the costs of these planning activities themselves can be provided for from the overall funding of the dams project, through the relevant ministries and other government agencies.

Enforce the laws for protection around the project areas to stop the present widespread illegal activities, including gold mining, logging, hunting and, trapping, all of which contribute to the destruction of wildlife and their habitats and rob Myanmar of valuable resources.

- Diversification of legal livelihood activities and income generation, including training in practical skills that prepare local people for employment in the construction and other industries
- Capacity building for environmental management and anti-poaching, including the sustainable harvesting of abundant wild resources under appropriate regulation
- Teach and educate local people about the significance of protecting the area and its wildlife through simple education/extension programmes, emphasizing the economic potential of well protected natural resources, through such income generating activities as eco-tourism
- Ensure that these programmes are adequately budgeted within the overall funding of the dams construction project

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Appendix 4.1.1. List of mammal species recorded in all survey areas

No.	Common Name	Scientific Name	IUCN Red list, 2009	CITES, 2009	1994Myanmar status,	Type of evidences
	PHOLIDOTA Manidae					
1	Chinese pangolin	*Manis pentadactyla*	EN	II		III. foot-1 (smoked), scales encountered frequency-1; I.II.III.VII. information
	INSECTIVORA Talpidae					
2	White-tailed mole	*Talpa leucura (Parascaptor leucura ?)*	–			III. dead body-1; IV. dead body-1, V. sighting-1
3	Eastern mole	*Talpa micrura*	–			I. burrow-1, captured from paddy fields, information (MTT, MMT); VII. dead body, feeding sign, information
	CHIROPTERA Pteropodidae					
4	Greater shortnosed fruit bat	*Cynopterus sphinx*	LC			VII. alive (dead)-2
5	Blanford's fruit bat	*Sphaerias blanfordi*	LC			VI. alive-4; VII. alive-4
	Rhinolophidae					
6	Great woolly horseshoe bat	*Rhinolophus luctus*	LC			VII. alive-1
7	Least horseshoe bat	*Rhinolophus pusillus*	–			IV. alive-2
8	Great Himalayan leaf-nosed bat	*Hipposideros armiger*	LC			IV. alive-1
	Hipposideridae					
9	Stoliczka's Asian trident bat (?)	*Aselliscus stoliczkanus* (?)	LC			IV. alive-2; VI. alive-3
	Vespertilionidae					
10	Least pipistrelle	*Pipistrellus tenuis*	–			II. alive (dead)-1
	PRIMATES Lorisidae					
11	Bengal slow loris	*Nycticebus bengalensis*	VU	I		I. skin-1; II. information from middleman and hunter (SSA); III. skin-1, information; VI. information from hunter (AST)
	Cercopithecidae					
12	Assam macaque	*Macaca assamensis*	NT	II		I. skull-5; II. skull-16; III. skull-2; IV. sighting-18, skull-26, skin-18, dead body-8; V. skull-1; VI. sighting-2, skull-8; VII. skull-15; I, II, III, IV, V, VI, VII - information
13	Stump-tailed macaque	*Macaca arctoides*	VU	II		I. skull-11, information; II. sighting-1, skull-6, information; III. skull-10, sighting-1; IV. sighting-1, skull-3; VI. sign-meat -1; VII. skull-1; group moving-information at VI, VII
14	Rhesus macaque	*Macaca mulatta*	LC	II		I. sighting-6, skull-3; II. skull-5; III. skull-2, sighting-12; V. sighting-12; VII. sighting-5, skull-6; information from all except IV, VI
15	Shortridge's langur	*Trachypithecus shortridgei*	EN	I		I. skull-1, sighting-1, information; II. skull-9, sighting-9, information; IV. sighting-2
	Hylobatidae					
16	Eastern Hoolock gibbon	*Hoolock leuconedys*	VU	I		I, II, III, IV.vocalization-4+4+7+1; II. skull-3; I.II.III.IV.VII. information
	CARNIVORA Canidae					
17	Dhole	*Cuon alpinus*	EN	II		I. skin-1; II. skull-1; information-l; VI. skin-1; VII. information-1
	Ursidae					
18	Asiatic black bear	*Ursus thibetanus*	VU	I		I. skull-3, information; II. genital organ-1, claw-2, skull-1, information; III. skull-3, information; IV. skull-1, information; VI. skull-2, information; VII. skull-1; I,II,III,IV,VI,VII - information
19	Sun bear	*Helarctos malayanus*	VU	II		I. teeth-1pair; II. skull-2, skin-1, teeth-2 pairs, gallbladder-1; IV. eating sign-1; VII. skull-4, recently captured at Aleaung and sold (skull left), information
	Ailuridae					

20	Red panda	*Ailurus fulgens*	VU	I		III. skin-1; V. skin-1; VII. skin-1; information-hunted from icy mountain
	Mustelidae					
21	Stripe-backed weasel	*Mustela strigidorsa*	LC			II. information-captured; IV. body part-1; VII. information from local hunter
22	Yellow-throated marten	*Martes flavigula*	LC	III		I. sighting-2, information; II. information from hunters; III. skin-2; VI. dead body-1; III,VI,VII. information from Forestry staff & WCS staff & villagers
	Viverridae					
23	Large Indian civet	*Viverra zibetha*	NT	III		I. skin-1, information from KIA ; II. skin-1, information from local people
24	Small Indian civet	*Viverricula indica*	LC	III		I. taxidermy-1, information; II. skull-5, tail-1, information; VII. information
25	Spotted linsang	*Prionodon pardicolor*	LC			I. information-hunter captured alive and sold 3000 yon; II. tail-1, skin-1, information; VII. information
26	Common palm civet	*Paradoxurus hermaphroditus*	LC	III		I. skin-1, tail-1, information; II. sighting-2, information; V. skull-2, information
27	Masked palm civet	*Paguma larvata*	LC	III		I. tail-1, information; II. skull-1, information; VII. dead body-1, skull-1, information
28	Small-toothed palm civet	*Arctogalidia trivirgata*	LC	I		I. information; III. skin-1
	Felidae					
29	Leopard cat	*Prionailurus bengalensis*	LC	II		I. skin-2, information; II. skin-3, information; VI. skin-1; VII. information
30	Fishing cat	*Prionailurus viverrinus*	EN	II		V. skin-1
31	Asian golden cat	*Pardofelis temminckii*	NT	II		III. skin-1; VII. skull-1, information
32	Marbled cat	*Pardofelis marmorata*	VU	II		III. skin-4; IV. skull-1; VII. information (Forestry staff)
33	Clouded leopard	*Neofelis nebulosa*	VU	II		I. information; II. skin-1, teeth on jaw-1, information; VII. skin-2, information
	PROBOSCIDA Elephantidae					
34	Asian elephant	*Elephas maximus*	EN	I	P	I. footprint, dung, destructive sign, information
	ARTIODACTYLA Suidae					
35	Eurasian wild pig	*Sus scrofa*	LC			I. footprint-11, digging-8, faeces-1, sighting-7, skull-6, teeth on lowerjaw-3; II. skull-5, teeth on lowerjaw-3, footprint-3, digging-1, shot WB at Taungya; III. skull-23, digging-3, IV. skull-36, digging-34, footprint-2, V. skull-59, footprint-1; VI. skull-24, footprint-3, digging-2, rubbing-1, eating site-2; VII. skull-4, rubbing-1, footprint-6, resting site-2; information from all
	Cervidae					
36	Leaf muntjac	*Muntiacus putaoensis*	DD			VI. skin-1, antler-1
37	Southern red muntjac	*Muntiacus muntjak*	LC		SP	I. antler-15, skin-6, sighting-1, information; II. antler-23, skin-19, information; III. skull-10, antler-17, skin-20, sighting-1, information; IV. skull-6, antler-10, skin-13, sighting-3, information; V. skull-5, antler-9, skin-3, sighting-1, information; VI. skull-14, antler-30, skin-8, information
38	Fea's muntjac (?)	*Muntiacus feae (?)*	DD		SP	III. skin-1, IV. dead body-1; V. skull-2, skin-6, antler-2; VI. skin-2; VII. skin-2, antler-1, information; CT at PND by HB
39	Black muntjac (?)	*Muntiacus crinifrons (?)*	VU	I		VII. skin-2, antler-6, information
40	Gongshan muntjac (?)	*Muntiacus gongshanensis (?)*	DD			IV. skin-1
41	Sambar	*Rusa unicolor*	VU		SP	II. antler-18, footprint-12, recently killed and seen of flesh and blooded skull, information; III. antler-1, information
	Bovidae					
42	Gaur	*Bos gaurus*	VU	I	P	I. horn-4, footprint-8, information; II. skull-2, information; III. horn-2
43	Takin	*Budorcas taxicolor*	VU	II	P	IV. horn-3, V. horn-15, VI. horn-4; VII. horn-3, hunted from icy mountain
44	Southwest China (Chenese) serow	*Capricornis milneedwardsii*	NT	I		II. skin-2; III. skull-9, horn-14, skin-5; IV. skull-8, horn-12, skin-14, information; V. skull-18, horn-20, skin-13, dead body -1; VI. skull-18, horn-27, skin-1; VII. horn-3, skin-3
45	Red serow	*Capricornis rubidus*	NT	I		I. skin-1, information-hunter saw it across the river and killed while fishing; II. skin-1, horn-1; III. skull-3, horn-5, skin-2; IV.

					skull-2; V. horn-1; VI. dead body-1, skull-2, horn-4
46	Red goral	*Naemorhedus baileyi*	VU	I	VII. skin-2, horn-1, hunted from icy mountain
	RODENTIA Sciuridae				
47	Black giant squirrel	*Ratufa bicolor*	NT	II	I. tail-1, sighting-1 (SSA, MTT, TZ); II. sighting-2, tail-1; III. sighting-2; IV. tail-1
48	Pallas's squirrel	*Callosciurus erythraeus*	LC		II. sighting-1 (Bird team); V. sighting-1 (AST)
49	Anderson's squirrel	*Callosciurus quinquestriatus*	NT		III. sighting-2 (AST)
50	Hoary-bellied (Irrawaddy) squirrel	*Callosciurus pygerythrus*	LC		I. sighting-1 (HB, Moses & SSA); III. captured alive by local people-1
51	Himalayan (Myanmar) striped squirrel	*Tamiops macclellandii*	LC		I. sighting-3 (He Bing, SSA, MTT, AST); II. sighting-1 (bird team)
52	Swinhoe's striped squirrel	*Tamiops swinhoei*	LC		I. sighting-1 (HB, MMT)
53	Orange-bellied Himalayan squirrel	*Dremomys lokriah*	LC		VI. dead body -1
	Pteromyidae				
54	Common (Red) giant flying squirrel	*Petaurista petaurista*	LC		II. whole body skin-1, ThanTunAung got it from local hunter above site II ; III. sighting-1 (AST)
	Muridae				
55	Black (House) rat	*Rattus rattus*	LC		II. dead body-1
56	Greater bandicoot rat	*Bandicota indica*	LC		VII. dead body-1
57	Chestnut white-bellied rat (Indomalayan Niviventer)	*Niviventer fulvescens*	LC		II. dead body-1
58	Bowers's rat (Bowers's white-toothed rat)	*Berylmys bowersi*	LC		III. dead body-1
59	Hoary bamboo rat	*Rhizomys pruinosus*	LC		VI. dead body-1; VII. dead body-1, alive-2
	Hystricidae				
60	Malayan porcupine	*Hystrix brachyura*	LC		I. quills- uncountable; II. quills-uncountable, skull-1, tail-1; III. skull-5, quills-unc.; IV. dead body-1; V. sighting-2 (AST); VII. quills-unc., information
61	Asiatic brush-tailed porcupine	*Atherurus macrourus*	LC		I. stomach-2, tail-1, information; II. tail-2, stomach-2, information; III. tail-1; VI. dead body, information; VII. resting site-3(?), information

Appendix 4.1.1 a. List of mammal species (unable to identify specific species) recorded in all surveyed areas

	PHOLIDOTA Manidae				
1	Pangolin sp(p).	*Manis* sp(p).	EN	II	III. foot-1 (smoked); I,II,III,VII. information
	INSECTIVORA Soricidae				
2	Shrew sp(p).	?	–		II. burrow-1, dead body-1 (MMTun, unidentified); III. sighting-1; IV. dead body-1; VI. dead body-1, information
	CARNIVORA Mustelidae				
3	Otter sp(p).	?	?	I/II	I. information from local people, footprint-1; III. information from hunters & villagers; IV. information from local people; VII. information from local hunters, otter were abundant last 10 years
4	Ferret badger	*Melogale* sp.	?		III. dead body-1
	Viverridae				
5	Civet sp(p).	?	?		I. footprints & scats of cat spp.
	Felidae				
6	Small cat sp(p).	?	?		I. footprints & scats of cat spp.
	ARTIODACTYLA Cervidae				
7	Muntjac sp(p).	?	?		Vocalization: I - 2; III - 5; IV - 2; III, IV, VI. footprints

Appendix 4.1.1 b. List of mammal species recorded (information only) in all survey areas

	PHOLIDOTA Manidae				
1	Sunda pangolin (?)	*Manis javanica* (?)	EN	II	III. foot-1 (smoked), information
	SCANDENTIA Tupaiidae				
2	Northern treeshrew	*Tupaia belangeri*	LC	II	II. information; VII. information (SSA)
	PRIMATES Cercopithecidae				
3	Northern pig-tailed macaque	*Macaca leonina*	VU	II	III. information from hunter-2 (AST); VII. information from local hunter (SSA)
	CARNIVORA Canidae				
4	Golden jackal (?)	*Canis aureus* (?)	LC	III	I, VII. information
	Mustelidae				
5	Oriental small-clawed otter	*Aonyx cinerea*	VU	II	VII. information
6	Hog badger	*Arctonyx collaris*	NT		I, II, VII. information
	Viverridae				
7	Large-spotted civet (?)	*Viverra megaspila* (?)	VU		VII. information
8	Binturong	*Arctictis binturong*	VU	III	I. information from local hunter; VII. information from WCS staff
	Felidae				
9	Jungle cat (?)	*Felis chaus* (?)	LC	II	VII. information

Areas: I = Myisone, II = Lasa, III = Chibwe, IV = Wusok, V = Pisa, VI = Khaunglanhpu, VII = Yenam;
IUCN Red List Data: EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern, DD = Data Deficient;
CITES Appendices I, II, III;
Myanmar Status: P = Protected, SP = Seasonally Protected

Appendix 4.1.2. Mammal species recorded in Myitsone area

Sr. no.	Order	Family	Common Name	Scientific Name	IUCN Red list	CITES	statusMyanmar	Visual & Vocal	Track & Sign	remainsWildlife	Information
1	PHOLIDOTA	Manidae	Chinese pangolin	*Manis pentadactyla*	EN	II					√
2	INSECTIVORA	Talpidae	Eastern mole	*Talpa micrura*	_				√		√
3	PRIMATES	Lorisidae	Bengal slow loris	*Nycticebus bengalensis*	VU	I				√	
4	PRIMATES	Cercopithecidae	Assam macaque	*Macaca assamensis*	NT	II				√	√
5	PRIMATES	Cercopithecidae	Stump-tailed macaque	*Macaca arctoides*	VU	II				√	√
6	PRIMATES	Cercopithecidae	Rhesus macaque	*Macaca mulatta*	LC	II		√		√	√
7	PRIMATES	Cercopithecidae	Shortridge's langur	*Trachypithecus shortridgei*	EN	I		√		√	√
8	PRIMATES	Hylobatidae	Eastern hoolock gibbon	*Hoolock leuconedys*	VU	I		√			√
9	CARNIVORA	Canidae	Dhole	*Cuon alpinus*	EN	II				√	
10	CARNIVORA	Ursidae	Asiatic black bear	*Ursus thibetanus*	VU	I			√	√	√
11	CARNIVORA	Ursidae	Sun bear	*Helarctos malayanus*	VU	II				√	
12	CARNIVORA	Mustelidae	Yellow-throated marten	*Martes flavigula*	LC	III		√			√
13	CARNIVORA	Viverridae	Large Indian civet	*Viverra zibetha*	NT	III				√	√

14	CARNIVORA	Viverridae	Small Indian civet	*Viverricula indica*	LC	III				√	√
15	CARNIVORA	Viverridae	Spotted linsang	*Prionodon pardicolor*	LC						√
16	CARNIVORA	Viverridae	Common palm civet	*Paradoxurus hermaphroditus*	LC	III				√	√
17	CARNIVORA	Viverridae	Masked palm civet	*Paguma larvata*	LC	III				√	√
18	CARNIVORA	Felidae	Leopard cat	*Prionailurus bengalensis*	LC	II				√	√
19	CARNIVORA	Felidae	Clouded leopard	*Neofelis nebulosa*	VU	II					√
20	PROBOSCIDA	Elephantidae	Asian elephant	*Elephas maximus*	EN	I	P		√		√
21	ARTIODACTYLA	Suidae	Eurasian wild pig	*Sus scrofa*	LC			√	√	√	√
22	ARTIODACTYLA	Cervidae	Southern red muntjac	*Muntiacus muntjak*	LC		SP	√		√	√
23	ARTIODACTYLA	Bovidae	Gaur	*Bos gaurus*	VU	I	P		√	√	√
24	ARTIODACTYLA	Bovidae	Red serow	*Capricornis rubidus*	NT	I				√	√
25	RODENTIA	Sciuridae	Black giant squirrel	*Ratufa bicolor*	NT	II		√		√	
26	RODENTIA	Sciuridae	Hoary-bellied (Irrawaddy) squirrel	*Callosciurus pygerythrus*	LC			√			
27	RODENTIA	Sciuridae	Himalayan (Myanmar) striped squirrel	*Tamiops macclellandii*	LC			√			
28	RODENTIA	Muridae	Hoary bamboo rat	*Rhizomys pruinosus*	LC						√
29	RODENTIA	Hystricidae	Malayan porcupine	*Hystrix brachyura*	LC					√	
30	RODENTIA	Hystricidae	Asiatic brush-tailed porcupine	*Atherurus macrourus*	LC					√	√

Appendix 4.1.2 a. Mammal species (unidentified species) recorded in Myitsone area

1	PHOLIDOTA	Manidae	Pangolin sp(p).	*Manis* sp(p).	EN	II		√
2	CARNIVORA	Ursidae	Bear sp(p).	?	VU	I/II	√	
3	CARNIVORA	Mustelidae	Otter sp(p).	?	?	I/II	√	√

Appendix 4.1.2 a. Mammal species (unidentified species) recorded in Myitsone area

4	CARNIVORA	Viverridae	Civet sp(p).	?	?	√
5	CARNIVORA	Felidae	Small cat sp(p).	?	?	√
6	ARTIODACTYLA	Cervidae	Muntjac sp(p).	?	?	

Appendix 4.1.2 b. Mammal species recorded (information only) in Myitsone area

1	CARNIVORA	Canidae	Golden jackal	*Canis aureus*	LC	III	√
2	CARNIVORA	Mustelidae	Hog badger	*Arctonyx collaris*	NT		√
3	CARNIVORA	Viverridae	Binturong	*Arctictis binturong*	VU	III	√
4	CARNIVORA	Viverridae	Small-toothed palm civet	*Arctogalidia trivirgata*	LC	I	√

IUCN Red List Data: EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern, DD = Data Deficient; CITES Appendices I, II, III; Myanmar Status: P = Protected, SP = Seasonally Protected

Appendix 4.1.3. Mammal species recorded in Lasa area

Sr. no.	Order	Family	Common Name	Scientific Name	IUCN Red list	CITES	Myanmar status	Visual & Vocal	Track & Sign	Wildlife remains	Information
1	PHOLIDOTA	Manidae	Chinese pangolin	*Manis pentadactyla*	EN	II					√
2	CHIROPTERA	Vespertilionidae	Least pipistrelle	*Pipistrellus tenuis*				√		√	
3	PRIMATES	Lorisidae	Bengal slow loris	*Nycticebus bengalensis*	VU	I					√
4	PRIMATES	Cercopithecidae	Assam macaque	*Macaca assamensis*	NT	II				√	√
5	PRIMATES	Cercopithecidae	Stump-tailed macaque	*Macaca arctoides*	VU	II		√		√	√
6	PRIMATES	Cercopithecidae	Rhesus macaque	*Macaca mulatta*	LC	II				√	√
7	PRIMATES	Cercopithecidae	Shortridge's langur	*Trachypithecus shortridgei*	EN	I		√		√	√
8	PRIMATES	Hylobatidae	Eastern hoolock gibbon	*Hoolock leuconedys*	VU	I		√		√	√
9	CARNIVORA	Canidae	Dhole	*Cuon alpinus*	EN	II				√	√
10	CARNIVORA	Ursidae	Asiatic black bear	*Ursus thibetanus*	VU	I				√	√
11	CARNIVORA	Ursidae	Sun bear	*Helarctos malayanus*	VU	II				√	√
12	CARNIVORA	Mustelidae	Stripe-backed weasel	*Mustela strigidorsa*	LC						√
13	CARNIVORA	Mustelidae	Yellow-throated marten	*Martes flavigula*	LC	III					√
14	CARNIVORA	Viverridae	Large Indian civet	*Viverra zibetha*	NT	III				√	√
15	CARNIVORA	Viverridae	Small Indian civet	*Viverricula indica*	LC	III				√	√
16	CARNIVORA	Viverridae	Spotted linsang	*Prionodon pardicolor*	LC					√	√
17	CARNIVORA	Viverridae	Common palm civet	*Paradoxurus hermaphroditus*	LC	III		√			√
18	CARNIVORA	Viverridae	Masked palm civet	*Paguma larvata*	LC	III				√	√
19	CARNIVORA	Felidae	Leopard cat	*Prionailurus bengalensis*	LC	II				√	√
20	CARNIVORA	Felidae	Clouded leopard	*Neofelis nebulosa*	VU	II				√	√
21	ARTIODACTYLA	Suidae	Eurasian wild pig	*Sus scrofa*	LC				√	√	√
22	ARTIODACTYLA	Cervidae	Southern red muntjac	*Muntiacus muntjak*	LC		SP			√	√
23	ARTIODACTYLA	Cervidae	Sambar	*Rusa unicolor*	VU		SP		√	√	√
24	ARTIODACTYLA	Bovidae	Gaur	*Bos gaurus*	VU	I	P			√	√
25	ARTIODACTYLA	Bovidae	Southwest China (Chenese) serow	*Capricornis milneedwardsii*	NT	I				√	
26	ARTIODACTYLA	Bovidae	Red serow	*Capricornis rubidus*	NT	I				√	

27	RODENTIA	Sciuridae	Black giant squirrel	*Ratufa bicolor*	NT	II		√	√	
28	RODENTIA	Sciuridae	Pallas's squirrel	*Callosciurus erythraeus*	LC			√		
29	RODENTIA	Sciuridae	Himalayan (Myanmar) striped squirrel	*Tamiops macclellandii*	LC			√		
30	RODENTIA	Pteromyidae	Common (Red) giant flying squirrel	*Petaurista petaurista*	LC					√
31	RODENTIA	Muridae	Black (House) rat	*Rattus rattus*	LC			√	√	
32	RODENTIA	Muridae	Chestnut white-bellied rat (Indomalayan Niviventer)	*Niviventer fulvescens*	LC			√	√	
33	RODENTIA	Muridae	Hoary bamboo rat	*Rhizomys pruinosus*	LC					√
34	RODENTIA	Hystricidae	Malayan porcupine	*Hystrix brachyura*	LC				√	√
35	RODENTIA	Hystricidae	Asiatic brush-tailed porcupine	*Atherurus macrourus*	LC				√	√

Appendix 4.1.3 a. Mammal species (unable to identify specific species) recorded in Lasa area

1	PHOLIDOTA	Manidae	Pangolin sp(p).	*Manis* sp(p).	EN	II			√
2	INSECTIVORA	Soricidae	Shrew sp(p).	?	_		√	√	

Appendix 4.1.3 b. Mammal species recorded (information only) in Lasa area

1	SCANDENTIA	Tupaiidae	Northern tree shrew	*Tupaia belangeri*	LC	II	√
2	CARNIVORA	Mustelidae	Hog badger	*Arctonyx collaris*	NT		√

IUCN Red List Data: EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern, DD = Data Deficient; CITES Appendices I, II, III; Myanmar Status: P = Protected, SP = Seasonally Protected

Appendix 4.1.4. Mammal species recorded in Chibwe area

Sr. no.	Order	Family	Common Name	Scientific Name	IUCN Red list	CITES	Myanmar status	Visual & Vocal	Track & Sign	Wildlife remains	Information
1	PHOLIDOTA	Manidae	Chinese pangolin	*Manis pentadactyla*	EN	II				√	√
2	INSECTIVORA	Talpidae	White-tailed mole	*Talpa leucura (Parascaptor leucura ?)*	–					√	
3	PRIMATES	Lorisidae	Bengal slow loris	*Nycticebus bengalensis*	VU	I				√	√
4	PRIMATES	Cercopithecidae	Assam macaque	*Macaca assamensis*	NT	II				√	√
5	PRIMATES	Cercopithecidae	Stump-tailed macaque	*Macaca arctoides*	VU	II		√		√	
6	PRIMATES	Cercopithecidae	Rhesus macaque	*Macaca mulatta*	LC	II		√		√	√
7	PRIMATES	Hylobatidae	Eastern hoolock gibbon	*Hoolock leuconedys*	VU	I		√			√
8	CARNIVORA	Ursidae	Asiatic black bear	*Ursus thibetanus*	VU	I				√	√
9	CARNIVORA	Ailuridae	Red panda	*Ailurus fulgens*	VU	I				√	
10	CARNIVORA	Mustelidae	Yellow-throated marten	*Martes flavigula*	LC	III				√	
12	CARNIVORA	Viverridae	Small-toothed palm civet	*Arctogalidia trivirgata*	LC	I				√	
13	CARNIVORA	Felidae	Asian golden cat	*Pardofelis temminckii*	NT	II				√	
14	CARNIVORA		Marbled cat	*Pardofelis marmorata*	VU	II			√		
15	ARTIODACTYLA	Suidae	Eurasian wild pig	*Sus scrofa*	LC				√	√	√
16	ARTIODACTYLA	Cervidae	Southern red muntjac	*Muntiacus muntjak*	LC		SP	√		√	√
17	ARTIODACTYLA	Cervidae	Fea's muntjac (?)	*Muntiacus feae* (?)	DD		SP			√	
19	ARTIODACTYLA	Bovidae	Gaur	*Bos gaurus*	VU	I	P			√	
21	ARTIODACTYLA	Bovidae	Southwest China (Chenese) serow	*Capricornis milneedwardsii*	NT	I				√	
22	ARTIODACTYLA	Bovidae	Red serow	*Capricornis rubidus*	NT	I				√	
23	RODENTIA	Sciuridae	Black giant squirrel	*Ratufa bicolor*	NT	II		√			
24	RODENTIA	Sciuridae	Anderson's squirrel	*Callosciurus quinquestriatus*	NT			√			
25	RODENTIA	Sciuridae	Hoary-bellied (Irrawaddy) squirrel	*Callosciurus pygerythrus*	LC					√	
26	RODENTIA	Pteromyidae	Common (Red) giant flying squirrel	*Petaurista petaurista*	LC			√			
27	RODENTIA	Muridae	Bowers's rat (Bowers's white-toothed rat	*Berylmys bowersi*	LC					√	
28	RODENTIA	Muridae	Hoary bamboo rat	*Rhizomys pruinosus*	LC						√
29	RODENTIA	Hystricidae	Malayan porcupine	*Hystrix brachyura*	LC					√	√

30	RODENTIA	Hystricidae	Asiatic brush-tailed porcupine	*Atherurus macrourus*	LC					√	√

Appendix 4.1.4 a. Mammal species (unable to identify specific species) recorded in Chibwe area

1	PHOLIDOTA	Manidae	Pangolin sp(p).	*Manis* sp(p).	EN	II		√	√
2	INSECTIVORA	Soricidae	Shrew sp(p).	?	_		√		
3	CARNIVORA	Mustelidae	Otter sp(p).	?	?	I/II			√

Appendix 4.1.4 a. Mammal species (unable to identify specific species) recorded in Chibwe area

4	CARNIVORA	Mustelidae	Ferret badger	*Melogale* sp.	?		√
5	ARTIODACTYLA	Cervidae	Muntjac sp(p).	?	?	√	

Appendix 4.1.4 b. Mammal species recorded (information only) in Chibwe area

1	PHOLIDOTA	Manidae	Sunda pangolin (?)	*Manis javanica* (?)	EN	II	√	√
2	PRIMATES	Cercopithecidae	Northern pig-tailed macaque	*Macaca leonina*	VU	II		√

IUCN Red List Data: EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern, DD = Data Deficient; CITES Appendices I, II, III; Myanmar Status: P = Protected, SP = Seasonally Protected

Appendix 4.1.5. Mammal species recorded in Wusok area

Sr. no.	Order	Family	Common Name	Scientific Name	IUCN Red list	CITES	Myanmar status	Visual & Vocal	Track & Sign	Wildlife remains	Information
1	INSECTIVORA	Talpidae	White-tailed mole	*Talpa leucura (Parascaptor leucura ?)*	–					√	
2	CHIOROPTERA	Rhinolophidae	Least horseshoe bat	*Rhinolophus pusillus*				√			
3	CHIOROPTERA	Hipposideridae	Great Himalayan leaf-nosed bat	*Hipposideros armiger*	LC			√			
4	CHIOROPTERA	Hipposideridae	Stoliczka's Asian trident bat	*Aselliscus stoliczkanus*	LC			√		√	
5	PRIMATES	Cercopithecidae	Assam macaque	*Macaca assamensis*	NT	II		√		√	√
6	PRIMATES	Cercopithecidae	Stump-tailed macaque	*Macaca arctoides*	VU	II		√		√	
7	PRIMATES	Cercopithecidae	Shortridge's langur	*Trachypithecus shortridgei*	EN	I		√			
8	PRIMATES	Hylobatidae	Eastern hoolock gibbon	*Hoolock leuconedys*	VU	I		√			√
9	CARNIVORA	Ursidae	Asiatic black bear	*Ursus thibetanus*	VU	I				√	√

10	CARNIVORA	Ursidae	Sun bear	*Helarctos malayanus*	VU	II			√		√
11	CARNIVORA	Mustelidae	Stripe-backed weasel	*Mustela strigidorsa*	LC					√	
12	CARNIVORA	Felidae	Marbled cat	*Pardofelis marmorata*	VU	II				√	
13	ARTIODACTYLA	Suidae	Eurasian wild pig	*Sus scrofa*	LC				√	√	√
14	ARTIODACTYLA	Cervidae	Southern red muntjac	*Muntiacus muntjak*	LC		SP	√		√	√
15	ARTIODACTYLA	Cervidae	Fea's muntjac (?)	*Muntiacus feae* (?)	DD		SP			√	
16	ARTIODACTYLA	Cervidae	Gongshan muntjac (?)	*Muntiacus gongshanensis* (?)	DD					√	
17	ARTIODACTYLA	Bovidae	Takin	*Budorcas taxicolor*	VU	II				√	
18	ARTIODACTYLA	Bovidae	Southwest China (Chenese) serow	*Capricornis milneedwardsi i*	NT	I				√	√
19	ARTIODACTYLA	Bovidae	Red serow	*Capricornis rubidus*	NT	I				√	
20	RODENTIA	Muridae	Hoary bamboo rat	*Rhizomys pruinosus*	LC					√	
21	RODENTIA	Hystricidae	Malayan porcupine	*Hystrix brachyura*	LC					√	
22	RODENTIA	Hystricidae	Asiatic brush-tailed porcupine	*Atherurus macrourus*	LC						√

Appendix 4.1.5 a. Mammal species (unable to identify specific species) recorded in Wusok area

1	INSECTIVORA	Soricidae	Shrew sp(p).	?				√	
2	INSECTIVORA	Mustelidae	Otter sp(p).	?	?	I/II			√
3	ARTIODACTYLA	Cervidae	Muntjac sp(p).	?	?		√		

IUCN Red List Data: EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern, DD = Data Deficient; CITES Appendices I, II, III; Myanmar Status: P = Protected, SP = Seasonally Protected

Appendix 4.1.6. Mammal species recorded in Pisa area

Sr. no.	Order	Family	Common Name	Scientific Name	IUCN Red list	CITES	Myanmar status	Visual & Vocal	Track & Sign	Wildlife/parts	Information
1	INSECTIVORA	Talpidae	White-tailed mole	*Talpa leucura (Parascaptor leucura ?)*	–			√			
2	PRIMATES	Cercopithecidae	Assam macaque	*Macaca assamensis*	NT	II				√	√
3	PRIMATES	Cercopithecidae	Rhesus macaque	*Macaca mulatta*	LC	II		√			√
4	CARNIVORA	Ailuridae	Red panda	*Ailurus fulgens*	VU	I				√	
5	CARNIVORA	Viverridae	Common palm civet	*Paradoxurus hermaphroditus*	LC	III				√	√
6	CARNIVORA	Felidae	Fishing cat	*Prionailurus viverrinus*	EN	II				√	
7	ARTIODACTYLA	Suidae	Eurasian wild pig	*Sus scrofa*	LC				√	√	√
8	ARTIODACTYLA	Cervidae	Southern red muntjac	*Muntiacus muntjak*	LC		SP	√		√	√

9	ARTIODACTYLA	Bovidae	Fea's muntjac (?)	*Muntiacus feae* (?)	DD		SP			√	
10	ARTIODACTYLA	Bovidae	Takin	*Budorcas taxicolor*	VU	II				√	
11	ARTIODACTYLA	Bovidae	Southwest China (Chenese) serow	*Capricornis milneedwardsii*	NT	I				√	
12	ARTIODACTYLA	Bovidae	Red serow	*Capricornis rubidus*	NT	I				√	
13	RODENTIA	Sciuridae	Pallas's squirrel	*Callosciurus erythraeus*	LC			√			
14	RODENTIA	Muridae	Hoary bamboo rat	*Rhizomys pruinosus*	LC						√
15	RODENTIA	Hystricidae	Malayan porcupine	*Hystrix brachyura*	LC			√			
16	RODENTIA	Hystricidae	Asiatic brush-tailed porcupine	*Atherurus macrourus*	LC						√

IUCN Red List Data: EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern, DD = Data Deficient; CITES Appendices I, II, III; Myanmar Status: P = Protected, SP = Seasonally Protected

Appendix 4.1.7. Mammal species recorded in Khaunglanhpu area

Sr. no .	Order	Family	Commo n Name	Scientific Name	IUCN Red list	CITES	Myanmar status	Visual & Vocal	Track & Sign	wildlife remains	Information
1	CHIROPTERA	Pteropodidae	Blanford's fruit bat	*Sphaerias blanfordi*	LC			√			
2	CHIROPTERA	Hipposideridae	Stoliczka's Asian trident bat	*Aselliscus stoliczkanus*	LC			√			
3	PRIMATES	Lorisidae	Bengal slow loris	*Nycticebus bengalensis*	VU	I					√
4	PRIMATES	Cercopithecidae	Assam macaque	*Macaca assamensis*	NT	II		√		√	√
5	PRIMATES	Cercopithecidae	Stump-tailed macaque	*Macaca arctoides*	VU	II				√	√
6	CARNIVORA	Canidae	Dhole	*Cuon alpinus*	EN	II				√	
7	CARNIVORA	Ursidae	Asiatic black bear	*Ursus thibetanus*	VU	I				√	√
8	CARNIVORA	Mustelidae	Yellow-throated marten	*Martes flavigula*	LC	III				√	
9	CARNIVORA	Felidae	Leopard cat	*Prionailurus bengalensis*	LC	II				√	
10	ARTIODACTYLA	Suidae	Eurasian wild pig	*Sus scrofa*	LC				√	√	√
11	ARTIODACTYLA	Cervidae	Leaf muntjac	*Muntiacus putaoensis*	DD					√	
12	ARTIODACTYLA	Cervidae	Southern red muntjac	*Muntiacus muntjak*	LC		SP			√	√
13	ARTIODACTYLA	Cervidae	Fea's muntjac (?)	*Muntiacus feae* (?)	DD		SP			√	
14	ARTIODACTYLA	Bovidae	Takin	*Budorcas taxicolor*	VU	II				√	
15	ARTIODACTYLA	Bovidae	Southwest China (Chenese) serow	*Capricornis milneedwards ii*	NT	I				√	
16	ARTIODACTYLA	Bovidae	Red serow	*Capricornis rubidus*	NT	I				√	
17	RODENTIA	Muridae	Hoary bamboo rat	*Rhizomys pruinosus*	LC					√	
18	RODENTIA	Hystricidae	Malayan porcupine	*Hystrix brachyura*	LC						√

19	RODENTIA	Hystricidae	Asiatic brush-tailed porcupine	*Atherurus macrourus*	LC					√	√

Appendix 4.1.7 a. Mammal species (unable to identify specific species) recorded in Khaunglanhpu area

1	INSECTIVORA	Soricidae	Shrew sp(p).	?	_					√	
2	ARTIODACTYLA	Cervidae	Muntjac sp(p).	?	?				√		

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Appendix 4.1.8. Mammal species recorded in Yenam area

Sr. no.	Order	Family	Common Name	Scientific Name	IUCN Red list	CITES	Myanmar status	Visual & Vocal	Track & Sign	Wildlife remains	Information
1	PHOLIDOTA	Manidae	Chinese pangolin	*Manis pentadactyla*	EN	II					√
2	INSECTIVORA	Talpidae	Eastern mole	*Talpa micrura*	_				√	√	√
3	CHIROPTERA	Pteropodidae	Greater shortnosed fruit bat	*Cynopterus sphinx*	LC			√		√	
4	CHIROPTERA	Pteropodidae	Blanford's fruit bat	*Sphaerias blanfordi*	LC			√			
5	CHIROPTERA	Rhinolophidae	Great woolly horseshoe bat	*Rhinolophus luctus*	LC			√			
6	PRIMATES	Cercopithecidae	Assam macaque	*Macaca assamensis*	NT	II				√	√
7	PRIMATES	Cercopithecidae	Stump-tailed macaque	*Macaca arctoides*	VU	II				√	√
8	PRIMATES	Cercopithecidae	Rhesus macaque	*Macaca mulatta*	LC	II		√		√	√
9	PRIMATES	Hylobatidae	Eastern hoolock gibbon	*Hoolock leuconedys*	VU	I					√
10	CARNIVORA	Canidae	Dhole	*Cuon alpinus*	EN	II					√
11	CARNIVORA	Ursidae	Asiatic black bear	*Ursus thibetanus*	VU	I				√	√
12	CARNIVORA	Ursidae	Sun bear	*Helarctos malayanus*	VU	II				√	√
13	CARNIVORA	Ailuridae	Red panda	*Ailurus fulgens*	VU	I				√	√
14	CARNIVORA	Mustelidae	Stripe-backed weasel	*Mustela strigidorsa*	LC						√
15	CARNIVORA	Mustelidae	Yellow-throated marten	*Martes flavigula*	LC	III					√
16	CARNIVORA	Viverridae	Small Indian civet	*Viverricula indica*	LC	III					√
17	CARNIVORA	Viverridae	Spotted linsang	*Prionodon pardicolor*	LC						√
18	CARNIVORA	Viverridae	Masked palm civet	*Paguma larvata*	LC	III				√	√
19	CARNIVORA	Felidae	Leopard cat	*Prionailurus bengalensis*	LC	II					√
20	CARNIVORA	Felidae	Asian golden cat	*Pardofelis temminckii*	NT	II				√	√

21	CARNIVORA	Felidae	Marbled cat	*Pardofelis marmorata*	VU	II					√
22	CARNIVORA	Felidae	Clouded leopard	*Neofelis nebulosa*	VU	II				√	√
23	ARTIODACTYLA	Suidae	Eurasian wild pig	*Sus scrofa*	LC				√	√	√
24	ARTIODACTYLA	Cervidae	Fea's muntjac (?)	*Muntiacus feae* (?)	DD		SP	√		√	√
25	ARTIODACTYLA	Cervidae	Black muntjac (?)	*Muntiacus crinifrons* (?)	VU	I				√	√
26	ARTIODACTYLA	Cervidae	Takin	*Budorcas taxicolor*	VU	II				√	√
27	ARTIODACTYLA	Cervidae	Southwest China (Chenese) serow	*Capricornis milneedwardsii*	NT	I				√	
28	ARTIODACTYLA	Cervidae	Red goral	*Naemorhedus baileyi*	VU	I				√	√
29	RODENTIA	Muridae	Greater bandicoot rat	*Bandicota indica*	LC					√	
30	RODENTIA	Muridae	Hoary bamboo rat	*Rhizomys pruinosus*	LC			√		√	√
31	RODENTIA	Hystricidae	Malayan porcupine	*Hystrix brachyura*	LC					√	√
32	RODENTIA	Hystricidae	Asiatic brush-tailed porcupine	*Atherurus macrourus*	LC				√		√

Appendix 4.1.8 a. Mammal species (unable to identify specific species) recorded in Yenam area

1	PHOLIDOTA	Manidae	Pangolin sp(p).	*Manis* sp(p).	EN	II	√
2	PHOLIDOTA	Mustelidae	Otter sp(p).	?	?	I/II	√

Appendix 4.1.8 b. Mammal species recorded (information only) in Yenam area

1	SCANDENTIA	Tupaiidae	Northern tree shrew	*Tupaia belangeri*	LC	II	√
2	PRIMATES	Cercopithecidae	Northern pig-tailed macaque	*Macaca leonina*	VU	II	√
3	CARNIVORA	Canidae	Golden jackal	*Canis aureus*	LC	III	√
4	CARNIVORA	Mustelidae	Oriental small-clawed otter	*Aonyx cinerea*	VU	II	√
5	CARNIVORA	Mustelidae	Hog badger	*Arctonyx collaris*	NT		√
6	CARNIVORA	Viverridae	Large-spotted civet (?)	*Viverra megaspila* (?)	VU		√
7	CARNIVORA	Viverridae	Binturong	*Arctictis binturong*	VU	III	√
8	CARNIVORA	Felidae	Jungle cat	*Felis chaus*	LC	II	√

IUCN Red List Data: EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern, DD = Data Deficient; CITES Appendices I, II, III; Myanmar Status: P = Protected, SP = Seasonally Protected

Appendix 4.1.9 Mammal species more recorded in all surveyed areas by Chinese researchers

Sr. no.	Order	Family	Common Name	Scientific Name	IUCN Red list, 2009	CITES, 2008	Type of evidence			DISTRIBUTION & AMOUNT LEVEL ***						
							Entity	Sign	Info.	I	II	III	IV	V	VI	VII
1	ARTIODACTYLA	Cervidae	Red Muntjac	*Muntiacus vaginalis*	LC		√	√	√	+++	+++	+++	+++	+++	+++	+++
2	ARTIODACTYLA	Bovidae	Blue Sheep	*Pseudois nayaur*	LC		√		√							+
3	RODENTIA	Sciuridae	Red-cheeked Squirrel	*Dremomys rufigenis*	LC		√								++	
4	RODENTIA	Pteromyidae	Indian Giant Flying Squirrel	*Petaurista philippensis*	LC		√	√				+++	+++			
5	RODENTIA	Pteromyidae	Small Orange-back Flying Squirrel	*Petaurista sybilla*			√					+	+			
6	RODENTIA	Muridae	Polynesian Rat	*Rattus exulans*	LC		√			+						

* Entity means that the whole body or some parts of the animal such as the skeleton, fur, hair, horn, antler, leg, foot and so on that we saw at the investigation area, especially in hunter's house. Sign indicates that the animal track, footprint, clawmark, feeding site and so on we found in the field. While Info. means that we just get the animal information from local people.

** Based on IUCN Red List 2009 and CITES 2008.

*** Distributions: I = Myitsone, II = Lasa, III = Chibwe, IV = Wusok, V = Pisa, VI = Khaunglanhpu, VII = Yenam

Amount Level, "-"= Less Recorded, "+"= Rare Species, "++"= Sustainable Population, "+++"= Very Common Species.

Appendix 4.2.1 Herpetofauna species recorded in all survey areas

No.	Family name	Common name	Scientific name	Observed frquency							IUCN, 2009	CITES, 2009	Type of evidence
				I	II	III	IV	V	VI	VII			
1	Bufonidae	Large ear toad	*Ingerophrynus (Bufo) macrotis*		1	1			1		LC		II,III,VI=alive-1 (wild)
2	Bufonidae	Common toad	*Duttaphrynus (Bufo) melanostictus*	9	1						LC		I=alive-9;II=alive-1 (wild)
3	Bufonidae	Dwarf toad	*Ingerophrynus (Bufo) parvus*	1							LC		I=alive-1 (wild)
4	Bufonidae	? Frog	*Bufo* sp.			1	1						III,IV=alive-1 (wild)
5	Hylidae	? Frog	*Hyla annectans*			8					LC		III=alive-8 (wild)
6	Megophryidae	Feas horned frog	*Brachytarsophrys feae*						1		LC		VI=alive-1 (wild)
7	Megophryidae	? Frog	*Leptobrachium* sp.			1							III=alive-1 (wild)
8	Megophryidae	? Frog	*Leptolalax* sp.	1									I=alive-1 (wild)
9	Megophryidae		*Megophry* sp.1			2							III=alive-2 (wild)
10	Megophryidae	? Frog	*Megophry* sp.2				5						IV=alive-5 (wild)
11	Megophryidae	? Frog	*Megophry* sp.3			2							III=alive-2 (wild)

12	Megophryidae	? Frog	*Megophry* sp.4			2						III=alive-2 (wild)
13	Megophryidae	? Frog	*Megophry* sp.5			2						III=alive-2 (wild)
14	Megophryidae	? Frog	*Megophry* sp.6			1						III=alive-1 (wild)
15	Microhylidae	Common bull frog	*Kaloula pulchra*	3							LC	I=alive-3 (wild)
16	Microhylidae	Ornated sand frog	*Microhyla ornata*	19							LC	I=alive-19 (wild)
17	Microhylidae	? Frog	*Microhyla* sp.	2								I=alive-2 (wild)
18	Ranidae	Nothern cascade frog	*Amolops kaulbacki*				1		1		DD	IV,VI=alive-1 (wild)
19	Ranidae	? Frog	*Amolops* sp.	2	2	1	2					I=alive-2;II=alive-2;III=alive1;IV=alive-2 (wild)
20	Ranidae	? Frog	*Occidozyga* sp.	4		1						I=alive-4;III=alive-1 (wild)
21	Ranidae	Paddy frog	*Fejervarya limnocharis*	44	42	4				3	LC	I=alive-44;II=alive-42;III=alive-4;VII=alive-3 (wild)
22	Ranidae	Khuls stream frog	*Limnonectes kuhlii*	2	1	2				2	LC	I=alive-2;II=alive-1;III=alive-2;VII=alive-2 (wild)
23	Ranidae	Broad headed frog	*Limnonectes laticeps*	1						1	LC	I,VII=alive-1 (wild)
24	Ranidae	Big-headed frog	*Limnonectes macrognathus*		1						DD	II=alive-1 (wild)
25	Ranidae	? Frog	*Limnonectes* sp.1			1						III=alive-1 (wild)
26	Ranidae	? Frog	*Limnonectes* sp.2				1					IV=alive-1 (wild)
27	Ranidae	? Frog	*Limnonectes* sp.3	3								I=alive-3 (wild)
28	Ranidae	Hill frog	*Clinotarsus (Rana) alticola*	1								I=alive-1 (wild)
29	Ranidae	? Frog	*Rana* sp.	2		4				1		I=alive-2;III=alive-4;VII=alive-1 (wild)
30	Ranidae	? Frog	*Rana* sp.	3		5				2		I=alive-2;III=alive-4;VII=alive-1 (wild)
31	Ranidae	? Frog	*Rana hexadactyla*			2						III=alive-2 (wild)
32	Ranidae	? Frog	*Rana laticeps*			2						III=alive-2 (wild)
33	Ranidae	Burmese rock frog	*Odrrana (Rana) livida*		1	2	1				DD	II,IV=alive-1;III=alive-2 (wild)
34	Ranidae	Dark-sided frog	*Hylarana (Rana) nigtovittata*	85	18						LC	I=alive-85;II=alive-18 (wild)
35	Rhacophoridae	? Frog	*Philautus* sp.1			1						III=alive-1 (wild)
36	Rhacophoridae	? Frog	*Philautus* sp.2			1						III=alive-1 (wild)
37	Rhacophoridae	? Frog	*Polypedates mutus*			2				1	LC	III=alive-2;VII=alive-1 (wild)
38	Rhacophoridae	Common tree frog	*Polypedates leucomystax*	2		2					LC	I=alive-2;III=alive-2 (wild)
39	Rhacophoridae	? Frog	*Polypedates* sp.				2					IV=alive-2 (wild)
40	Rhacophoridae	Feas tree frog	*Rhacophorus (Polypedates) feae*			1					LC	III=alive-1 (wild)
41	Rhacophoridae	Spotted flying frog	*Rhacophorus dennysii*							4		VII=alive-4 (wild)
42	Rhacophoridae	? Frog	*Rhacophorus* sp.1			1						III=alive-1 (wild)
43	Rhacophoridae	? Frog	*Rhacophorus* sp.2			3			5			III=alive-3 (wild)
44	Rhacophoridae	? Frog	*Rhacophorus* sp.3	22	9	8	6	3	20	3		I=alive-22;II=alive-9;III=alive,8;IV=alive-6,V=alive-3;VI=alive-20;VII=alive-3(wild)
45	Rhacophoridae	? Frog	*Rhacophorus maximus*			2					LC	III=alive-2 (wild)
46	Rhacophoridae	? Frog	*Theloderma asperum*			2					LC	III=alive-2 (wild)
47	Rhacophoridae	? Frog	*Theloderma* sp.	2					9	1		I=alive-2;VI=alive-9;VII=alive-1 (wild)
48	Ichthyophiidae	Hill caecilians	*Ichthyophis glutinosus*		1						LC	II=alive-1 (wild)

49	Agamidae	? Lizard	*Calotes jerdoni*			3	1		4			III=alive=3;IV=alive-1;VI=alive-4 (wild)
50	Agamidae	? Lizard	*Calotes kingdonwardi*						1			VI=alive-1 (wild)
51	Agamidae	Blue crested lizard	*Calotes mystaceus*	8								I=alive-8 (wild)
52	Agamidae	Garden fence lizard	*Calotes versicolor*	3								I=alive-3 (wild)
53	Agamidae	? Skink	*Calotes* sp.						1			VI=alive-1 (wild)
54	Agamidae	Banford's flying dragon	*Draco blanfordii*	1								I=alive-1 (wild)
55	Agamidae	Spotted gliding lizfard	*Draco maculatus*	1		1	1					I,III,IV=alive-1 (wild)
56	Agamidae	Earless hill lizard	*Ptyctolameus gularis*		1		4					II=alive-1;IV=alive-4 (wild)
57	Agamidae	Earless hill lizard	*Ptyctolameus* sp.						1			VI=alive-1 (wild)
58	Gekkonidae	Four-clawed gecko	*Gehyra multilata*	1	1							I,II=alive-1 (wild)
59	Gekkonidae	? Slender-toe gecko	*Cyrtodactylus* sp.			2						II=alive-2 (wild)
60	Gekkonidae	Brook's house gecko	*Hemidactylus bowringii*	1								I=alive-1 (wild)
61	Gekkonidae	House gecko	*Hemidactylus brookii*	1								I=alive-1 (wild)
62	Gekkonidae	Common house gecko	*Hemidactylus frenatus*	4	1							I=alive-4;II=alive-1 (wild)
63	Gekkonidae	Garnot's gecko	*Hemidactylus garnotii*	6	1							I=alive-6;II=alive-1 (wild)
64	Scincidae	Browing's supple skink	*Lygosoma bowringii*	3								I=alive-3 (wild)
65	Scincidae	? Skink	*Lygosoma* sp.	2								I=alive-2 (wild)
66	Scincidae	Long-tailed skink	*Mabuya longicaudata*		3							II=alive-3 (wild)
67	Scincidae	Common sun skink	*Mabuya multifasciata*	12						4		I=alive-12;VII=alive-4 (wild)
68	Scincidae	? Skink	*Mabuya* sp.				3	2				IV=alive-3;V=alive-2 (wild)
69	Scincidae	? Skink	*Scincella* sp.			1						III=alive-1 (wild)
70	Scincidae	? Skink	*Sphenomorphus indicus*	3	1		1	3	7	4		I,V=alive-3;II,IV=alive-1;VI=alive-7;VII=alive-4 (wild)
71	Scincidae	Spotted forest skink	*Sphenomorphus maculatus*	42	51	3			2	1		I=alive-42;II=alive-51;III=alive-3 (wild)
72	Varanidae	Water monitor	*Varanus salvator*	1	1						II	II=camera trap-1 (wild)
73	Varanidae	Harlequin monitor	*Varanus dumerilii*	1								I=alive-1 (wild)
74	Anguidae	Limbless lizard	*Ophisaurus gracilis*			1						III=alive-1 (wild)
75	Colubridae	Long-nosed whip snake	*Ahaetulla nasuta*		1							II=alive-1 (wild)
76	Colubridae	Green whip snake	*Ahaetulla prasina*			1	1	1				III,V=alive-1 (wild);IV=dead-1
77	Colubridae	Golden tree snake	*Chrysopelea ornata*	1								I=alive-1(wild)
78	Colubridae	Painted bronzeback	*Dendrelaphis pictus*	2	1	1				1		I=alive-2;II=dead-1;III,VII=alive-1 (wild)
79	Colubridae	Burmese bronzeback	*Dendrelaphis subocularis*	1	1							II=alive-1 (wild)
80	Colubridae	? Snake	*Dendrelaphis* sp.			2	1					III=alive-2,IV=alive-1 (wild)
81	Colubridae	Red mountain racer	*Elaphe porphyracea*							1		IV=dead-1;VII=alive-1 (wild)
82	Colubridae	Green tree racer	*Elaphe prasina*			1						III=alive-1 (wild)
83	Colubridae	? Snake	*Elaphe* sp.1				1					IV=alive-1 (wild)
84	Colubridae	? Snake	*Elaphe* sp.2							1		VII=alive-1 (wild)

85	Colubridae	? Snake	*Lycodon* sp.1	1									I=alive-1 (wild)
86	Colubridae	? Snake	*Lycodon* sp.2			1							III=alive-1 (wild)
87	Colubridae	? Snake	*Lycodon* sp.3			2							III=alive-2 (wild)
88	Colubridae	Indo-chinese rat snake	*Ptyas korros*	1									I=alive-1 (wild)
89	Colubridae	? Snake	*Sibynophis* sp.1				1	1					IV,V=alive-1 (wild)
90	Colubridae	? Snake	*Sibynophis* sp.2						1				VI=alive-1 (wild)
91	Colubridae	Inornate kukri snake	*Oligodon inonortus*	2									I=alive-2 (wild)
92	Colubridae	? Snake	*Oligodon* sp.				1						IV=alive-1 (wild)
93	Colubridae	Striped keelback	*Amphiesma stolata*						2				VI=alive-2 (wild)
94	Colubridae	? Snake	*Amphiesma* sp.				1						IV=alive-1 (wild)
95	Colubridae	Himalayana keelback	*Rhadophis himalayana*						1				VI=alive-1 (wild)
96	Colubridae	Green kieelback	*Rhadophis nigrocincta*		1								II=alive-1 (wild)
97	Colubridae	Red-necked keelback	*Rhadophis subminiata*	2	1	1	3						I=alive-2;II,III=alive-1;IV=alive-3 (wild)
98	Colubridae	? Keelback	*Sinonatrix percarinata*		1								II=alive-1 (wild)
99	Colubridae	? Snake	*Pareas* sp.			1							III=alive-1 (wild)
100	Colubridae	Chequered keelback	*Xenochrophis piscator*	6								III	I=alive-6 (wild)
101	Elapidae	Malayan krait	*Bungarus candidus*	1									I=alvie-1 (wild)
102	Elapidae	Monocellate cobra	*Naja kaouthia*			1						II	III=alive-1 (wild)
103	Elapidae	King cobra	*Ophiophagus hannah*	1				1				II	I,V=dead (captive)
104	Pythonidae	Burmese python	*Python molurus*	3	1						NT		I=skin-2;I=alive-1 (wild);II=skin-1
105	Typhlopidae	Common blind snake	*Ramphotyphlops braminus*	7	1								I=alive-7;II=alive-1 (wild)
106	Typhlopidae	Diard's blind snake	*Typhlops diardi*		1								II=alive-1 (wild)
107	Viperidae	Mountain pit-viper	*Ovophis monticola*							3			VII=alive-3 (wild)
108	Viperidae	White-lipped pitviper	*Trimeresurus albolabris*	2									I=alvie-2 (wild)
109	Xenopeltidae	Sunbeam snake	*Xenopeltis unicolor*	2	1								I=alive-2 (wild);II=dead-1 (captive)
110	Emydidae	Asian leaf turtle	*Cyclemys dentala*		1								II=shell-1 (captive)
111	Emydidae	Giant asian pond turtle	*Heosemys grandis*		3						VU	II	II=shell-3 (captive)
112	Emydidae	Keeled box turtle	*Pyxidea mouhotii*	2	3					1	EN		I,II=shell-2;II=alive-1
113	Emydidae	Malayan soft shell turtle	*Dogonia subplana*	2									I=alive-2 (captive) sold to middleman
114	Emydidae	Indian black turtle	*Melanochelys trijuga*	1	1						NT		I=shell-1;II-shell-1
115	Emydidae	Myanmar roofed turtle	*Kachuga trivittata*	1							EN	II	I=shell-1

Areas: I = Myisone, II = Lasa, III = Chibwe, IV = Wusok, V = Pisa, VI = Khaunglanhpu, VII = Yenam;
IUCN Red List Data: EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern, DD = Data Deficient;
CITES Appendices I, II, III;

Appendix 4.2.2 Herpetofauna species recorded in Myitsone area

No.	Family name	Common name	Scientific name	I freq.Obs.	I Obs. day	IUCN, 2009	CITES, 2009	Microhabitat
1	Bufonidae	Common toad	*Duttaphrynus (Bufo) melanostictus*	9	4	LC		mud
2	Bufonidae	Dwarf toad	*Ingerophrynus (Bufo) parvus*	1	1	LC		small pond
3	Megophryidae	? Frog	*Leptolalax* sp.	1	1			in small stream
4	Microhylidae	Common bull frog	*Kaloula pulchra*	3	1	LC		in mud
5	Microhylidae	Ornated sand frog	*Microhyla ornata*	19	7	LC		near small stream
6	Microhylidae	? Frog	*Microhyla* sp.	2	1			in shurb
7	Ranidae	? Frog	*Amolops* sp.	2	1			in small stream
8	Ranidae	? Frog	*Occidozyga* sp.	4	1			in small pond
9	Ranidae	Paddy frog	*Fejervarya limnocharis*	44	6	LC		near small stream
10	Ranidae	Khuls stream frog	*Limnonectes kuhlii*	2	2	LC		in gravel
11	Ranidae	Broad headed frog	*Limnonectes laticeps*	1	1	LC		in gravel
12	Ranidae	? Frog	*Limnonectes* sp.3	3	1			in small pond
13	Ranidae	Hill frog	*Clinotarsus (Rana) alticola*	1	1			in shurb
14	Ranidae	? Frog	*Rana* sp.	2	1			in shurb
15	Ranidae	Dark-sided frog	*Hylarana (Rana) nigtovittata*	85	10	LC		in small pond
16	Rhacophoridae	Common tree frog	*Polypedates leucomystax*	2	1	LC		on tree
17	Rhacophoridae	? Frog	*Rhacophorus* sp.3	22	4			in bamboo
18	Rhacophoridae	? Frog	*Theloderma* sp.	2	2			near small stream
19	Agamidae	Blue crested lizard	*Calotes mystaceus*	8	4			on tree
20	Agamidae	Garden fence lizard	*Calotes versicolor*	3	2			in shurb
21	Agamidae	Banford's flying dragon	*Draco blanfordii*	1	1			on tree
22	Agamidae	Spotted gliding lizfard	*Draco maculatus*	1	1			on tree
23	Gekkonidae	Four-clawed gecko	*Gehyra multilata*	1	1			on wall
24	Gekkonidae	Brook's house gecko	*Hemidactylus bowringii*	1	1			on wall
25	Gekkonidae	House gecko	*Hemidactylus brookii*	1	1			on tree
26	Gekkonidae	Common house gecko	*Hemidactylus frenatus*	4	2			on roof
27	Gekkonidae	Garnot's gecko	*Hemidactylus garnotii*	6	4			on roof
28	Scincidae	Browing's supple skink	*Lygosoma bowringii*	3	3			under log
29	Scincidae	? Skink	*Lygosoma* sp.	2	1			in soil
30	Scincidae	Common sun skink	*Mabuya multifasciata*	12	5			in shurb
31	Scincidae	? Skink	*Sphenomorphus indicus*	3	3			in gravel
32	Scincidae	Spotted forest skink	*Sphenomorphus maculatus*	42	9			in gravel
33	Varanidae	Water monitor	*Varanus salvator*	1	1		II	on hole
34	Varanidae	Harlequin monitor	*Varanus dumerilii*	1	1			on wood
35	Colubridae	Golden tree snake	*Chrysopelea ornata*	1	1			on tree
36	Colubridae	Painted bronzeback	*Dendrelaphis pictus*	2	2			on tree
37	Colubridae	? Snake	*Lycodon* sp.1	1	1			on road
38	Colubridae	Indo-chinese rat snake	*Ptyas korros*	1	1			in shurb

39	Colubridae	Inornate kukri snake	*Oligodon inonortus*	2	2			in shurb
40	Colubridae	Red-necked keelback	*Rhadophis subminiata*	2	2			on road
41	Colubridae	Chequered keelback	*Xenochrophis piscator*	6	6		III	in bush
42	Elapidae	Malayan krait	*Bungarus candidus*	1	1			in shurb
43	Elapidae	King cobra	*Ophiophagus hannah*	1	1		II	under log
44	Pythonidae	Burmese python	*Python molurus*	3	2	NT		in hole
45	Typhlopidae	Common blind snake	*Ramphotyphlops braminus*	7	6			under log
46	Viperidae	White-lipped pitviper	*Trimeresurus albolabris*	2	2			near small pond
47	Xenopeltidae	Sunbeam snake	*Xenopeltis unicolor*	2	2			on road
48	Emydidae	Keeled box turtle	*Pyxidea mouhotii*	2	2	EN		near small stream
49	Emydidae	Malayan soft shell turtle	*Dogonia subplana*	2	2			in small stream
50	Emydidae	Indian black turtle	*Melanochelys trijuga*	1	1	NT		in small stream
51	Emydidae	Myanmar roofed turtle	*Kachuga trivittata*	1	1	EN	II	near small stream

Area: I = Myisone;
IUCN Red List Data: EN = Endangered, NT = Near Threatened, LC = Least Concern;
CITES Appendices II;

Appendix 4.2.3 Herpetofauna data recorded in Lasa area, 16 January to 25 May 2009

No.	Family name	Common name	Scientific name	II		IUCN, 2009	CITES, 2009	Micohabitat
				Obs. freq.	Obs. day			
1	Bufonidae	Large ear toad	*Ingerophrynus (Bufo) macrotis*	1	1	LC		in small stream
2	Ranidae	? Frog	*Amolops* sp.	2	2			in small stream
3	Ranidae	Paddy frog	*Fejervarya limnocharis*	42	8	LC		in small pond
4	Ranidae	Khuls stream frog	*Limnonectes kuhlii*	1	1	LC		in small pond
5	Ranidae	Big-headed frog	*Limnonectes macrognathus*	1	1	DD		in small pond
6	Ranidae	Burmese rock frog	*Odrrana (Rana) livida*	1	1	DD		in stream
7	Ranidae	Dark-sided frog	*Hylarana (Rana) nigtovittata*	18	3	LC		in shurb
8	Rhacophoridae	? Frog	*Rhacophorus* sp.3	9	4			in shurb
9	Ichthyophiidae	Hill caecilians	*Ichthyophis glutinosus*	1	1	LC		under log
10	Agamidae	Earless hill lizard	*Ptyctolameus gularis*	1	1			on tree
11	Gekkonidae	Four-clawed gecko	*Gehyra multilata*	1	1			on wall
12	Gekkonidae	Common house gecko	*Hemidactylus frenatus*	1	1			on roof
13	Gekkonidae	Garnot's gecko	*Hemidactylus garnotii*	1	1			on wall
14	Scincidae	Long-tailed skink	*Mabuya longicaudata*	3	3			on tree
15	Scincidae	? Skink	*Sphenomorphus indicus*	1	1			in shurb
16	Scincidae	Spotted forest skink	*Sphenomorphus maculatus*	51	8			in shurb
17	Varanidae	Water monitor	*Varanus salvator*	1	1		II	on wall
18	Colubridae	Long-nosed whip snake	*Ahaetulla nasuta*	1	1			on tree
19	Colubridae	Painted bronzeback	*Dendrelaphis pictus*	1	1			in shurb
20	Colubridae	Burmese bronzeback	*Dendrelaphis subocularis*	1	1			in shurb
21	Colubridae	Green kieelback	*Rhadophis nigrocincta*	1	1			in hole
22	Colubridae	Red-necked keelback	*Rhadophis subminiata*	1	1			on tree

23	Colubridae	? Keelback	*Sinonatrix percarinata*	1	1			in shurb
24	Pythonidae	Burmese python	*Python molurus*	1	1	NT		in shurb
25	Typhlopidae	Common blind snake	*Ramphotyphlops braminus*	1	1			under log
26	Typhlopidae	Diard's blind snake	*Typhlops diardi*	1	1			under log
27	Xenopeltidae	Sunbeam snake	*Xenopeltis unicolor*	1	1			in shurb
28	Emydidae	Asian leaf turtle	*Cyclemys dentala*	1	1			near stream
29	Emydidae	Giant asian pond turtle	*Heosemys grandis*	3	3	VU	II	near stream
30	Emydidae	Keeled box turtle	*Pyxidea mouhotii*	3	3	EN		near stream
31	Emydidae	Indian black turtle	*Melanochelys trijuga*	1	1	NT		near stream

Area: II = Lasa;
IUCN Red List Data: EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern, DD = Data Deficient;
CITES Appendices II;

Appendix 4.2.4 Herpetofauna data recorded in Chibwe area

No.	Family name	Common name	Scientific name	Observed frequency	Observed day	2009IUCN Red List Data,	CITES, 2009	Microhabitat
1	Bufonidae	Large ear toad	*Ingerophrynus (Bufo) macrotis*	1	1	LC		in mud
2	Bufonidae	? Frog	*Bufo* sp.	1	1			in mud
3	Hylidae	? Frog	*Hyla annectans*	8	2	LC		in small stream
4	Megophryidae	? Frog	*Leptobrachium* sp.	1	1			in shurb
5	Megophryidae		*Megophry* sp.1	2	1			on bank
6	Megophryidae	? Frog	*Megophry* sp.3	2	1			on bank
7	Megophryidae	? Frog	*Megophry* sp.4	2	1			near stream
8	Megophryidae	? Frog	*Megophry* sp.5	2	1			in shurb
9	Megophryidae	? Frog	*Megophry* sp.6	1	1			in shurb
10	Ranidae	? Frog	*Amolops* sp.	1	1			near stream
11	Ranidae	? Frog	*Occidozyga* sp.	1	1			in gravel
12	Ranidae	Paddy frog	*Fejervarya limnocharis*	4	2	LC		in small pond
13	Ranidae	Khuls stream frog	*Limnonectes kuhlii*	2	1	LC		in small stream
14	Ranidae	? Frog	*Limnonectes* sp.1	1	1			in small stream
15	Ranidae	? Frog	*Rana* sp.	4	2			in shurb
16	Ranidae	? Frog	*Rana khulii*	2	1			on bank
17	Ranidae	? Frog	*Rana hexadactyla*	2	1			in small pond
18	Ranidae	? Frog	*Rana laticeps*	2	1			in mud
19	Ranidae	Burmese rock frog	*Odrrana (Rana) livida*	2	1	DD		near stream
20	Rhacophoridae	? Frog	*Philautus* sp.1	1	1			in stream
21	Rhacophoridae	? Frog	*Philautus* sp.2	1	1			in gravel
22	Rhacophoridae	? Frog	*Polypedates mutus*	2	1	LC		in small stream
23	Rhacophoridae	Common tree frog	*Polypedates leucomystax*	2	1	LC		in small stream
24	Rhacophoridae	Feas tree frog	*Rhacophorus (Polypedates) feae*	1	1	LC		in bamboo
25	Rhacophoridae	? Frog	*Rhacophorus* sp.1	1	1			in bamboo
26	Rhacophoridae	? Frog	*Rhacophorus* sp.2	3	2			on tree
27	Rhacophoridae	? Frog	*Rhacophorus* sp.3	8	8			in shurb
28	Rhacophoridae	? Frog	*Rhacophorus maximus*	2	1	LC		in small stream
29	Rhacophoridae	? Frog	*Theloderma asperum*	2	1	LC		near stream
30	Agamidae	? Lizard	*Calotes jerdoni*	3	1			on tree
31	Agamidae	Spotted gliding lizfard	*Draco maculatus*	1	1			on tree

32	Gekkonidae	? Slender-toe gecko	*Cyrtodactylus* sp.	2	1			in hole
33	Scincidae	? Skink	*Scincella* sp.	1	1			in shurb
34	Scincidae	Spotted forest skink	*Sphenomorphus maculatus*	3	1			in shurb
35	Anguidae	Limbless lizard	*Ophisaurus gracilis*	1	1			in shurb
36	Colubridae	Green whip snake	*Ahaetulla prasina*	1	1			on tree
37	Colubridae	Painted bronzeback	*Dendrelaphis pictus*	1	1			on tree
38	Colubridae	? Snake	*Dendrelaphis* sp.	2	1			in shurb
39	Colubridae	Green tree racer	*Elaphe prasina*	1	1			on road
40	Colubridae	? Snake	*Lycodon* sp.2	1	1			in shurb
41	Colubridae	? Snake	*Lycodon* sp.3	2	1			in shurb
42	Colubridae	Red-necked keelback	*Rhadophis subminiata*	1	1			in shurb
43	Colubridae	? Snake	*Pareas* sp.	1	1			on road
44	Elapidae	Monocellate cobra	*Naja kaouthia*	1	1		II	on tree

IUCN Red List Data: LC = Least Concern, DD = Data Deficient; CITES Appendices II

Appendix 4.2.5 Herpetofauna data recorded in Wusok area

No.	Family name	Common name	Scientific name	IV		IUCN, 2009	2009CITES,	Microhabitat
				freq.Obs.	Obs. day			
1	Bufonidae	? Frog	*Bufo* sp.	1	1			on road
2	Megophryidae	? Frog	*Megophry* sp.2	5	1			in small stream
3	Ranidae	Nothern cascade frog	*Amolops kaulbacki*	1	1	DD		near stream
4	Ranidae	? Frog	*Amolops* sp.	2	1			in pond
5	Ranidae	? Frog	*Limnonectes* sp.2	1	1			in gravel
6	Ranidae	Burmese rock frog	*Odrrana (Rana) livida*	1	1	DD		on bank
7	Rhacophoridae	? Frog	*Polypedates* sp.	2	1			in small stream
8	Rhacophoridae	? Frog	*Rhacophorus* sp.3	6	2			on bamboo
9	Agamidae	? Lizard	*Calotes jerdoni*	1	1			on tree
10	Agamidae	Spotted gliding lizfard	*Draco maculatus*	1	1			on tree
11	Agamidae	Earless hill lizard	*Ptyctolameus gularis*	4	1			on tree
12	Scincidae	? Skink	*Mabuya* sp.	3	1			in shurb
13	Scincidae	? Skink	*Sphenomorphus indicus*	1	1			in shurb
14	Colubridae	Green whip snake	*Ahaetulla prasina*	1	1			on tree
15	Colubridae	? Snake	*Dendrelaphis* sp.	1	1			on tree
16	Colubridae	? Snake	*Elaphe* sp.1	1	1			on road
17	Colubridae	? Snake	*Sibynophis* sp.1	1	1			in shurb
18	Colubridae	? Snake	*Oligodon* sp.	1	1			in shurb
19	Colubridae	? Snake	*Amphiesma* sp.	1	1			under log
20	Colubridae	Red-necked keelback	*Rhadophis subminiata*	3	1			in shurb

IUCN Red List Data: DD = Data Deficient;

Appendix. 4.2.6 Herpetofauna data recorded in Pisa area

No.	Family name	Common name	Scientific name	V Obs. freq.	V Obs. day	IUCN, 2009	CITES, 2009	Microhabitat
1	Rhacophoridae	? Frog	*Rhacophorus* sp.3	3	1			in shurb
2	Scincidae	? Skink	*Mabuya* sp.	2	1			in shurb
3	Scincidae	? Skink	*Sphenomorphus indicus*	3	1			in shurb
4	Colubridae	Green whip snake	*Ahaetulla prasina*	1	1			on tree
5	Colubridae	? Snake	*Sibynophis* sp.1	1	1			on road
6	Elapidae	King cobra	*Ophiophagus hannah*	1	1		II	in hole

CITES Appendices II

Appendix 4.2.7 Herpetofauna data recorded in Khaunglanhpu area

No.	Family name	Common name	Scientific name	VI Obs. freq.	VI Obs. day	IUCN, 2009	CITES, 2009	Microhabita
1	Bufonidae	Large ear toad	*Ingerophrynus (Bufo) macrotis*	1	1	LC		near stream
2	Megophryidae	Feas horned frog	*Brachytarsophrys feae*	1	1	LC		under gravel
3	Ranidae	Nothern cascade frog	*Amolops kaulbacki*	1	1	DD		near stream
4	Rhacophoridae	? Frog	*Rhacophorus* sp.2	5	1			in bamboo
5	Rhacophoridae	? Frog	*Rhacophorus* sp.3	20	2			on tree
6	Rhacophoridae	? Frog	*Theloderma* sp.	9	2			in bamboo
7	Agamidae	? Lizard	*Calotes jerdoni*	4	3			on tree
8	Agamidae	? Lizard	*Calotes kingdonwardi*	1	1			on tree
9	Agamidae	? Skink	*Calotes* sp.	1	1			in shurb
10	Agamidae	Earless hill lizard	*Ptyctolameus* sp.	1	1			in shurb
11	Scincidae	? Skink	*Sphenomorphus indicus*	7	3			in field
12	Scincidae	Spotted forest skink	*Sphenomorphus maculatus*	2	2			in shurb
13	Colubridae	? Snake	*Sibynophis* sp.2	1	1			near stream
14	Colubridae	Striped keelback	*Amphiesma stolata*	2	2			in shurb
15	Colubridae	Himalayana keelback	*Rhadophis himalayana*	1	1			under leaf

IUCN Red List Data: LC = Least Concern, DD = Data Deficient

Appendix 4.2.8 Herpetofauna data recorded in Yenam area

No.	Family name	Common name	Scientific name	VII		IUCN, 2009	CITES, 2009	Microhabitat
				Obs. freq.	Obs. day			
1	Ranidae	Paddy frog	*Fejervarya limnocharis*	3	1	LC		in small stream
2	Ranidae	Khuls stream frog	*Limnonectes kuhlii*	2	1	LC		in small stream
3	Ranidae	Broad headed frog	*Limnonectes laticeps*	1	1	LC		in small stream
4	Ranidae	? Frog	*Rana* sp.	1	1			in shurb
5	Rhacophoridae	? Frog	*Polypedates mutus*	1	1	LC		in bamboo
6	Rhacophoridae	Spotted flying frog	*Rhacophorus dennysii*	4	1			in shurb
7	Rhacophoridae	? Frog	*Rhacophorus* sp.3	3	2			in shurb
8	Rhacophoridae	? Frog	*Theloderma* sp.	1	1			in small stream
9	Scincidae	Common sun skink	*Mabuya multifasciata*	4	3			in shurb
10	Scincidae	? Skink	*Sphenomorphus indicus*	4	4			in shurb
11	Scincidae	Spotted forest skink	*Sphenomorphus maculatus*	1	1			in shurb
12	Colubridae	Painted bronzeback	*Dendrelaphis pictus*	1	1			in shurb
13	Colubridae	Red mountain racer	*Elaphe porphyracea*	1	1			on tree
14	Colubridae	? Snake	*Elaphe* sp.2	1	1			on road
15	Viperidae	Mountain pit-viper	*Ovophis monticola*	3	3			in shurb
16	Emydidae	Keeled box turtle	*Pyxidea mouhotii*	1	1	EN		near stream

IUCN Red List Data: EN = Endangered,,LC = Least Concern

Table 4.2.9 Herpetofauna species recorded more by Chinese researchers

No.	Family name	Common name	Scientific name	Study area							2009IUCN,	2009CITES,	Remark
				I	II	III	IV	V	VI	VII			
1	Megophryidae		*Leptobrachium sp.*1			√							
2	Microhylidae	Arcuate-spotted pygmy frog	*Microhyla heymonsi*	√							LC		interview
3	Microhylidae	Beautiful pygmy frog	*Microhyla pulchra*	√							LC		
4	Ranidae	Marbled sucker frog	*Amolops marmoratus*	√	√	√	√			√	LC		
5	Ranidae		*Occidozyga sp.*2	√			√						
6	Ranidae		*Odorrana rotodora*	√	√				√	√	DD		
7	Ranidae		*Odorrana sp.*1							√			
8	Ranidae		*Odorrana sp.* 2			√	√						
9	Ranidae		*Odorrana sp.* 3	√					√				
10	Ranidae	Yunnan spiny frog	*Paa yunnanensis*	√	√						EN		
11	Ranidae	Yunnan pond frog	*Pelophylax pleuraden*	√							LC		
12	Rhacophoridae	Htun win's flying frog	*Rhacophorus htunwini*			√					LC		
13	Rhacophoridae		*Rhacophorus sp.*4		√								
14	Rhacophoridae	Gongshan flying-frog	*Polypedates gongshanensis*						√		NT		
15	Rhacophoridae	Xizhang warty treefrog	*Theloderma moloch*						√		VU		
16	Rhacophoridae		*Theloderma* sp. 2						√				
17	Rhacophoridae	Serrated-legged bush-frog				√	√		√		LC		
18	Gekkonidae	Large wall gecko	*Gekko gecko*	√	√								
19	Scincidae		*Ateuchosaurus sp.*1	√									
20	Colubridae	White chain snake	*Dinodon septentrionalis*			√							
21	Colubridae	Jadespot beauty snake	*Elaphe mandarina*							√			
22	Colubridae	Smooth-scaled snake	*Liopeltis frenatus*	√	√	√					DD		
23	Colubridae		*Plagiopholis sp.*1	√									
24	Colubridae	Taiwan leopard snake	*Psammodynastes pulverulentus*				√						
25	Colubridae	Burma neck-troughed snake	*Rhabdophis leonardi*							√			
26	Colubridae		*Rhabdops sp.*1	√									
27	Colubridae	Black head snake	*Sibynophis chinensis*					√	√				
28	Colubridae	Cycle striped China traveler	*Sinonatrix aequifasciata*	√	√				√				
29	Colubridae	Black lined big eye snake	*Zaocys nigromarginatus*						√	√			
30	Elapidae	Banded	*Bungarus*	√									interview

		krait	*fasciatus*		
31	Elapidae	Umbrella snake	*Bungarus multicinctus*	√	interview

I = Myitsone Area, II = Lasa Area, III = Chibwe Area, IV = Wusok Area, V = Pisa Area, VI = Khaunglanhpu Area, VII = Yenam Area; IUCN Red List Data: EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern, DD = Data Deficient

Appendix 4.3.1. Butterfly species recorded in all surveyed areas

Sr. no.	Family	Species name	I	II	III	IV	V	VI	VII	Status (Kenyon, 2004)
			frequencyIndividual	frequencyIndividual	frequencyIndividual	frequencyIndividual	frequencyIndividual	frequencyIndividual	frequencyIndividual	
1	PAPILIONIDAE	*Troides aeacus*	1		3		1			LC
2	PAPILIONIDAE	*Troides* sp.		2	7	2				
3	PAPILIONIDAE	*Atrophaneura polla*			2	1	2			UC
4	PAPILIONIDAE	*Atrophaneura polyeuctes*			6	9				C
5	PAPILIONIDAE	*Atrophaneura dasarada*				10			1	UC
6	PAPILIONIDAE	*Atrophaneura aidoneus*				1				R
7	PAPILIONIDAE	*Atrophaneura varuna*			10					UC
8	PAPILIONIDAE	*Atrophaneura* sp.	2							
9	PAPILIONIDAE	*Papilio bianor*			1					R
10	PAPILIONIDAE	*Papilio paris*	1	3	11	10			1	C
11	PAPILIONIDAE	*Papilio demoleus*	8		1					C
12	PAPILIONIDAE	*Papilio nephelus*	8	1	2	5				R
13	PAPILIONIDAE	*Papilio helenus*	5	9	7	16	1	1		C
14	PAPILIONIDAE	*Papilio polytes*	11		1					VC
15	PAPILIONIDAE	*Papilio memnon*	9	2	1			2		VC
16	PAPILIONIDAE	*Papilio protenor*	1		1	5		3		UC
17	PAPILIONIDAE	*Papilio alcmenor*				9	1	1		UC
18	PAPILIONIDAE	*Papilio* spp.	2	2					2	
19	PAPILIONIDAE	*Chilasa agestor*	3			5				UC
20	PAPILIONIDAE	*Chilasa epycides*				15	10			UC
21	PAPILIONIDAE	*Chilasa paradoxa*	10	1	1					UC
22	PAPILIONIDAE	*Graphium cloanthus*				5				UC
23	PAPILIONIDAE	*Graphium sarpedon*	8	8	11	3	1	1	5	C
24	PAPILIONIDAE	*Graphium doson*	1							UC
25	PAPILIONIDAE	*Graphium euryplus*	17							C
26	PAPILIONIDAE	*Graphium bathycles*	1	2	1					UC
27	PAPILIONIDAE	*Graphium agamemnon*	2							C
28	PAPILIONIDAE	*Paranticopsis xenocles*	2							UC

29	PAPILIONIDAE	*Paranticopsis*sp.		3						
30	PAPILIONIDAE	*Graphium glycerion*				20				UC
31	PAPILIONIDAE	*Graphium agetes*			4	7				UC
32	PAPILIONIDAE	*Graphium antiphates*	5	5	6					UC
33	PAPILIONIDAE	*Graphium* spp.		13						
34	PAPILIONIDAE	*Lamproptera curius*	10		1	1				UC
35	PAPILIONIDAE	*Lamproptera meges*			1		2			UC
36	PAPILIONIDAE	*Lamproptera* sp.	1	5			1			
37	PIERIDAE	*Delias berinda*			1	3				UC
38	PIERIDAE	*Delias belladonna*			1	8				UC
39	PIERIDAE	*Delias acalis*	1							UC
40	PIERIDAE	*Delias descombesi*	1							C
41	PIERIDAE	*Delias hyparete*	9							C
42	PIERIDAE	*Prioneris thestylis*	5	2	4					UC
43	PIERIDAE	*Artogeia napi*	12		1			1		UC
44	PIERIDAE	*Pieris canidia*	51	20	40	30	5	20	51	C
45	PIERIDAE	*Cepora nerissa*			1					
46	PIERIDAE	*Cepora nadina*		3	9					C
47	PIERIDAE	*Appias libythea*	1							C
48	PIERIDAE	*Appias lyncida*	48	3	14					C
49	PIERIDAE	*Appias albina*	5							C
50	PIERIDAE	*Appias nero*			3					C
51	PIERIDAE	*Appias lalage*	15		16	20	20	3		UC
52	PIERIDAE	*Appias indra*			11					UC
53	PIERIDAE	*Appias*sp. 1	15							
54	PIERIDAE	*Appias*sp. 2	10							
55	PIERIDAE	*Ixias pyrene*	7		14					C
56	PIERIDAE	*Dercas verhuelli*	11	7	8				1	C
57	PIERIDAE	*Dercas lycorias*						1		UC
58	PIERIDAE	*Hebomoia glaucippe*	7		3					C
59	PIERIDAE	*Catopsilia pyranthe*	10	5						C
60	PIERIDAE	*Catopsilia pomona*	11				1	1		C
61	PIERIDAE	*Gandaca harina*	9		6	3				C
62	PIERIDAE	*Colias fieldi*						1	2	UC
63	PIERIDAE	*Eurema hecabe*	2		1					C
64	PIERIDAE	*Eurema andersoni*	20	23	3	4			5	C
65	PIERIDAE	*Eurema blanda*	18		2					C
66	PIERIDAE	*Eurema simulatrix*	45	7	11	7		1		C
67	PIERIDAE	*Eurema* sp. 1							2	
68	PIERIDAE	*Eurema* sp. 2	17	18	1			2		

69	DANAIDAE	*Danaus chrysippus*	11							C
70	DANAIDAE	*Danaus genutia*	13	75	26					C
71	DANAIDAE	*Danaus septentrionis*	3		3					C
72	DANAIDAE	*Danaus* sp. 1	2	20						
73	DANAIDAE	*Danaus* sp. 2		1						
74	DANAIDAE	*Parantica aglea*	14	15	15					C
75	DANAIDAE	*Parantica melaneus*	20		8					UC
76	DANAIDAE	*Parantica sita*	13		16	3	7	1		C
77	DANAIDAE	*Euploea sylvester*	3	15						R
78	DANAIDAE	*Euploea mulciber*	20	20	67	10	3	1		C
79	DANAIDAE	*Euploea leucostictos*	2							UC
80	DANAIDAE	*Euploea diocletianus*	12	11						R
81	DANAIDAE	*Euploea aglea*	1							C
82	DANAIDAE	*Euploea core*	1							C
83	SATYRIDAE	*Melanitis* sp. 1	5	3						
84	SATYRIDAE	*Melanitis* sp. 2	1		2	1				
85	SATYRIDAE	*Melanitis* sp. 3			3	3				
86	SATYRIDAE	*Lethe europa*	1							C
87	SATYRIDAE	*Lethe sinorix*				1		1	1	C
88	SATYRIDAE	*Lethe verma*	6		11	7	6		1	UC
89	SATYRIDAE	*Lethe confusa*	4	2	3			1		C
90	SATYRIDAE	*Lethe chandica*	2							UC
91	SATYRIDAE	*Lethe mekara*	4							UC
92	SATYRIDAE	*Lethe vindhya*			1	1	1	1		UC
93	SATYRIDAE	*Lethe bhairava*					1		3	UC
94	SATYRIDAE	*Lethe gulnihal*			1		2	5		UC
95	SATYRIDAE	*Lethe* sp. 1							1	
96	SATYRIDAE	*Lethe* sp. 2	1		1					
97	SATYRIDAE	*Neope bhadra*			2	25	1	1	1	UC
98	SATYRIDAE	*Neope pulaha*	2					2		C
99	SATYRIDAE	*Neope muirheadi*			1					UC
100	SATYRIDAE	*Neorina* sp.							3	UC
101	SATYRIDAE	*Orinoma damaris*		1						UC
102	SATYRIDAE	*Ethope himachala*	11	3	8					UC
103	SATYRIDAE	*Penthema lisarda*		3	2					UC
104	SATYRIDAE	*Orsotriaena medus*	9	25						C
105	SATYRIDAE	*Mycalesis* sp. 1	1							
106	SATYRIDAE	*Mycalesis* sp. 2	2		1					
107	SATYRIDAE	*Mycalesis* sp. 3	2							
108	SATYRIDAE	*Mycalesis* sp. 4			13					

109	SATYRIDAE	*Mycalesis* sp. 5	5							
110	SATYRIDAE	*Mycalesis* sp. 6	10	1	4	11				
111	SATYRIDAE	*Mycalesis* sp. 7	5	3						
112	SATYRIDAE	*Mycalesis* sp. 8	1							
113	SATYRIDAE	*Mycalesis* sp. 9	5							
114	SATYRIDAE	*Mycalesis* sp. 10			26	29	4	1		
115	SATYRIDAE	*Ypthima hubneri*	2							UC
116	SATYRIDAE	*Ypthima sakra*			4	1	1			C
117	SATYRIDAE	*Ypthima watsoni*	2							UC
118	SATYRIDAE	*Ypthima confusa*			2					
119	SATYRIDAE	*Ypthima* sp. 1				1				
120	SATYRIDAE	*Ypthima* sp. 2	3							
121	SATYRIDAE	*Ypthima* sp. 3	1							
122	SATYRIDAE	*Ypthima* sp. 4	6	5						
123	SATYRIDAE	*Ypthima* sp. 5			2	1				
124	SATYRIDAE	*Ypthima* sp. 6	10	1	13	19				
125	SATYRIDAE	*Callerebia narasingha*			27	3				
126	SATYRIDAE	*Zipaetis scyllax*			7	6	2			UC
127	SATYRIDAE	*Elymnias hypermnestra*	4							C
128	SATYRIDAE	*Elymnias malelas*	2		3					UC
129	NYMPHALIDAE	*Acrea issoria*			25					C
130	NYMPHALIDAE	*Ariadne ariadne*	5							C
131	NYMPHALIDAE	*Ariadne merione*	5		2					C
132	NYMPHALIDAE	*Ariadne* sp. 1	1							
133	NYMPHALIDAE	*Ariadne* sp. 2	6	3						
134	NYMPHALIDAE	*Pseudergolis wedah*		3	14	7		1	1	UC
135	NYMPHALIDAE	*Calinaga buddha*			1	14				UC
136	NYMPHALIDAE	*Cupha erymanthis*	23	26	9					C
137	NYMPHALIDAE	*Phalanta phalanta*	2	1						C
138	NYMPHALIDAE	*Phalanta alcippe*	11							C
139	NYMPHALIDAE	*Vagrans egista*	5							C
140	NYMPHALIDAE	*Vindula erota*	22		6					C
141	NYMPHALIDAE	*Cirrochroa tyche*	11	3	2					UC
142	NYMPHALIDAE	*Cirrochroa surya*	4							UC
143	NYMPHALIDAE	*Cirrochroa* sp.	6	1	1					
144	NYMPHALIDAE	*Cethosia biblis*	3		9					C
145	NYMPHALIDAE	*Cethosia cyane*		1	1				1	C
146	NYMPHALIDAE	*Childrena childreni*				1				UC
147	NYMPHALIDAE	*Argyreus hyperbius*	8	5	3			15	8	UC
148	NYMPHALIDAE	*Vanessa indica*	27	3	1	2		2	2	C

149	NYMPHALIDAE	*Vanessa cardui*						1		
150	NYMPHALIDAE	*Kaniska canace*	3		1	1		1		C
151	NYMPHALIDAE	*Junonia lemonias*	58		49					C
152	NYMPHALIDAE	*Junonia orithya*	5	1						C
153	NYMPHALIDAE	*Junonia hierta*	36	1	1					C
154	NYMPHALIDAE	*Junonia iphita*	28		51	8	1	1		C
155	NYMPHALIDAE	*Junonia almana*	21	1						C
156	NYMPHALIDAE	*Junonia atlites*	27	20	1					C
157	NYMPHALIDAE	*Symbrenthia lilaea*	12		10			10	3	UC
158	NYMPHALIDAE	*Symbrenthia hypselis*			3	1		1		UC
159	NYMPHALIDAE	*Hypolimnas bolina*	2		1					C
160	NYMPHALIDAE	*Hypolimnas* sp.	1							
161	NYMPHALIDAE	*Doleschallia bisaltide*	1		1					UC
162	NYMPHALIDAE	*Kallima inachus*	1	5	19	1		2		
163	NYMPHALIDAE	*Stibochiona nicea*			3	1		1		UC
164	NYMPHALIDAE	*Chersonesia risa*						1	1	C
165	NYMPHALIDAE	*Cherosonesia* sp.			2					
166	NYMPHALIDAE	*Cyrestis thyodamas*	3	20	9	13		1		C
167	NYMPHALIDAE	*Cyrestis cocles*	23		6					UC
168	NYMPHALIDAE	*Cyrestis* sp.	2							
169	NYMPHALIDAE	*Pantoporia* sp. 1	5							
170	NYMPHALIDAE	*Pantoporia* sp. 2		6						
171	NYMPHALIDAE	*Pantoporia* sp. 3		10						
172	NYMPHALIDAE	*Neptis harita*	2		3	1				C
173	NYMPHALIDAE	*Neptis miah*			5	30	1			
174	NYMPHALIDAE	*Neptis sappho*		10						UC
175	NYMPHALIDAE	*Neptis hylas*	27	25	6	5		2		C
176	NYMPHALIDAE	*Neptis clinia*	11				3			C
177	NYMPHALIDAE	*Neptis ananta*			2	6				UC
178	NYMPHALIDAE	*Neptis* sp. 1	15							
179	NYMPHALIDAE	*Neptis* sp. 2	5						9	
180	NYMPHALIDAE	*Neptis* sp. 3			12	26		1		
181	NYMPHALIDAE	*Neptis* sp. 4							1	
182	NYMPHALIDAE	*Athyma pravara*	21							UC
183	NYMPHALIDAE	*Athyma jina*				17				UC
184	NYMPHALIDAE	*Athyma perius*	1							C
185	NYMPHALIDAE	*Athyma asura*				14				C
186	NYMPHALIDAE	*Athyma selenophora*	10			1				C
187	NYMPHALIDAE	*Athyma zeroca*				3				UC
188	NYMPHALIDAE	*Athyma cama*			1					

189	NYMPHALIDAE	*Athyma nefte*	1							C
190	NYMPHALIDAE	*Athyma* sp. 1	10							
191	NYMPHALIDAE	*Athyma* sp. 2	10							
192	NYMPHALIDAE	*Sumalia daraxa*		3	2	11		2		UC
193	NYMPHALIDAE	*Parasarpa dudu*		1	1	11				C
194	NYMPHALIDAE	*Bhagadatta austenia*		1	6					UC
195	NYMPHALIDAE	*Auzakia danava*			5	8				UC
196	NYMPHALIDAE	*Moduza procris*	3		4					C
197	NYMPHALIDAE	*Lebadea martha*	5							UC
198	NYMPHALIDAE	*Parthenos sylvia*	5	15	20					UC
199	NYMPHALIDAE	*Neurosigma siva*			1					
200	NYMPHALIDAE	*Tanaecia julii*		3						UC
201	NYMPHALIDAE	*Tanaecia lepidea*	3							UC
202	NYMPHALIDAE	*Tanaecia* sp. 1		3						
203	NYMPHALIDAE	*Tanaecia* sp. 2			5					
204	NYMPHALIDAE	*Euthalia franciae*			1	2	1	1		UC
205	NYMPHALIDAE	*Euthalia monina*			1					UC
206	NYMPHALIDAE	*Euthalia* sp. 1			3					
207	NYMPHALIDAE	*Euthalia* sp. 2	13							
208	NYMPHALIDAE	*Euthalia* sp. 3	2		1					
209	NYMPHALIDAE	*Rohana parisatis*	1		14					UC
210	NYMPHALIDAE	*Rohana* sp.	1							
211	NYMPHALIDAE	*Apatura ambica*	6		9	5				UC
212	NYMPHALIDAE	*Apatura chevana*			1					UC
213	NYMPHALIDAE	*Sephisa chandra*	1							UC
214	NYMPHALIDAE	*Herona marathus*	3							UC
215	NYMPHALIDAE	*Hestina nama*		5	21	10		1	1	UC
216	NYMPHALIDAE	*Eurippus nyctelius*	4		1	3				UC
217	NYMPHALIDAE	*Polyura athamas*	2		23	10				C
218	NYMPHALIDAE	*Polyura eudamippus*			18	10				UC
219	NYMPHALIDAE	*Polyura dolon*			20					UC
220	NYMPHALIDAE	*Charaxes bernardus*	1	3	4					C
221	NYMPHALIDAE	*Charaxes* spp.				3				
222	AMATHUSIIDAE	*Thaumantis diores*	1		3					R
223	AMATHUSIIDAE	*Thauria aliris*		1	4					UC
224	AMATHUSIIDAE	*Discophora deo*			1	6				UC
225	AMATHUSIIDAE	*Discophora sondaica*	1							UC
226	AMATHUSIIDAE	*Enispe euthymius*	1		1	2				UC
227	AMATHUSIIDAE	*Enipse cycnus*					1			UC
228	LIBYTHEIDAE	*Libythea celtis*		8	2					UC

229	LIBYTHEIDAE	*Libythea myrrha*	18	5	18					UC
230	RIODINIDAE	*Zemeros flegyas*	38	20	29	3	10	5	27	C
231	RIODINIDAE	*Dodona dipoea*			3	7		3		C
232	RIODINIDAE	*Dodona ouida*			1	1		1	9	UC
233	RIODINIDAE	*Abisara fylla*		3	6	25	5	6	1	C
234	RIODINIDAE	*Abisara neophron*	1		1	1	2			UC
235	RIODINIDAE	*Abisara chela*			1		1	1		
236	RIODINIDAE	*Abisara* sp. 1	3							
237	RIODINIDAE	*Abisara* sp. 2	10							
238	LYCAENIDAE	*Miletus* sp.			2					
239	LYCAENIDAE	*Allotinus* sp.					1			
240	LYCAENIDAE	*Taraka hamada*	5		2					
241	LYCAENIDAE	*Curetis bulis*	2	1	1	7				
242	LYCAENIDAE	*Curetis* sp.		5						
243	LYCAENIDAE	*Arhopala pseudocentaurus*			1					
244	LYCAENIDAE	*Arhopala* sp.			1					
245	LYCAENIDAE	*Surendra quercetorum*	1							
246	LYCAENIDAE	*Zinaspa* ?			1					
247	LYCAENIDAE	*Catapaecilma major*			7	1				
248	LYCAENIDAE	*Yasoda tripunctata*	2		1					
249	LYCAENIDAE	*Loxura atymnus*	12		3					
250	LYCAENIDAE	*Ticherra acte*			1					
251	LYCAENIDAE	*Cheritra freja*	1							
252	LYCAENIDAE	*Spindasis lohita*			1					
253	LYCAENIDAE	*Spindasis syama*		3	1					
254	LYCAENIDAE	*Spindasis* sp.		1						
255	LYCAENIDAE	*Ancema ctesia*				1				
256	LYCAENIDAE	*Acytolepis puspa*	5			1				
257	LYCAENIDAE	*Celastrina albocaerulea*						1	1	
258	LYCAENIDAE	*Celastrina lavendularis*			1					
259	LYCAENIDAE	*Celastrina argiolus*	1		3				2	
260	LYCAENIDAE	*Celastrina marginata*				1	10	5		
261	LYCAENIDAE	*Celastrina* sp. 1	5							
262	LYCAENIDAE	*Celastrina* sp. 2			2	27	20			
263	LYCAENIDAE	*Callenya* ?			1					
264	LYCAENIDAE	*Udara dilecta*						1		
265	LYCAENIDAE	*Udara* sp.						1		
266	LYCAENIDAE	*Hypolycaena erylus*	23		1					
267	LYCAENIDAE	*Hypolycaena othona*			1					
268	LYCAENIDAE	*Hypolycaena kina*				1	3			

269	LYCAENIDAE	*Zeltus amasa*	9	1	11				
270	LYCAENIDAE	*Rapala pheretima*	2						
271	LYCAENIDAE	*Rapala nissa*			2			1	
272	LYCAENIDAE	*Rapala* sp. 1		1					
273	LYCAENIDAE	*Rapala* sp. 2			1				
274	LYCAENIDAE	*Heliophorus brahma*	5	3				2	
275	LYCAENIDAE	*Heliophorus epicles*	1	5					3
276	LYCAENIDAE	*Heliophorus ila*	4	10					1
277	LYCAENIDAE	*Heliophorus androcles*			1			6	
278	LYCAENIDAE	*Heliophorus* sp. 1	7		9	1	2	3	
279	LYCAENIDAE	*Heliophorus* sp. 2		1					
280	LYCAENIDAE	*Anthene emolus*	11		20				
281	LYCAENIDAE	*Anthene lycaenina*			30				
282	LYCAENIDAE	*Anthene* spp.	6	7					
283	LYCAENIDAE	*Niphanda asialis*	1		1				
284	LYCAENIDAE	*Orthomiella pontis*						3	
285	LYCAENIDAE	*Nacaduba* sp. 1	1		25				
286	LYCAENIDAE	*Nacaduba* sp. 2		1					
287	LYCAENIDAE	*Nacaduba* sp. 3	1		5	1	1		
288	LYCAENIDAE	*Ionolyce helicon*			8				
289	LYCAENIDAE	*Prosotas* spp.			378	2	1		
290	LYCAENIDAE	*Jamides bochus*			34	22		3	
291	LYCAENIDAE	*Jamides celeno*							2
292	LYCAENIDAE	*Jamides elpis*	1						
293	LYCAENIDAE	*Jamides alecto*			1				
294	LYCAENIDAE	*Jamides* sp. 1				1			
295	LYCAENIDAE	*Jamides* sp. 2	3		1				
296	LYCAENIDAE	*Lampides boeticus*			1	7		5	
297	LYCAENIDAE	*Catochrysops panormus*	1		2				
298	LYCAENIDAE	*Catochrysops strabo*			2			1	
299	LYCAENIDAE	*Catochrysops* sp.			1				
300	LYCAENIDAE	*Syntarucus plinius*			1			1	
301	LYCAENIDAE	*Castalius rosimon*	6						
302	LYCAENIDAE	*Caleta roxus*	5	15					
303	LYCAENIDAE	*Caleta elna*	1		21	14	1		
304	LYCAENIDAE	*Everes lacturnus*	3						
305	LYCAENIDAE	*Megisba malaya*	4			1			
306	LYCAENIDAE	*Euchrysops cnejus*			1				
307	LYCAENIDAE	*Chilades lajus*	2		1				
308	LYCAENIDAE	*Zizina otis*	1						

309	LYCAENIDAE	*Zizeeria karsandra*	4						
310	LYCAENIDAE	*Zizeeria maha*	7	5	87		1	20	
311	HESPERIIDAE	*Hasora vitta*			2				
312	HESPERIIDAE	*Hasora taminatus*			1				
313	HESPERIIDAE	*Hasora anura*						1	
314	HESPERIIDAE	*Hasora* spp.				6		4	
315	HESPERIIDAE	*Choaspes xanthopogon*						1	
316	HESPERIIDAE	*Celaenorrhinus leucocera*				1			
317	HESPERIIDAE	*Celaenorrhinus dhanada*			2	1			
318	HESPERIIDAE	*Celaenorrhinus putra*				1			
319	HESPERIIDAE	*Tapena thawaitesi*			5				
320	HESPERIIDAE	*Sarangesa dasahara*	1						
321	HESPERIIDAE	*Pseudocoladenia* sp.	1						
322	HESPERIIDAE	*Tagiades* sp.	1	1					
323	HESPERIIDAE	*Odontoptilum angulatum*	1						
324	HESPERIIDAE	*Ochus subvittatus*			5				
325	HESPERIIDAE	*Thoressa cerata*			1	1			
326	HESPERIIDAE	*Halpe* sp.		4	2				
327	HESPERIIDAE	*Pithauria stramineipennis*			52	3			
328	HESPERIIDAE	*Pithauria* sp.	2						
329	HESPERIIDAE	*Koruthaialos sindu*	1						
330	HESPERIIDAE	*Koruthaialos butleri*						2	
331	HESPERIIDAE	*Koruthaialos* spp.	1		7	6			
332	HESPERIIDAE	*Notocrypta curvifascia*		1	2	3		1	
333	HESPERIIDAE	*Notocrypta* sp.							1
334	HESPERIIDAE	*Suastus* sp.		1					
335	HESPERIIDAE	*Scobura* sp. 1	1					1	
336	HESPERIIDAE	*Scobura* sp. 2	1		2	2	1		
337	HESPERIIDAE	*Matapa* sp.	1						
338	HESPERIIDAE	*Pirdana* sp.	5						
339	HESPERIIDAE	*Oriens* sp.		1					
340	HESPERIIDAE	*Potanthus* sp.			2	3			
341	HESPERIIDAE	*Pelopidas* sp.			1	5			
342	HESPERIIDAE	*Polytremis eltola*			7				
343	HESPERIIDAE	*Polytremis* sp.		4					
344	HESPERIIDAE	*Caltoris* sp. 1							3
345	HESPERIIDAE	*Caltoris* sp. 2		4					

I = Myitsone, II = Lasa, III = Chibwe, IV = Wusok, V = Pisa, VI = Kaunglanphu, VII = YenamVC = Very common, C = Common, R = Rare, SU = Status Unknown, LC = Locally Common, UC = Uncommon

Appendix 4.3.2. Butterfly species recorded in Myitsone area

No.	Family	Species name	Individual frequency	Study site		Status (Kenyon, 2004)	Microhabitat
1	PAPILIONIDAE	*Troides aeacus*	1	I	h	LC	paddyfield
2	PAPILIONIDAE	*Atrophaneura* sp.	2	I	e		rock
3	PAPILIONIDAE	*Papilio paris*	1	I	c	C	river
4	PAPILIONIDAE	*Papilio demoleus*	8	I	c,f,i	C	citrus, in flight, bush, grass
5	PAPILIONIDAE	*Papilio nephelus*	8	I	j	R	stream
6	PAPILIONIDAE	*Papilio helenus*	5	I	c,d,k	C	in flight, stream
7	PAPILIONIDAE	*Papilio polytes*	11	I	a,c,d	VC	river, cultivation, citrus, in flight, flower
8	PAPILIONIDAE	*Papilio memnon*	9	I	c,d,k,i	VC	river, bush, in flight, bamboo, stream, flower
9	PAPILIONIDAE	*Papilio protenor*	1	I	d	UC	bush
10	PAPILIONIDAE	*Papilio* spp.	2	I	c		cultivation
11	PAPILIONIDAE	*Chilasa agestor*	3	I	a	UC	river
12	PAPILIONIDAE	*Chilasa paradoxa*	10	I	c	UC	forest
13	PAPILIONIDAE	*Graphium sarpedon*	8	I	d,h,j	C	river, stream
14	PAPILIONIDAE	*Graphium doson*	1	I	h	UC	river
15	PAPILIONIDAE	*Graphium euryplus*	17	I	c,h,j	C	forest, river, stream
16	PAPILIONIDAE	*Graphium bathycles*	1	I	g	UC	river
17	PAPILIONIDAE	*Graphium agamemnon*	2	I	h,i	C	river, bush
18	PAPILIONIDAE	*Paranticopsis xenocles*	2	I	g,h	UC	river
19	PAPILIONIDAE	*Graphium antiphates*	5	I	j	UC	stream
20	PAPILIONIDAE	*Lamproptera curius*	10	I	j	UC	stream
21	PAPILIONIDAE	*Lamproptera* sp.	1	I	g		river
22	PIERIDAE	*Delias acalis*	1	I	c	UC	river
23	PIERIDAE	*Delias descombesi*	1	I	d	C	in flight
24	PIERIDAE	*Delias hyparete*	9	I	a	C	river
25	PIERIDAE	*Prioneris thestylis*	5	I	c	UC	river
26	PIERIDAE	*Artogeia napi*	12	I	a,c,d	UC	bush, cultivation
27	PIERIDAE	*Pieris canidia*	51	I	c,d,f,g,i	C	bush, in flight, mustard, flower, stream
28	PIERIDAE	*Appias libythea*	1	I	d	C	in flight
29	PIERIDAE	*Appias lyncida*	48	I	a,g,h,j	C	river, stream
30	PIERIDAE	*Appias albina*	5	I	a	C	bush
31	PIERIDAE	*Appias lalage*	15	I	a	UC	river
32	PIERIDAE	*Appias* sp. 1	15	I	b	C	forest
33	PIERIDAE	*Appias* sp. 2	10	I	c		forest
34	PIERIDAE	*Ixias pyrene*	7	I	c,d,k	C	bush, in flight, bamboo, stream

35	PIERIDAE	*Dercas verhuelli*	11	I	c,d	C	river, in flight
36	PIERIDAE	*Hebomoia glaucippe*	7	I	f,h,i,k	C	river, stream, bush
37	PIERIDAE	*Catopsilia pyranthe*	10	I	c	C	river
38	PIERIDAE	*Catopsilia pomona*	11	I	a,d	C	river, in flight
39	PIERIDAE	*Gandaca harina*	9	I	a,g,h	C	river
40	PIERIDAE	*Eurema hecabe*	2	I	h	C	flower
41	PIERIDAE	*Eurema andersonii*	20	I	c,e,j	C	river, bush, forest, in flight, grass
42	PIERIDAE	*Eurema blanda*	18	I	a,d	C	river, in flight

No.	Family	Species name	Individual frequency	Study site		Status (Kenyon, 2004)	Microhabitat
43	PIERIDAE	*Eurema simulatrix*	45	I	a,c,e	C	river, bush, forest
44	PIERIDAE	*Eurema* sp. 2	17	I	a,e,i		stream, river, forest, grass
45	DANAIDAE	*Danaus chrysippus*	11	I	f,g,i	C	flower, river, grass
46	DANAIDAE	*Danaus genutia*	13	I	a,c,f	C	bush, forest, flower
47	DANAIDAE	*Danaus septentrionis*	3	I	a,c	C	forest, flower
48	DANAIDAE	*Danaus* sp. 1	2	I	c	C	forest
49	DANAIDAE	*Parantica aglea*	14	I	a,d	C	in flight, bush, forest
50	DANAIDAE	*Parantica melaneus*	20	I	a,c,k	UC	river, forest, road, stream
51	DANAIDAE	*Parantica sita*	13	I	c	C	bush, forest
52	DANAIDAE	*Euploea sylvester*	3	I	f,g	R	flower, river
53	DANAIDAE	*Euploea mulciber*	20	I	a,d,g,i,k	C	bush, forest, in flight, river, stream
54	DANAIDAE	*Euploea leucostictos*	2	I	a	UC	bush, forest
55	DANAIDAE	*Euploea diocletianus*	12	I	c,f,g,i	R	river, flower, stream
56	DANAIDAE	*Euploea aglea*	1	I	f	C	flower
57	DANAIDAE	*Euploea core*	1	I	f	C	flower
58	SATYRIDAE	*Melanitis* sp. 1	5	I	i		bush
59	SATYRIDAE	*Melanitis* sp. 2	1	I	d		bush
60	SATYRIDAE	*Lethe europa*	1	I	d	C	bush
61	SATYRIDAE	*Lethe verma*	6	I	c	UC	river
62	SATYRIDAE	*Lethe confusa*	4	I	a,d	C	bush, forest
63	SATYRIDAE	*Lethe chandica*	2	I	a,d	UC	forest
64	SATYRIDAE	*Lethe mekara*	4	I	d,e	UC	bush
65	SATYRIDAE	*Lethe* sp. 2	1	I	c		bamboo
66	SATYRIDAE	*Neope pulaha*	2	I	k	C	stream
67	SATYRIDAE	*Ethope himachala*	11	I	i,k	UC	bush, stream
68	SATYRIDAE	*Orsotriaena medus*	9	I	a,d,e	C	bush, forest
69	SATYRIDAE	*Mycalesis* sp. 1	1	I	a	C	forest
70	SATYRIDAE	*Mycalesis* sp. 2	2	I	d	UC	forest, bamboo
71	SATYRIDAE	*Mycalesis* sp. 3	2	I	d	UC	bush
72	SATYRIDAE	*Mycalesis* sp. 5	5	I	c	UC	forest
73	SATYRIDAE	*Mycalesis* sp. 6	10	I	a,c,i	C	river, bush
74	SATYRIDAE	*Mycalesis* sp. 7	5	I	c,j	C	stream, bush
75	SATYRIDAE	*Mycalesis* sp. 8	1	I	a	C	forest
76	SATYRIDAE	*Mycalesis* sp. 9	5	I	e	UC	bush
77	SATYRIDAE	*Ypthima hubneri*	2	I	h	UC	trail
78	SATYRIDAE	*Ypthima watsoni*	2	I	f,h	UC	bush, trail

No.	Family	Species name	Individual frequency	Study site		Status (Kenyon, 2004)	Microhabitat
79	SATYRIDAE	*Ypthima* sp. 2	3	I	e	UC	bamboo
80	SATYRIDAE	*Ypthima* sp. 3	1	I	d	C	bush
81	SATYRIDAE	*Ypthima* sp. 4	6	I	e	UC	bush
82	SATYRIDAE	*Ypthima* sp. 6	10	I	i		bush
83	SATYRIDAE	*Elymnias hypermnestra*	4	I	a,k	C	bush, stream
84	SATYRIDAE	*Elymnias malelas*	2	I	e,h	UC	river
85	NYMPHALIDAE	*Ariadne ariadne*	5	I	a,d,f	C	bush, forest, leaf
86	NYMPHALIDAE	*Ariadne merione*	5	I	c,d,e	C	bush, forest
87	NYMPHALIDAE	*Ariadne* sp. 1	1	I	e		forest
88	NYMPHALIDAE	*Ariadne* sp. 2	6	I	c,e		river, forest
89	NYMPHALIDAE	*Cupha erymanthis*	23	I	a,d,j	C	bush, stream
90	NYMPHALIDAE	*Phalanta phalanta*	2	I	c,f	C	in flight, flower
91	NYMPHALIDAE	*Phalanta alcippe*	11	I	g,h	C	river
92	NYMPHALIDAE	*Vagrans egista*	5	I	g,j	C	river, stream
93	NYMPHALIDAE	*Vindula erota*	22	I	c,e,i,j	C	bush, river, mustard, stream
94	NYMPHALIDAE	*Cirrochroa tyche*	11	I	g,i	UC	river, road
95	NYMPHALIDAE	*Cirrochroa surya*	4	I	a	UC	river, forest
96	NYMPHALIDAE	*Cirrochroa* spp.	6	I	c		cultivation
97	NYMPHALIDAE	*Cethosia biblis*	3	I	c,i	C	river, road
98	NYMPHALIDAE	*Argyreus hyperbius*	8	I	i	UC	road
99	NYMPHALIDAE	*Vanessa indica*	27	I	c,d,e,i	C	bush, edge, in flight, grass
100	NYMPHALIDAE	*Kaniska canace*	3	I	a	C	river
101	NYMPHALIDAE	*Junonia lemonias*	58	I	a,c,d,f,i	C	river, bush, grass, forest, edge, flower, stream, road
102	NYMPHALIDAE	*Junonia orithya*	5	I	i	C	grass
103	NYMPHALIDAE	*Junonia hierta*	36	I	a,c,d,i	C	grass, road, bush, forest, river
104	NYMPHALIDAE	*Junonia iphita*	28	I	a,c,e,i	C	bush, forest, stream
105	NYMPHALIDAE	*Junonia almana*	21	I	c,f,i	C	forest, bush, grass
106	NYMPHALIDAE	*Junonia atlites*	27	I	a,c,d,e,f	C	bush, grass, forest, edge
107	NYMPHALIDAE	*Symbrenthia lilaea*	12	I	c,d,j	UC	bush, edge, stream
108	NYMPHALIDAE	*Hypolimnas bolina*	2	I	a,i	C	bush, grass
109	NYMPHALIDAE	*Hypolimnas* sp.	1	I	b	C	forest
110	NYMPHALIDAE	*Doleschallia bisaltide*	1	I	d	UC	forest
111	NYMPHALIDAE	*Kallima inachus*	1	I	i		bush
112	NYMPHALIDAE	*Cyrestis thyodamas*	3	I	d,e	C	bush, in flight
113	NYMPHALIDAE	*Cyrestis cocles*	23	I	g,h,i	UC	river, stream
114	NYMPHALIDAE	*Cyrestis* sp.	2	I	i		road
115	NYMPHALIDAE	*Pantoporia* sp. 1	5	I	e	C	bush
116	NYMPHALIDAE	*Neptis harita*	2	I	d	C	bush, forest
117	NYMPHALIDAE	*Neptis hylas*	27	I	c,d,e,f	C	shrub, in flight, bush
118	NYMPHALIDAE	*Neptis clinia*	11	I	a,c	C	river, grass
119	NYMPHALIDAE	*Neptis* sp. 1	15	I	a,c	UC	river, forest
120	NYMPHALIDAE	*Neptis* sp. 2	5	I	a	UC	forest
121	NYMPHALIDAE	*Athyma pravara*	21	I	d,i	UC	in flight, road

No.	Family	Species name	Individual frequency	Study site		2004)Status (Kenyon,	Microhabitat
122	NYMPHALIDAE	*Athyma perius*	1	I	c	C	in flight
123	NYMPHALIDAE	*Athyma selenophora*	10	I	c	C	forest
124	NYMPHALIDAE	*Athyma nefte*	1	I	d	C	bush
125	NYMPHALIDAE	*Athyma* sp. 1	10	I	c	UC	forest
126	NYMPHALIDAE	*Athyma* sp. 2	10	I	i		bush
127	NYMPHALIDAE	*Moduza procris*	3	I	k	C	stream
128	NYMPHALIDAE	*Lebadea martha*	5	I	a	UC	river
129	NYMPHALIDAE	*Parthenos sylvia*	5	I	c,d	UC	river, bush, forest, in flight
130	NYMPHALIDAE	*Tanaecia lepidea*	3	I	a,d	UC	in flight, forest
131	NYMPHALIDAE	*Euthalia* sp. 2	13	I	a,c	UC	river, forest
132	NYMPHALIDAE	*Euthalia* sp. 3	2	I	a		forest
133	NYMPHALIDAE	*Rohana parisatis*	1	I	i	UC	road
134	NYMPHALIDAE	*Rohana* sp.	1	I	a		bush
135	NYMPHALIDAE	*Apatura ambica*	6	I	d,i	UC	cultivation, road
136	NYMPHALIDAE	*Sephisa chandra*	1	I	i	UC	road
137	NYMPHALIDAE	*Herona marathus*	3	I	a	UC	bush
138	NYMPHALIDAE	*Eurippus nyctelius*	4	I	h,j	UC	river, stream
139	NYMPHALIDAE	*Polyura athamas*	2	I	k	C	stream
140	NYMPHALIDAE	*Charaxes bernardus*	1	I	i	C	scat
141	AMATHUSIIDAE	*Thaumantis diores*	1	I	i	R	road
142	AMATHUSIIDAE	*Discophora sondaica*	1	I	a	UC	rubber plantation
143	AMATHUSIIDAE	*Enispe euthymius*	1	I	d	UC	bush
144	LIBYTHEIDAE	*Libythea myrrha*	18	I	d,h,i,k	UC	in village, river, road, stream
145	RIODINIDAE	*Zemeros flegyas*	38	I	a,c,d,e,i	C	river, bush, forest, edge
146	RIODINIDAE	*Abisara neophron*	1	I	a		rubber plantation
147	RIODINIDAE	*Abisara* sp. 1	3	I	a		forest
148	RIODINIDAE	*Abisara* sp. 2	10	I	c		forest, cultivation
149	LYCAENIDAE	*Taraka hamada*	5	I	a		grass
150	LYCAENIDAE	*Curetis bulis*	2	I	h		river
151	LYCAENIDAE	*Surendra quercetorum*	1	I	d		bush
152	LYCAENIDAE	*Yasoda tripunctata*	2	I	d		bush, forest
153	LYCAENIDAE	*Loxura atymnus*	12	I	e,g,i		forest, river, stream
154	LYCAENIDAE	*Cheritra freja*	1	I	a		forest
155	LYCAENIDAE	*Acytolepis puspa*	5	I	h		river
156	LYCAENIDAE	*Celastrina argiolus*	1	I	d		river
157	LYCAENIDAE	*Celastrina* sp. 1	5	I	a		river
158	LYCAENIDAE	*Hypolycaena erylus*	23	I	a,g,h,i,j		road, river, stream
159	LYCAENIDAE	*Zeltus amasa*	9	I	c,d,i,k		bush, rock, road, stream
160	LYCAENIDAE	*Rapala pheretima*	2	I	a,c		bamboo, bush
161	LYCAENIDAE	*Heliophorus brahma*	5	I	i		bush
162	LYCAENIDAE	*Heliophorus epicles*	1	I	g		river
163	LYCAENIDAE	*Heliophorus ila*	4	I	d,e		edge, bamboo
164	LYCAENIDAE	*Heliophorus* sp. 1	7	I	a,e		bush
165	LYCAENIDAE	*Anthene emolus*	11	I	a,d		river, road

166	LYCAENIDAE	*Anthene* spp.	6	I	e		river, bush
167	LYCAENIDAE	*Niphanda asialis*	1	I	g		river
168	LYCAENIDAE	*Nacaduba* sp. 1	1	I	g		dung
169	LYCAENIDAE	*Nacaduba* sp. 3	1	I	d		river
170	LYCAENIDAE	*Jamides elpis*	1	I	d		river
171	LYCAENIDAE	*Jamides* sp. 2	3	I	i		bush
172	LYCAENIDAE	*Catochrysops panormus*	1	I	g		river
173	LYCAENIDAE	*Castalius rosimon*	6	I	d,h		bush, river
174	LYCAENIDAE	*Caleta roxus*	5	I	a,h,i		grass, river, bush
175	LYCAENIDAE	*Caleta elna*	1	I	c		river
176	LYCAENIDAE	*Everes lacturnus*	3	I	c,d		river, bush
177	LYCAENIDAE	*Megisba malaya*	4	I	a,h		road, river

No.	Family	Species name	Individual frequency	Study site		Status (Kenyon, 2004)	Microhabitat
178	LYCAENIDAE	*Chilades lajus*	2	I	a		river
179	LYCAENIDAE	*Zizina otis*	1	I	h		grass
180	LYCAENIDAE	*Zizeeria karsandra*	4	I	c,g		sandbar, river
181	LYCAENIDAE	*Zizeeria maha*	7	I	c,d,e		river, bush
182	HESPERIIDAE	*Sarangesa dasahara*	1	I	a		bush
183	HESPERIIDAE	*Pseudocoladenia* sp.	1	I	d		river
184	HESPERIIDAE	*Tagiades* sp.	1	I	d		forest
185	HESPERIIDAE	*Odontoptilum angulatum*	1	I	d		cultivation
186	HESPERIIDAE	*Pithauria* sp.	2	I	i		bush
187	HESPERIIDAE	*Koruthaialos sindu*	1	I	d		river, forest
188	HESPERIIDAE	*Koruthaialos* spp.	1	I	d		river
189	HESPERIIDAE	*Scobura* sp.1	1	I	i		bush
190	HESPERIIDAE	*Scobura* sp. 2	1	I	a		bush
191	HESPERIIDAE	*Matapa* sp.	1	I	a		forest
192	HESPERIIDAE	*Pirdana* sp.	5	I	a		river

I = Myitsone area

Appendix 4.3.3. Butterfly species recorded in Lasa area

No	Family	Species	Individual frequency	Study site		Status (Kenyon, 2004)	Microhabitat
1	PAPILIONIDAE	*Troides* sp.	2	II	b,d	LC	stream
2	PAPILIONIDAE	*Papilio paris*	3	II	d	C	stream
3	PAPILIONIDAE	*Papilio nephelus*	1	II	d	R	stream
4	PAPILIONIDAE	*Papilio helenus*	9	II	a,d	C	riverbank, stream
5	PAPILIONIDAE	*Papilio memnon*	2	II	c,d	VC	stream
6	PAPILIONIDAE	*Papilio* spp.	2	II	d		stream

No	Family	Species	Individual frequency	Study site		Status (Kenyon, 2004)	Microhabitat
7	PAPILIONIDAE	*Chilasa paradoxa*	1	II	d	UC	stream
8	PAPILIONIDAE	*Graphium sarpedon*	8	II	c,d	C	stream
9	PAPILIONIDAE	*Graphium bathycles*	2	II	d	UC	stream
10	PAPILIONIDAE	*Paranticopsis* sp.	3	II	d	C	stream
11	PAPILIONIDAE	*Graphium antiphates*	5	II	d	UC	stream
12	PAPILIONIDAE	*Graphium* spp.	13	II	c,d		stream
13	PAPILIONIDAE	*Lamproptera* sp.	5	II	d		stream
14	PIERIDAE	*Prioneris thestylis*	2	II	d	UC	stream
15	PIERIDAE	*Pieris canidia*	20	II	d	C	grass
16	PIERIDAE	*Cepora nadina*	3	II	c	C	stream
17	PIERIDAE	*Appias lyncida*	3	II	c,d	C	stream
18	PIERIDAE	*Dercas verhuelli*	7	II	c,d	C	stream
19	PIERIDAE	*Catopsilia pyranthe*	5	II	d	C	grass
20	PIERIDAE	*Eurema andersoni*	23	II	b,d	C	stream
21	PIERIDAE	*Eurema simulatrix*	7	II	a,d	C	stream, bush
22	PIERIDAE	*Eurema* sp. 2	18	II	c,d		stream
23	DANAIDAE	*Danaus genutia*	75	II	b,c,d	C	stream
24	DANAIDAE	*Danaus* sp. 1	20	II	c	C	stream
25	DANAIDAE	*Danaus* sp. 2	1	II	a		stream
26	DANAIDAE	*Parantica aglea*	15	II	a,c,d	C	stream
27	DANAIDAE	*Euploea sylvester*	15	II	c,d	R	stream
28	DANAIDAE	*Euploea mulciber*	20	II	a,c,d	C	stream
29	DANAIDAE	*Euploea diocletianus*	11	II	a,c,d	R	stream
30	SATYRIDAE	*Melanitis* sp. 1	3	II	d	UC	banana
31	SATYRIDAE	*Lethe confusa*	2	II	d	C	grass
32	SATYRIDAE	*Orinoma damaris*	1	II	d	UC	riverbank
33	SATYRIDAE	*Ethope himachala*	3	II	d	UC	stream
34	SATYRIDAE	*Penthema lisarda*	3	II	c,d	UC	stream
35	SATYRIDAE	*Orsotriaena medus*	25	II	c,d	C	stream
36	SATYRIDAE	*Mycalesis* sp. 6	1	II	c	C	grass
37	SATYRIDAE	*Mycalesis* sp. 7	3	II	d	C	stream
38	SATYRIDAE	*Ypthima* sp. 4	5	II	b,d	UC	stream
39	SATYRIDAE	*Ypthima* sp. 6	1	II	a		bush
40	NYMPHALIDAE	*Ariadne* sp. 2	3	II	d		grass
41	NYMPHALIDAE	*Pseudergolis wedah*	3	II	a	UC	bush
42	NYMPHALIDAE	*Cupha erymanthis*	26	II	d	C	forest
43	NYMPHALIDAE	*Phalanta phalanta*	1		pha wan	C	stream
44	NYMPHALIDAE	*Cirrochroa tyche*	3	II	a	UC	bush
45	NYMPHALIDAE	*Cirrochroa* sp.	1	II	c		stone
46	NYMPHALIDAE	*Cethosia cyane*	1	II	d	C	stream
47	NYMPHALIDAE	*Argyreus hyperbius*	5	II	b	UC	stream
48	NYMPHALIDAE	*Vanessa indica*	3	II	a,d	C	stream
49	NYMPHALIDAE	*Junonia orithya*	1	II	a	C	bush
50	NYMPHALIDAE	*Junonia hierta*	1	II	b	C	stream

No	Family	Species	Individual frequency	Study site		Status (Kenyon, 2004)	Microhabitat
51	NYMPHALIDAE	*Junonia almana*	1	II	d	C	stream
52	NYMPHALIDAE	*Junonia atlites*	20	II	a,b,c,d	C	stream
53	NYMPHALIDAE	*Kallima inachus*	5	II	c,d		banana
54	NYMPHALIDAE	*Cyrestis thyodamas*	20	II	a,b,d	C	stream
55	NYMPHALIDAE	*Pantoporia* sp. 2	6	II	d	UC	stream
56	NYMPHALIDAE	*Pantoporia* sp. 3	10	II	b,c		stream
57	NYMPHALIDAE	*Neptis sappho*	10	II	d	UC	stream
58	NYMPHALIDAE	*Neptis hylas*	25	II	a,b,c,d	C	stream, bush
59	NYMPHALIDAE	*Sumalia daraxa*	3	II	c	UC	stone
60	NYMPHALIDAE	*Parasarpa dudu*	1	II	c	C	banana
61	NYMPHALIDAE	*Bhagadatta austenia*	1	II	d	UC	leaf
62	NYMPHALIDAE	*Parthenos sylvia*	15	II	b,c,d	UC	stream
63	NYMPHALIDAE	*Tanaecia julii*	3	II	a	UC	bush
64	NYMPHALIDAE	*Tanaecia* sp. 1	3	II	c	UC	stream
65	NYMPHALIDAE	*Hestina nama*	5	II	b,d	UC	stream
66	NYMPHALIDAE	*Charaxes bernardus*	3	II	d	C	stream
67	AMATHUSIIDAE	*Thauria aliris*	1	II	d	UC	forest
68	LIBYTHEIDAE	*Libythea celtis*	8	II	c,d	UC	stream
69	LIBYTHEIDAE	*Libythea myrrha*	5	II	d	UC	stream
70	RIODINIDAE	*Zemeros flegyas*	20	II	a,b,c,d	C	stream
71	RIODINIDAE	*Abisara fylla*	3	II	b	C	stream
72	LYCAENIDAE	*Curetis bulis*	1	II	a		stream
73	LYCAENIDAE	*Curetis* sp.	5	II	d		stream
74	LYCAENIDAE	*Spindasis syama*	3	II	b,c		stream
75	LYCAENIDAE	*Spindasis* sp.	1	II	d		grass
76	LYCAENIDAE	*Zeltus amasa*	1	II	a		stream
77	LYCAENIDAE	*Rapala* sp. 1	1	II	c,d		stream
78	LYCAENIDAE	*Heliophorus brahma*	3	II	a,d		stream
79	LYCAENIDAE	*Heliophorus epicles*	5	II	d		grass
80	LYCAENIDAE	*Heliophorus ila*	10	II	c		stream
81	LYCAENIDAE	*Heliophorus* sp. 2	1	II	d		stream
82	LYCAENIDAE	*Anthene* spp.	7	II	d		grass
83	LYCAENIDAE	*Nacaduba* sp. 2	1	II	d		stream
84	LYCAENIDAE	*Caleta roxus*	15	II	a,c		stream
85	LYCAENIDAE	*Zizeeria maha*	5	II	a		bush
86	HESPERIIDAE	*Tagiades* sp.	1	II	c		leaf
87	HESPERIIDAE	*Halpe* sp.	4	II	b,d		stream
88	HESPERIIDAE	*Notocrypta curvifascia*	1	II	a		stream
89	HESPERIIDAE	*Suastus* sp.	1	II	d		grass
90	HESPERIIDAE	*Oriens* sp.	1	II	b		stream
91	HESPERIIDAE	*Polytremis* sp.	4	II	d		stream
92	HESPERIIDAE	*Caltoris* sp.	4	II	c		stream

II = Lasa area

Appendix 4.3.4. Butterfly species recorded in Chibwe area

No	Family	Species name	Individual frequency	Study site		Status (Kenyon, 2004)	Microhabitat
1	PAPILIONIDAE	*Troides aeacus*	3	III	f, h, j	LC	paddyfield, bush, flower
2	PAPILIONIDAE	*Troides* sp.	7	III	e, f, g, j		flower, in flight
3	PAPILIONIDAE	*Atrophaneura polla*	2	III	k, m	UC	road, river
4	PAPILIONIDAE	*Atrophaneura polyeuctes*	6	III	e, j	C	flower, bush
5	PAPILIONIDAE	*Atrophaneura varuna*	10	III	f	UC	road
6	PAPILIONIDAE	*Papilio bianor*	1	III	f	R	stream
7	PAPILIONIDAE	*Papilio paris*	11	III	b, e, f	C	stream, road, flower
8	PAPILIONIDAE	*Papilio demoleus*	1	III	m	C	road
9	PAPILIONIDAE	*Papilio nephelus*	2	III	f, n	R	stream, pool
10	PAPILIONIDAE	*Papilio helenus*	7	III	a, c, f	C	stream, river
11	PAPILIONIDAE	*Papilio polytes*	1	III	c	VC	bush
12	PAPILIONIDAE	*Papilio memnon*	1	III	m	VC	bush
13	PAPILIONIDAE	*Papilio protenor*	1	III	o	UC	trail
14	PAPILIONIDAE	*Chilasa paradoxa*	1	III	n	UC	pool
15	PAPILIONIDAE	*Graphium sarpedon*	11	III	a, b, d, e, h, i, n	C	trail, river, stream, road
16	PAPILIONIDAE	*Graphium bathycles*	1	III	f	UC	stream
17	PAPILIONIDAE	*Graphium agetes*	4	III	b, f, k	UC	stream, road, river
18	PAPILIONIDAE	*Graphium antiphates*	6	III	a, b, c, n	UC	stream, river
19	PAPILIONIDAE	*Lamproptera curius*	1	III	m	UC	stream
20	PAPILIONIDAE	*Lamproptera meges*	1	III	n	UC	stream

No	Family	Species name	Individual frequency		Study site	2004)Status (Kenyon,	Microhabitat
21	PIERIDAE	*Delias berinda*	1	III	e	UC	stream
22	PIERIDAE	*Delias belladonna*	1	III	e	UC	stream
23	PIERIDAE	*Prioneris thestylis*	4	III	c, e, f	UC	stream, river
24	PIERIDAE	*Artogeia napi*	1	III	c	UC	road
25	PIERIDAE	*Pieris canidia*	40	III	f, k, g, h, I, j, n	C	trail, leaf, road, stream
26	PIERIDAE	*Cepora nerissa*	1	III	b		road
27	PIERIDAE	*Cepora nadina*	9	III	a, b, d, e, f	C	stream, dung, road
28	PIERIDAE	*Appias lyncida*	14	III	b, d, e, m	C	stream, road
29	PIERIDAE	*Appias nero*	3	III	f	C	stream
30	PIERIDAE	*Appias lalage*	16	III	f, i	UC	stream, river
31	PIERIDAE	*Appias indra*	11	III	e, m	UC	stream
32	PIERIDAE	*Ixias pyrene*	14	III	b, c, d, e, f, k, n	C	trail, bush, road
33	PIERIDAE	*Dercas verhuelli*	8	III	e, m, n	C	bush, road, trail
34	PIERIDAE	*Hebomoia glaucippe*	3	III	b, e, n	C	bush, trail
35	PIERIDAE	*Gandaca harina*	6	III	d, e, a, n	C	stream, road, trail
36	PIERIDAE	*Eurema hecabe*	1	III	m	C	road
37	PIERIDAE	*Eurema andersoni*	3	III	a, b, n	C	stream, flower, bush
38	PIERIDAE	*Eurema blanda*	2	III	e, n	C	stream, trail
39	PIERIDAE	*Eurema simulatrix*	11	III	c, a, l, i, g, j	C	trail, flower, road
40	PIERIDAE	*Eurema* sp. 2	1	III	n		trail
41	DANAIDAE	*Danaus genutia*	26	III	c, e, f, n	C	trail, road, flower, leaf, bush
42	DANAIDAE	*Danaus septentrionis*	3	III	c, e	C	flower, road
43	DANAIDAE	*Parantica aglea*	15	III	d, e, k, n	C	road, flower, bush, trail
44	DANAIDAE	*Parantica melaneus*	8	III	b, f	UC	trail, flower, road
45	DANAIDAE	*Parantica sita*	16	III	c, d, e, b, k, j	C	rock, flower, bush
46	DANAIDAE	*Euploea mulciber*	67	III	c, e, b, a, k, m, f, h, n, o, j	C	trail, flower, road, leaf, bush
47	SATYRIDAE	*Melanitis* sp. 2	2	III	f, j	C	trail
48	SATYRIDAE	*Melanitis* sp. 3	3	III	d, l, n		road, bush
49	SATYRIDAE	*Lethe verma*	11	III	f	UC	trail
50	SATYRIDAE	*Lethe confusa*	3	III	e, n	C	bush
51	SATYRIDAE	*Lethe vindhya*	1	III	e	UC	road
52	SATYRIDAE	*Lethe gulnihal*	1	III	h	UC	trail
53	SATYRIDAE	*Lethe* sp. 2	1	III	e		forest
54	SATYRIDAE	*Neope bhadra*	2	III	e	UC	road
55	SATYRIDAE	*Neope muirheadi*	1	III	c	UC	bush

No	Family	Species name	Individual frequency	Study site		Status (Kenyon, 2004)	Microhabitat
56	SATYRIDAE	*Ethope himachala*	8	III	b, k, l, n	UC	stream, road, bush
57	SATYRIDAE	*Penthema lisarda*	2	III	e, o	UC	forest, bamboo
58	SATYRIDAE	*Mycalesis* sp. 2	1	III	i	UC	trail
59	SATYRIDAE	*Mycalesis* sp. 4	13	III	f, i		trail
60	SATYRIDAE	*Mycalesis* sp. 6	4	III	e, f	C	trail, road
61	SATYRIDAE	*Mycalesis* sp. 10	26	III	d, b, a, k, l, f		trail, road, stream, bush, leaf
62	SATYRIDAE	*Ypthima sakra*	4	III	e	C	road
63	SATYRIDAE	*Ypthima confusa*	2	III	e		road
64	SATYRIDAE	*Ypthima* sp. 5	2	III	i, g	UC	bush, trail
65	SATYRIDAE	*Ypthima* sp. 6	13	III	c, e, b, a, f, g		trail, road, bush
66	SATYRIDAE	*Callerebia narasingha*	27	III	e, a, g, j		trail, stream, road
67	SATYRIDAE	*Zipaetis scyllax*	7	III	f, j	UC	trail, road
68	SATYRIDAE	*Elymnias malelas*	3	III	a, f	UC	trail, dung
69	NYMPHALIDAE	*Acrea issoria*	25	III	e, b, h, i, g, n	C	cultivation, trail, stone, road, bush
70	NYMPHALIDAE	*Ariadne merione*	2	III	e	C	stream
71	NYMPHALIDAE	*Pseudergolis wedah*	14	III	e, f, h, i	UC	stream, trail, river
72	NYMPHALIDAE	*Calinaga buddha*	1	III	f	UC	stream, scat
73	NYMPHALIDAE	*Cupha erymanthis*	9	III	d, e	C	bush, stream
74	NYMPHALIDAE	*Vindula erota*	6	III	d, b, f, o	C	stream, road, trail
75	NYMPHALIDAE	*Cirrochroa tyche*	2	III	d, m	UC	stream, bush
76	NYMPHALIDAE	*Cirrochroa* sp.	1	III	e		road
77	NYMPHALIDAE	*Cethosia biblis*	9	III	e, b, a, f, h, i, j	C	scat, trail, bush, stream
78	NYMPHALIDAE	*Cethosia cyane*	1	III	e	C	road
79	NYMPHALIDAE	*Argyreus hyperbius*	3	III	c, f, g	UC	trail, road
80	NYMPHALIDAE	*Vanessa indica*	1	III	e	C	bush
81	NYMPHALIDAE	*Kaniska canace*	1	III	e	C	bush
82	NYMPHALIDAE	*Junonia lemonias*	49	III	d, e, b, a, m, h, i, n	C	trail, cultivation, road, bush
83	NYMPHALIDAE	*Junonia hierta*	1	III	e	C	road
84	NYMPHALIDAE	*Junonia iphita*	51	III	c, e, b, a, k, f, n, o, j	C	trail, road, bush, leaf
85	NYMPHALIDAE	*Junonia atlites*	1	III	e	C	bush
86	NYMPHALIDAE	*Symbrenthia lilaea*	10	III	c, e, f, h, n	UC	stream, river
87	NYMPHALIDAE	*Symbrenthia hypselis*	3	III	f, h	UC	stream, bush
88	NYMPHALIDAE	*Hypolimnas bolina*	1	III	n	C	bush
89	NYMPHALIDAE	*Doleschallia bisaltide*	1	III	m	UC	stream
90	NYMPHALIDAE	*Kallima inachus*	19	III	e, b, i, n		forest, bush, road, bamboo
91	NYMPHALIDAE	*Stibochiona nicea*	3	III	e	UC	road

No	Family	Species name	Individual frequency	Study site		Status (Kenyon, 2004)	Microhabitat
92	NYMPHALIDAE	*Cherosonesia* sp.	2	III	n		stream
93	NYMPHALIDAE	*Cyrestis thyodamas*	9	III	b, a, i	C	river, stream, road
94	NYMPHALIDAE	*Cyrestis cocles*	6	III	d, e	UC	stream
95	NYMPHALIDAE	*Neptis harita*	3	III	f	C	stream
96	NYMPHALIDAE	*Neptis miah*	5	III	d, f, g		trail, stream
97	NYMPHALIDAE	*Neptis hylas*	6	III	k, f, g, n	C	trail, road, bush
98	NYMPHALIDAE	*Neptis* sp. 3	12	III	a, f	C	trail, stream, stone
99	NYMPHALIDAE	*Neptis ananta*	2	III	e, g	UC	trail, road
100	NYMPHALIDAE	*Athyma cama*	1	III	b		stream
101	NYMPHALIDAE	*Sumalia daraxa*	2	III	f, j	UC	stream
102	NYMPHALIDAE	*Parasarpa dudu*	1	III	j	C	stream
103	NYMPHALIDAE	*Bhagadatta austenia*	6	III	h, i, g	UC	trail, forest
104	NYMPHALIDAE	*Auzakia danava*	5	III	a, f	UC	stream
105	NYMPHALIDAE	*Moduza procris*	4	III	c, m, f	C	road, bush
106	NYMPHALIDAE	*Parthenos sylvia*	20	III	e, b, a, o	UC	stream, forest, road, bush
107	NYMPHALIDAE	*Neurosigma siva*	1	III	i		trail
108	NYMPHALIDAE	*Tanaecia* sp. 2	5	III	o		forest
109	NYMPHALIDAE	*Euthalia franciae*	1	III	e	UC	road
110	NYMPHALIDAE	*Euthalia monina*	1	III	e	UC	forest
111	NYMPHALIDAE	*Euthalia* sp. 1	3	III	e, b	UC	road, forest
112	NYMPHALIDAE	*Euthalia* sp. 3	1	III	n		trail
113	NYMPHALIDAE	*Rohana parisatis*	14	III	e, f, h, n	UC	trail, stream, road
114	NYMPHALIDAE	*Apatura ambica*	9	III	e, b, a	UC	stream
115	NYMPHALIDAE	*Apatura chevana*	1	III	e	UC	road
116	NYMPHALIDAE	*Hestina nama*	21	III	d, e, b, m, f, h, i	UC	trail, river, road, stream
117	NYMPHALIDAE	*Eurippus nyctelius*	1	III	h	UC	stream
118	NYMPHALIDAE	*Polyura athamas*	23	III	c, e, b, a, k, f, i, g, n	C	stream, river, road, trail
119	NYMPHALIDAE	*Polyura eudamippus*	18	III	b, f, i, n	UC	stream, river
120	NYMPHALIDAE	*Polyura dolon*	20	III	f	UC	stream
121	NYMPHALIDAE	*Charaxes bernardus*	4	III	e, b, i	C	river, stream
122	AMATHUSIIDAE	*Thaumantis diores*	3	III	e, n	R	stream, bush
123	AMATHUSIIDAE	*Thauria aliris*	4	III	d, e, o	UC	bamboo, forest
124	AMATHUSIIDAE	*Discophora deo*	1	III	g	UC	trail
125	AMATHUSIIDAE	*Enipse euthymius*	1	III	g	UC	trail
126	LIBYTHEIDAE	*Libythea celtis*	2	III	d, i	UC	river, stream
127	LIBYTHEIDAE	*Libythea myrrha*	18	III	c, d, e, a, m	UC	stream, river

No	Family	Species name	Individual frequency	Study site		Status (Kenyon, 2004)	Microhabitat
128	RIODINIDAE	*Zemeros flegyas*	29	III	a, k, m, f, o, j	C	trail, road, leaf, bush
129	RIODINIDAE	*Dodona dipoea*	3	III	f, h	C	stream
130	RIODINIDAE	*Dodona ouida*	1	III	j	UC	trail
131	RIODINIDAE	*Abisara fylla*	6	III	e ,f	C	road, stone
132	RIODINIDAE	*Abisara neophron*	1	III	f	UC	trail
133	RIODINIDAE	*Abisara chela*	1	III	f		trail
134	LYCAENIDAE	*Miletus* sp.	2	III	d, i		forest, road
135	LYCAENIDAE	*Taraka hamada*	2	III	i, j		bush, forest
136	LYCAENIDAE	*Curetis bulis*	1	III	e		road
137	LYCAENIDAE	*Arhopala pseudocentaurus*	1	III	o		forest
138	LYCAENIDAE	*Arhopala* sp.	1	III	n		trail
139	LYCAENIDAE	*Zinaspa?*	1	III	g		trail
140	LYCAENIDAE	*Catapaecilma major*	7	III	f, g		trail, road
141	LYCAENIDAE	*Yasoda tripunctata*	1	III	i		forest
142	LYCAENIDAE	*Loxura atymnas*	3	III	d, m		road, bush
143	LYCAENIDAE	*Ticherra acte*	1	III	e		forest
144	LYCAENIDAE	*Spindasis lohita*	1	III	m		stream
145	LYCAENIDAE	*Spindasis syama*	1	III	h		bush
No	**Family**	**Species name**	**Individual frequency**	**Study site**		**Status (Kenyon, 2004)**	**Microhabitat**
146	LYCAENIDAE	*Celastrina lavendularis*	1	III	j		trail
147	LYCAENIDAE	*Celastrina argiolus*	3	III	b, l, m, n		stream, road
148	LYCAENIDAE	*Celastrina* sp. 2	2	III	d, g		trail, dung
149	LYCAENIDAE	*Callenya?*	1	III	b		road
150	LYCAENIDAE	*Hypolycaena erylus*	1	III	d		stream
151	LYCAENIDAE	*Hypolycaena othona*	1	III	a		road
152	LYCAENIDAE	*Zeltus amasa*	11	III	c, d, b, m, f, n		bush, stream, leaf, road, trail
153	LYCAENIDAE	*Rapala nissa*	2	III	h, i		trail, leaf
154	LYCAENIDAE	*Rapala* sp. 2	1	III	n		trail
155	LYCAENIDAE	*Heliophorus androcles*	1	III	g		trail
156	LYCAENIDAE	*Heliophorus* sp. 1	9	III	f		trail, stone
157	LYCAENIDAE	*Anthene emolus*	20	III	e, b		stream
158	LYCAENIDAE	*Anthene lycaenina*	30	III	b		stream
159	LYCAENIDAE	*Niphanda asialis*	1	III	n		trail
160	LYCAENIDAE	*Nacaduba* sp. 1	25	III	d		stream
161	LYCAENIDAE	*Nacaduba* sp. 3	5	III	b		stream
162	LYCAENIDAE	*Ionolyce helicon*	8	III	d, e, a, m		stream, road
163	LYCAENIDAE	*Prosotas* spp.	378	III	d, b, a, k, f, h, i		trail, stream, road

No	Family	Species name	Individual frequency	Study site		Status (Kenyon, 2004)	Microhabitat
164	LYCAENIDAE	*Jamides bochus*	34	III	d, e, f, h		trail, stream, road
165	LYCAENIDAE	*Jamides alecto*	1	III	d		road
166	LYCAENIDAE	*Jamides* sp. 2	1	III	c		bush
167	LYCAENIDAE	*Lampides boeticus*	1	III	g		trail
168	LYCAENIDAE	*Catochrysops panormus*	2	III	a, l		road
169	LYCAENIDAE	*Catochrysops strabo*	2	III	e, n		stream
170	LYCAENIDAE	*Catochrysops* sp.	1	III	j		trail
171	LYCAENIDAE	*Syntarucus plinius*	1	III	a		road
172	LYCAENIDAE	*Caleta elna*	21	III	c, d, f, g, n, o		trail, stream, river
173	LYCAENIDAE	*Euchrysops cnejus*	1	III	g		trail
174	LYCAENIDAE	*Chilades lajus*	1	III	a		road
175	LYCAENIDAE	*Zizeeria maha*	87	III	c, d, k, f, j		trail, flower, road, bush, leaf
176	HESPERIIDAE	*Hasora vitta*	2	III	j		rock
177	HESPERIIDAE	*Hasora taminatus*	1	III	j		rock
178	HESPERIIDAE	*Celaenorrhinus dhanada*	2	III	f, h		stream, bush
179	HESPERIIDAE	*Tapena thawaitesi*	5	III	f		stone
180	HESPERIIDAE	*Ochus subvittatus*	5	III	e, b, h, g		stream, trail
181	HESPERIIDAE	*Thoressa cerata*	1	III	f		trail
182	HESPERIIDAE	*Halpe* sp.	2	III	c, b		stream, road
183	HESPERIIDAE	*Pithauria stramineipennis*	52	III	b, f		stream
184	HESPERIIDAE	*Koruthaialos* spp.	7	III	f, g		leaf, trail
185	HESPERIIDAE	*Notocrypta curvifascia*	2	III	f, h		bush
186	HESPERIIDAE	*Scobura* sp. 2	2	III	j		trail
187	HESPERIIDAE	*Potanthus* sp.	2	III	c, b, n		road, trail
188	HESPERIIDAE	*Pelopidas* sp.	1	III	g		trail
189	HESPERIIDAE	*Polytremis eltola*	7	III	e, g		trail, stream

III = Chibwe area

Appendix 4.3.5. Butterfly species recorded in Wusok area

No	Family	Species name	Individual frequency	Study site	Status (Kenyon, 2004)	Microhabitat

No	Family	Species name	frequencyIndividual	Study site		Status (Kenyon, 2004)	Microhabitat
1	PAPILIONIDAE	*Troides* sp.	2	IV	c,e	LC	stream, flower
2	PAPILIONIDAE	*Atrophaneura polla*	1	IV	a	UC	stream
3	PAPILIONIDAE	*Atrophaneura polyeuctes*	9	IV	c,d,e	C	flower, stream
4	PAPILIONIDAE	*Atrophaneura dasarada*	10	IV	a,b	UC	stream
5	PAPILIONIDAE	*Atrophaneura aidoneus*	1	IV	c	R	flower
6	PAPILIONIDAE	*Papilio paris*	10	IV	a,d,e	C	trail, stream
7	PAPILIONIDAE	*Papilio nephelus*	5	IV	b	R	stream
8	PAPILIONIDAE	*Papilio helenus*	16	IV	a,b,d	C	stream, road
9	PAPILIONIDAE	*Papilio protenor*	5	IV	b	UC	road
10	PAPILIONIDAE	*Papilio alcmenor*	9	IV	a,d	UC	stream, leaf
11	PAPILIONIDAE	*Chilasa agestor*	5	IV	b	UC	road
12	PAPILIONIDAE	*Chilasa epycides*	15	IV	b,d	UC	stream
13	PAPILIONIDAE	*Graphium cloanthus*	5	IV	d	UC	stream
14	PAPILIONIDAE	*Graphium sarpedon*	3	IV	b	C	stone
15	PAPILIONIDAE	*Graphium glycerion*	20	IV	b	UC	stream
16	PAPILIONIDAE	*Graphium agetes*	7	IV	b,d	UC	stream
17	PAPILIONIDAE	*Lamproptera curius*	1	IV	a	UC	road
18	PIERIDAE	*Delias berinda*	3	IV	a	UC	stream
19	PIERIDAE	*Delias belladonna*	8	IV	b	UC	stream, road
20	PIERIDAE	*Pieris canidia*	30	IV	a,b,e	C	flower, trail, road, leaf
21	PIERIDAE	*Appias lalage*	20	IV	b,d	UC	stream, road
22	PIERIDAE	*Gandaca harina*	3	IV	b	C	leaf
23	PIERIDAE	*Eurema andersoni*	4	IV	a,c	C	trail
24	PIERIDAE	*Eurema simulatrix*	7	IV	b,c,e	C	trail, leaf
25	DANAIDAE	*Parantica sita*	3	IV	a,e	C	rock, bush
26	DANAIDAE	*Euploea mulciber*	10	IV	a,e	C	bush, leaf, road
27	SATYRIDAE	*Melanitis* sp. 2	1	IV	e	C	bush
28	SATYRIDAE	*Melanitis* sp. 3	3	IV	b,c		trail, stream
29	SATYRIDAE	*Lethe sinorix*	1	IV	e	C	trail
30	SATYRIDAE	*Lethe verma*	7	IV	c,e	UC	trail
31	SATYRIDAE	*Lethe vindhya*	1	IV	c	UC	trail
32	SATYRIDAE	*Neope bhadra*	25	IV	c,d,e	UC	trail
33	SATYRIDAE	*Mycalesis* sp. 6	11	IV	a,b	C	trail, leaf
34	SATYRIDAE	*Mycalesis* sp. 10	29	IV	b,c,d		trail, stone, road, stream
35	SATYRIDAE	*Ypthima sakra*	1	IV	c	C	trail

No	Family	Species name	Individual frequency	Study site		Status (Kenyon, 2004)	Microhabitat
36	SATYRIDAE	*Ypthima* sp. 1	1	IV	c	C	trail
37	SATYRIDAE	*Ypthima* sp. 5	1	IV	c		trail
38	SATYRIDAE	*Ypthima* sp. 6	19	IV	a, b, c		trail, leaf, stream
39	SATYRIDAE	*Callerebia narasingha*	3	IV	b		leaf
40	SATYRIDAE	*Zipaetis scyllax*	6	IV	a	UC	trail
41	NYMPHALIDAE	*Pseudergolis wedah*	7	IV	a,c,d	UC	stream, trail
42	NYMPHALIDAE	*Calinaga buddha*	14	IV	a,b	UC	rock, leaf, road
43	NYMPHALIDAE	*Childrena childreni*	1	IV	a	UC	rock
44	NYMPHALIDAE	*Vanessa indica*	2	IV	a,c	C	trail, rock
45	NYMPHALIDAE	*Kaniska canace*	1	IV	e	C	stream
46	NYMPHALIDAE	*Junonia iphita*	8	IV	b,d	C	trail, stone, leaf
47	NYMPHALIDAE	*Symbrenthia hypselis*	1	IV	d	UC	trail
48	NYMPHALIDAE	*Kallima inachus*	1	IV	e		bush
49	NYMPHALIDAE	*Stibochiona nicea*	1	IV	c	UC	trail
50	NYMPHALIDAE	*Cyrestis thyodamas*	13	IV	a,b,d	C	pool, stream
51	NYMPHALIDAE	*Neptis harita*	1	IV	d	C	stream
52	NYMPHALIDAE	*Neptis miah*	30	IV	b		stream, leaf
53	NYMPHALIDAE	*Neptis hylas*	5	IV	b	C	leaf
54	NYMPHALIDAE	*Neptis ananta*	6	IV	b,d	UC	stream
55	NYMPHALIDAE	*Neptis* sp.3	26	IV	b,d	C	stream, stone
56	NYMPHALIDAE	*Athyma jina*	17	IV	a,b	UC	stone
57	NYMPHALIDAE	*Athyma asura*	14	IV	a,b	C	stream, stone
58	NYMPHALIDAE	*Athyma selenophora*	1	IV	d	C	trail
59	NYMPHALIDAE	*Athyma zeroca*	3	IV	a,d	UC	trail, forest
60	NYMPHALIDAE	*Sumalia daraxa*	11	IV	d,e	UC	stream
61	NYMPHALIDAE	*Parasarpa dudu*	11	IV	a,b,d	C	stream, leaf, road
62	NYMPHALIDAE	*Auzakia danava*	8	IV	a,b	UC	stream
63	NYMPHALIDAE	*Euthalia franciae*	2	IV	d,e	UC	trail
64	NYMPHALIDAE	*Apatura ambica*	5	IV	b	UC	road
65	NYMPHALIDAE	*Hestina nama*	10	IV	b	UC	road
66	NYMPHALIDAE	*Eurippus nyctelius*	3	IV	b	UC	stone
67	NYMPHALIDAE	*Polyura athamas*	10	IV	b	C	road
68	NYMPHALIDAE	*Polyura eudamippus*	10	IV	b	UC	stream
69	NYMPHALIDAE	*Charaxes* spp.	3	IV	b	R	stream
70	AMATHUSIIDAE	*Discophora deo*	6	IV	b	UC	bush, road

No	Family	Species name	frequencyIndividual	Study site		Status (Kenyon, 2004)	Microhabitat
71	AMATHUSIIDAE	*Enipse euthymius*	2	IV	c,e	UC	trail
72	RIODINIDAE	*Zemeros flegyas*	3	IV	b	C	stone
73	RIODINIDAE	*Dodona dipoea*	7	IV	d,e	C	stream
74	RIODINIDAE	*Dodona ouida*	1	IV	c	UC	trail
75	RIODINIDAE	*Abisara fylla*	25	IV	b,c,e	C	trail, road
76	RIODINIDAE	*Abisara neophron*	1	IV	c	UC	trail
77	LYCAENIDAE	*Curetis bulis*	7	IV	b,d		stream
78	LYCAENIDAE	*Catapaecilma major*	1	IV	a		trail
79	LYCAENIDAE	*Ancema ctesia*	1	IV	d		stream
80	LYCAENIDAE	*Acytolepis puspa*	1	IV	e		trail
81	LYCAENIDAE	*Celastrina marginata*	1	IV	a		stream
82	LYCAENIDAE	*Celastrina* sp. 2	27	IV	b		leaf, road, stream, leaf
83	LYCAENIDAE	*Hypolycaena kina*	1	IV	e		trail
84	LYCAENIDAE	*Heliophorus* sp. 1	1	IV	a		stream
85	LYCAENIDAE	*Nacaduba* sp. 3	1	IV	a		trail
86	LYCAENIDAE	*Prosotas* spp.	2	IV	b,d		stream, leaf
87	LYCAENIDAE	*Jamides bochus*	22	IV	a,e		range, leaf
88	LYCAENIDAE	*Jamides* sp. 1	1	IV	e		range
89	LYCAENIDAE	*Lampides boeticus*	7	IV	b,c		trail, stream
90	LYCAENIDAE	*Caleta elna*	14	IV	b,c		trail, road, leaf
91	LYCAENIDAE	*Megisba malaya*	1	IV	a		trail
92	HESPERIIDAE	*Hasora* sp.	6	IV	a,b		trail, road
93	HESPERIIDAE	*Celaenorrhinus leucocera*	1	IV	a		bush
94	HESPERIIDAE	*Celaenorrhinus dhanada*	1	IV	a		stream
95	HESPERIIDAE	*Celaenorrhinus putra*	1	IV	a		stream
96	HESPERIIDAE	*Thoressa cerata*	1	IV	a		rock
97	HESPERIIDAE	*Pithauria stramineipennis*	3	IV	a,b		rock, leaf
98	HESPERIIDAE	*Koruthaialos* spp.	6	IV	b		stream, leaf
99	HESPERIIDAE	*Notocrypta curvifascia*	3	IV	a,c		bush, trail
100	HESPERIIDAE	*Scobura* sp. 2	2	IV	e		stream
101	HESPERIIDAE	*Potanthus* sp.	3	IV	b		leaf
102	HESPERIIDAE	*Pelopidas* sp.	5	IV	b		stream

IV = Wusok area

Appendix 4.3.6. Butterfly species recorded in Pisa area

No	Family	Species name	Individual frequency	Study site		Status (Kenyon, 2004)	Microhabitat
1	PAPILIONIDAE	*Troides aeacus*	1	V	b	LC	stream
2	PAPILIONIDAE	*Atrophaneura polla*	2	V	b	UC	stream
3	PAPILIONIDAE	*Papilio helenus*	1	V	b	C	stream
4	PAPILIONIDAE	*Papilio alcmenor*	1	V	b	UC	stream
5	PAPILIONIDAE	*Chilasa epycides*	10	V	b	UC	stream
6	PAPILIONIDAE	*Graphium sarpedon*	1	V	b	C	stream
7	PAPILIONIDAE	*Lamproptera meges*	2	V	a	UC	stream
8	PAPILIONIDAE	*Lamproptera* sp.	1	V	b		stream
9	PIERIDAE	*Pieris canidia*	5	V	b	C	trail
10	PIERIDAE	*Appias lalage*	20	V	b	UC	stream
11	PIERIDAE	*Catopsilia pomona*	1	V	b	C	trail
12	DANAIDAE	*Parantica sita*	7	V	a,b	C	trail, stream
13	DANAIDAE	*Euploea mulciber*	3	V	b	C	stream
14	SATYRIDAE	*Lethe verma*	6	V	a,b	UC	trail
15	SATYRIDAE	*Lethe vindhya*	1	V	a	UC	trail
16	SATYRIDAE	*Lethe bhairava*	1	V	a	UC	trail
17	SATYRIDAE	*Lethe gulnihal*	2	V	b	UC	trail
18	SATYRIDAE	*Neope bhadra*	1	V	b	UC	trail
19	SATYRIDAE	*Mycalesis* sp. 10	4	V	a,b		trail
20	SATYRIDAE	*Ypthima sakra*	1	V	b	UC	trail
21	SATYRIDAE	*Zipaetis scyllax*	2	V	b	UC	trail
22	NYMPHALIDAE	*Junonia iphita*	1	V	b	C	trail
23	NYMPHALIDAE	*Neptis miah*	1	V	b		stream
24	NYMPHALIDAE	*Neptis clinia*	3	V	b	C	stream
25	NYMPHALIDAE	*Euthalia franciae*	1	V	a	UC	trail
26	AMATHUSIDAE	*Enipse cycnus*	1	V	b	UC	trail
27	RIODINIDAE	*Zemeros flegyas*	10	V	b	C	scat
28	RIODINIDAE	*Abisara fylla*	5	V	b	C	trail

29	RIODINIDAE	*Abisara neophron*	2	V	b	UC	trail
30	RIODINIDAE	*Abisara chela*	1	V	a		trail
31	LYCAENIDAE	*Allotinus* sp.	1	V	b		bush
32	LYCAENIDAE	*Celastrina marginata*	10	V	b		stream
33	LYCAENIDAE	*Celastrina* sp. 2	20	V	b		stream
34	LYCAENIDAE	*Hypolycaena kina*	3	V	b		stream
35	LYCAENIDAE	*Heliophorus* sp. 1	2	V	b		stream, scat
36	LYCAENIDAE	*Nacaduba* sp. 3	1	V	b		scat
37	LYCAENIDAE	*Prosotas* spp.	1	V	b		stream
38	LYCAENIDAE	*Caleta elna*	1	V	b		stream
39	LYCAENIDAE	*Zizeeria maha*	1	V	b		trail
40	HESPERIIDAE	*Scobura* sp. 2	1	V	b		trail

V = Pisa area

Appendix 4.3.7. Butterfly species data collected from Khaunglanhpu area

No	Family	Species name	frequencyIndividual	Study site		Status (Kenyon, 2004)	Microhabitat
1	PAPILIONIDAE	*Papilio helenus*	1	VI	a	C	stream
2	PAPILIONIDAE	*Papilio memnon*	2	VI	a	VC	flower
3	PAPILIONIDAE	*Papilio protenor*	3	VI	a, e	C	stream, flower
4	PAPILIONIDAE	*Papilio alcmenor*	1	VI	e, f	UC	flower, stream
5	PAPILIONIDAE	*Graphium sarpedon*	1	VI	f	C	riverbank
6	PIERIDAE	*Artogeia napi*	1	VI	a	UC	cultivation, edge
7	PIERIDAE	*Pieris canidia*	20	VI	a, d, e, f	C	cultivation, bush, flower
8	PIERIDAE	*Appias lalage*	3	VI	e, f	UC	flower, edge
9	PIERIDAE	*Dercas lycorias*	1	VI	e	UC	flower
10	PIERIDAE	*Catopsilia pomona*	1	VI	a	C	edge
11	PIERIDAE	*Colias fieldi*	1	VI	b	UC	flower

12	PIERIDAE	*Eurema simulatrix*	1	VI	a, d	C	stream, cultivation, edge
13	PIERIDAE	*Eurema* sp. 2	2	VI	d		edge
14	DANAIDAE	*Parantica sita*	1	VI	b,c,d,e,f	C	flower, cultivation, edge
15	DANAIDAE	*Euploea mulciber*	1	VI	d	C	flower
16	SATYRIDAE	*Lethe sinorix*	1	VI	b	C	edge
17	SATYRIDAE	*Lethe confusa*	1	VI	f	C	edge
18	SATYRIDAE	*Lethe vindhya*	1	VI	e, f	UC	bush, forest
19	SATYRIDAE	*Lethe gulnihal*	5	VI	b, e, f	UC	bush, forest, edge
20	SATYRIDAE	*Neope bhadra*	1	VI	e	UC	edge
21	SATYRIDAE	*Neope pulaha*	2	VI	d, e	C	stream
22	SATYRIDAE	*Mycalesis* sp. 10	1	VI	a		stream, edge
23	NYMPHALIDAE	*Pseudergolis wedah*	1	VI	a	UC	stream
24	NYMPHALIDAE	*Argyreus hyperbius*	15	VI	a, d, f	UC	cultivation, edge
25	NYMPHALIDAE	*Vanessa indica*	2	VI	a, d, e	C	stream, flower, cultivation, edge
26	NYMPHALIDAE	*Vanessa cardui*	1	VI	d		edge
27	NYMPHALIDAE	*Kaniska canace*	1	VI	b	C	banana
28	NYMPHALIDAE	*Junonia iphita*	1	VI	f	C	edge
29	NYMPHALIDAE	*Symbrenthia lilaea*	10	VI	a, c, d, e	UC	stream, bush, edge
30	NYMPHALIDAE	*Symbrenthia hypselis*	1	VI	a, f	UC	stream, edge
31	NYMPHALIDAE	*Kallima inachus*	2	VI	f		river
32	NYMPHALIDAE	*Stibochiona nicea*	1	VI	b	UC	dung
33	NYMPHALIDAE	*Chersonesia risa*	1	VI	a	C	sandbar
34	NYMPHALIDAE	*Cyrestis thyodamas*	1	VI	e	C	bush
35	NYMPHALIDAE	*Neptis hylas*	2	VI	a, d, e	C	stream, cultivation, edge

No	**Family**	**Species name**	**Individual frequency**	**Study site**		**Status (Kenyon, 2004)**	**Microhabitat**
36	NYMPHALIDAE	*Neptis* sp. 3	1	VI	a, f	C	edge
37	NYMPHALIDAE	*Sumalia daraxa*	2	VI	a, c, e	UC	stream
38	NYMPHALIDAE	*Euthalia franciae*	1	VI	f	UC	river
39	NYMPHALIDAE	*Hestina nama*	1	VI	f	UC	river
40	RIODINIDAE	*Zemeros flegyas*	5	VI	a, d, e	C	stream, bush, edge
41	RIODINIDAE	*Dodona dipoea*	3	VI	a,d, f	C	stream, flower
42	RIODINIDAE	*Dodona ouida*	1	VI	d, f	UC	edge, forest
43	RIODINIDAE	*Abisara fylla*	6	VI	a, d, e	C	stream, bush, edge
44	RIODINIDAE	*Abisara chela*	1	VI	a, b		bush, stream
45	LYCAENIDAE	*Celastrina albocaerulea*	1	VI	a		stream
46	LYCAENIDAE	*Celastrina marginata*	5	VI	a		flower, stream

47	LYCAENIDAE	*Udara dilecta*	1	VI	d		grass
48	LYCAENIDAE	*Udara* sp.	1	VI	b		flower
49	LYCAENIDAE	*Rapala nissa*	1	VI	d		flower
50	LYCAENIDAE	*Heliophorus brahma*	2	VI	a, b		stream, bush
51	LYCAENIDAE	*Heliophorus androcles*	6	VI	a, c, d, e		bush, edge
52	LYCAENIDAE	*Heliophorus* sp. 1	3	VI	a,c,d,e,f		bush, edge, stream
53	LYCAENIDAE	*Orthomiella pontis*	3	VI	a, d		stream
54	LYCAENIDAE	*Jamides bochus*	3	VI	a, e		edge
55	LYCAENIDAE	*Lampides boeticus*	5	VI	a, c, d, f		grass, edge, flower
56	LYCAENIDAE	*Catochrysops strabo*	1	VI	f		edge
57	LYCAENIDAE	*Syntarucus plinius*	1	VI	b		edge
58	LYCAENIDAE	*Zizeeria maha*	20	VI	a, d		cultivation, flower
59	HESPERIIDAE	*Hasora anura*	1	VI	a		rock
60	HESPERIIDAE	*Hasora* spp.	4	VI	a, c, d		flower, edge, road
61	HESPERIIDAE	*Choaspes xanthopogon*	1	VI	e		flower
62	HESPERIIDAE	*Koruthaialos butleri*	2	VI	a		stream
63	HESPERIIDAE	*Notocrypta curvifascia*	1	VI	a, e		bush, grass
64	HESPERIIDAE	*Scobura* sp. 1	1	VI	e		flower

VI = Khaunglanhpu

Appendix 4.3.8. Butterfly species recorded in Yenam area

No	Family	Species name	Individual frequency	Study site		Status (Kenyon, 2004)	Microhabitat
1	PAPILIONIDAE	*Atrophaneura dasarada*	1	VII	b	UC	bush
2	PAPILIONIDAE	*Papilio paris*	1	VII	d	C	-
3	PAPILIONIDAE	*Papilio* spp.	2	VII	a,d		bush, road
4	PAPILIONIDAE	*Graphium sarpedon*	5	VII	b,c	C	in flight, stream
5	PIERIDAE	*Pieris canidia*	51	VII	a,b,c	C	bush, flower, grass
6	PIERIDAE	*Dercas verhuelli*	1	VII	a	C	road
7	PIERIDAE	*Colias fieldi*	2	VII	d	UC	bush
8	PIERIDAE	*Eurema andersoni*	5	VII	d	C	stream
9	PIERIDAE	*Eurema* sp. 1	2	VII	c	C	flower

10	SATYRIDAE	*Lethe sinorix*	1	VII	b	C	riverbank
11	SATYRIDAE	*Lethe verma*	1	VII	a	UC	bush
12	SATYRIDAE	*Lethe bhairava*	3	VII	b	UC	bush
13	SATYRIDAE	*Lethe* sp. 1	1	VII	c	UC	grass
14	SATYRIDAE	*Neope bhadra*	1	VII	c	UC	bush
15	SATYRIDAE	*Neorina* sp.	3	VII	a,c,d	UC	bush
16	NYMPHALIDAE	*Pseudergolis wedah*	1	VII	a	UC	stream
17	NYMPHALIDAE	*Cethosia cyane*	1	VII	a	C	stream
18	NYMPHALIDAE	*Argyreus hyperbius*	8	VII	a,c,d	UC	grass, flower, stream, in flight
19	NYMPHALIDAE	*Vanessa indica*	2	VII	a	C	stream
20	NYMPHALIDAE	*Symbrenthia lilaea*	3	VII	d	UC	stone, stream
21	NYMPHALIDAE	*Chersonesia risa*	1	VII	b	C	bush
22	NYMPHALIDAE	*Neptis* sp. 2	9	VII	a,c,d	UC	bush, stream, road
23	NYMPHALIDAE	*Neptis* sp. 4	1	VII	c	UC	bush
24	NYMPHALIDAE	*Hestina nama*	1	VII	b	UC	bush
25	RIODINIDAE	*Zemeros flegyas*	27	VII	a,b,d	C	stream, bush, road, stone
26	RIODINIDAE	*Dodona ouida*	9	VII	d	UC	stream, stone, bush
27	RIODINIDAE	*Abisara fylla*	1	VII	d	C	stone
28	LYCAENIDAE	*Celastrina albocaerulea*	1	VII	d		stream
29	LYCAENIDAE	*Celastrina argiolus*	2	VII	c		grass
30	LYCAENIDAE	*Heliophorous epicles*	3	VII	c,d		stone, rock, road
31	LYCAENIDAE	*Heliophorous ila*	1	VII	d		stream
32	LYCAENIDAE	*Jamides celeno*	2	VII	a		bush
33	HESPERIIDAE	*Notocrypta* sp.	1	VII	d		stone
34	HESPERIIDAE	*Caltoris* sp. 1	3	VII	b,d		bush

VII = Yenam

EIA Ornithological Report on Hydropower Development of Ayeyarwady River Basin above Myitkyina, Kachin state

THET ZAW NAING, SAW MOSES, SAO MYO ZAW, LAY KO KO, TIN AG HTUN, YE WIN, THIRI DAEWI AG and MA NYUNT SHWE

1. INTRODUCTION

This report on ornithological investigation is not included in fauna report but reported separately because the region where this hydropower development project lies is one of the unique areas for conservation of birds not only for Myanmar but also for the world. The area includes Important Bird Areas, Endemic Bird Areas and Secondary Areas. These areas are considered important places for conservation of birds in the world.

Birds are good indicators, and can be used to identify the most biologically rich areas, as well as environmental changes and problems. They are found in almost all natural habitats, they are high in the food chain and thus reflect changes lower down, a wealth of data have been collected by ornithologists, and their conservation status is well known relative to other taxa. In general, places that are rich in bird species are also rich for other forms of biodiversity.

So, birds can be used as indicators to locate these important areas. Studying birds can tell us about the habitats on which we all depend, and the loss of threatened birds from many parts of the region is a measure of a more general deterioration in other biodiversity and the natural environment. (BirdLife International 2005 "Saving Asia Threatened Birds")

Endemic birds are birds inhabiting in a restricted area. They only survive in a special niche or restricted area and habitat. These birds are more prone to extinction because of their nature in surviving within a restricted area. Once that area is degraded or destroyed they cannot migrate to other areas and will definitely face extinction. (See details in chapter 4)

They are therefore considered a priority for conservation.

2. ORNITHOLOGICAL INVESTIGATION

Ornithological investigations as part of EIA fauna special investigations on Hydropower Development of Ayeyarwady River basin above Myitkyina was carried out by Myanmar scientists from BANCA in collaboration with the Chinese scientists from January till May 2009. A total of 442 species of birds were recorded out of which one was considered critically endangered, 6 vulnerable and 9 near threatened. 11 species of endemic birds (restricted range species) were also recorded. There were also 14 new records for north Myanmar. This is the first time Chinese and Myanmar ornithologists collaboratively carried out such a kind of investigation.

The team managed to cover a relatively large area above the confluence. But due to limited time available for the studies the results of these investigations should not be considered comprehensive. Although having sufficient time to study Yenam, Khaunglanhpu, Chebwe, Myitsone and Lasa flooded areas the study period for Pisa and Wusok flooded areas was very short with only two days for Pisa flooded area. Moreover, the season for the study of Chibwe flooded area did not overlap with that of the winter migration of birds. Therefore many migrating birds were already on their way back to their breeding grounds in the north. Should the investigation be started in early December there is a strong possibility that more birds would be recorded in these investigations.

3. HISTORY OF ORNITHOLOGY IN THE KACHIN STATE

Historically, ornithological information for Myanmar especially for the Kachin state was quite limited. No known checklist of Myanmar bird species was available during the era of Myanmar kings. Literally, out of a thousand bird species occurring in Myanmar there was only over 200 names of bird species in Myanmar language. The reason could be that the areas ruled by Myanmar kings were situated only around central Myanmar where those 200 bird species occurred.

Myanmar was partially colonised by the British from the last Myanmar king in the late 1820s but the British were only able to annex the southern and lower part of Myanmar as one of the states of British India. Starting from that time the British gradually colonized the country and by 1852 over half of the country was under the British rule. During the early days some ornithological surveys were conducted in Tanintharyi division and lower Myanmar.(Hume, 1875 W. Davison, on behalf of A. O. Hume, and W. L. Abbott for the United States National Museum (USNM) 1875, 1877)

The upper Myanmar and the whole country were totally taken over by the British in the year 1885. Ornithological surveys and expeditions of upper Myanmar and Kachin State started a few years after the colonization of upper Myanmar. (*) Ornithological reports for northern Myanmar were not available before that period.

As a result of these expeditions "The Birds of Burma" by B.E. Symthies was published in 1940. That book was the first comprehensive reference bird book for Myanmar describing almost all the birds found in Myanmar. The second edition was published in 1949 followed by another edition in 1953. The fourth edition was published in 1981 and the fifth edition in 1986. In these books were descriptions of more than a thousand species of birds found in Myanmar. Although these were not field guide books, these books were considered as a bible for birds of Myanmar because they give reliable information of Myanmar birds.

There was a gap of ornithological expeditions about 60 years from 1949 till 1997, apart from a small collection of birds made west of Putao by O.Milton in 1958 - 1961. In the year 1975 Ben King of United States published a book on "Field Guide to the Birds of South East Asia". In that book was information of birds found in Myanmar together with other birds found in the mainland Southeast Asia. Since there were no other field guide books published for this region during that time all ornithologist have to rely on this book as a field guide of this region and was printed several times. (Total 11 times)

In 1998 December, King Bird Tour of the United States of America lead by the author of "Field Guide to the Birds of Southeast Asia" Ben F King, who is at that time considered to be the renowned ornithologist for Southeast Asian region, together with 5 other top ornithologists in the world, conducted an expedition to Mount Phonganrazi

*(Harington,1909-1910, Stanford & Ticehurst,1938-39, Mayr,1938, Stanford & Mayr, 1940-1941, and Gyldenstolpe ,1916, Stanford,J.K. (1931) Prome, Stanford,J.K. (1935)Sittang-Irrawaddy Plain, Stanford,J.K. (1938-39) Northern Burma, Stresemann, E.Heinrich (1940) Mt Victoria, Lowe,W.P.(1933) Vernay expedition to Tenasserim, Macdonald, K.C.(1906) Myingyan birds, Macdonald.K.C (1908) Amherst Birds, Mayr,E. (1938) Vernay Chindwin expedition, Mears,A.et al (1907) Chindwin birds, Meyer de Schauensee,R. (1934) SSS birds, Meyer de Schauensee,R.(1946) SSS, Oates,E.W.(1894) Birds of Byingyi Mt Shan, Oates,E.W.(1895) Ruby mines, Ripley,S.D (1961) Birds of North Burma, Rippon,G.(1896) Kalaw birds, Rippon,G.(1897)Kalaw,SSS, Rippon,G.(1901) SSS, Sewell,J.H.(1899) Kyaukse Birds, Smith, H.C.et al (1940) Smythies,B.E (1949) N'Mai Hka drainage, Nattaung,Karen, Smith, H.C.et al (1943-1944) Karen Birds, Stanford,J.K. (1940-41) Vernay-Cutting expedition North Myanmar, Anderson, J (1887) Birds of Mergui, Baker,E.C.S. (1922-1930)Fauna of British India, Bingham 1900, collection of birds from SSS , J.Asiatic Soc. Bengal 69:102-143, Bingham 1903, Ibis(8)3:584-606, Christison, *et al* (1946) Notes of Arakan birds. J Nat. His. Soc 46:13-32, Cook,J.P (1912) Notes on Thandaung birds, Cook,J.P (1913) Kalaw Birds, Harington,H.H . (1909-1910) Bhamo district birds, H.H.H (1911) Bhamo District, H.H.H (1911) Maymyo, Hopwood,C. (1908) Birds of Chindwin upper Burma, H.C (1912) Chindwin valley birds, H.C. (1912) Birds of Arakan birds, H.C. *et al* (1917) .

and its surroundings. The area is situated in the north western part of extreme Kachin state. The expedition took nearly four weeks. Following that, another expedition was carried out by Ben king *et al* at 1999 to the same area. Those two expeditions added much new information of northern Myanmar birds. Status and distribution of eastern Himalayan birds was reconfirmed after a gap of nearly 60 years. Starting from that time the ornithology of extreme north Myanmar became well known around the world and many surveys were continuously carried out by several conservation organizations and bird-watching tours resulting in and reconfirmation of the presence of many species that had not been recorded in the Kachin State. At the same time unpublished ornithological reports were also made by many bird-watching tours and expeditions. Those expeditions, bird-watching tours and surveys expanded knowledge of the status and distribution of many species in the state. (**2**) As one of the results a species new to science Naungmung Scimitar Babbler *Jabouilleia naungmungnensis* was discovered. (J.H.Rappole *et al, the Auk* 122(4):1064-1069, 2005) That bird was named after the place it was discovered, Naungmung, a town which is located in the surveyed area. Several new records for Myanmar were also made adding new species to the country's list as well as to the list of Southeast Asia.

4. INFORMATION AND STATUS OF BIRDS

Information and status of birds in this report are in reference to guidelines and red list data published by BirdLife International. **BirdLife international is the official IUCN Red List Authority for birds.**

4.1. Who is BirdLife International?

BirdLife International is a global Partnership of conservation organisations that strives to conserve birds, their habitats and global biodiversity, working with people towards sustainability in the use of natural resources.

4.2. BirdLife's Global Species Programme

BirdLife International is the leading authority on the conservation of the world's birds. Through its Global Species Programme, BirdLife has collated, assessed and published information on the world's threatened birds for over 25 years.

Since the first compilation in the late 1970s, a series of detailed regional Red Data Bookshas been published, covering Africa (1985), the Americas (1992) and most recently, Asia (1999). Global checklists of all the world's threatened birds were published as *Birds to watch* (1988), *Birds to watch 2* (1994), *Threatened birds of the world* (2000), and *Threatened birds of the world 2004* CD-ROM. Threatened birds of the world now contains factsheets and additional data tables for all the world's birds, including, all c.8,000 Least Concern species. BirdLife collates information from a global network of experts and collaborating organisations and from publications and unpublished sources to assess each species's extinction risk, using the categories and criteria of the IUCN Red List.Information on Globally Threatened Birds is used to focus global conservation efforts and to guide BirdLife's priorities for action. It is therefore essential that data on Globally Threatened Birds are kept up to date and regularly reviewed and revised.

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2 (Thein Ag & Zin Oo, 1999, King *et al* 2001, Rappole *et al* 2005, Wildbird Adventure Travels and Tours WATT 1998, 1999, 2003, 2004, 2005, 2006, 2007, 2008, van der Van, 2000, 2001, 2002,2003, BANCA BirdLife expedition to Mt Emawbum, 2004,2005,2006) .

4.3. EBA (Endemic Bird Areas) and Secondary areas in Myanmar

The Union of Myanmar lies in the range of four EBAs and three Secondary areas which are home to more than 40 restricted range bird species. (BirdLife International, Endemic Bird Areas of the world, BirdLife Conservation Series No.7)

4.4. Restricted-range bird species

Definition

A restricted-range bird species is a land bird which is judged to have had a breeding range of less than 50,000 km2 throughout historical times (1800). Some birds which have small ranges today were historically widespread, and are therefore not treated as restricted-range species. Extinct birds which qualify on range size are included.

4.5. EBA Endemic Bird Area

Definition

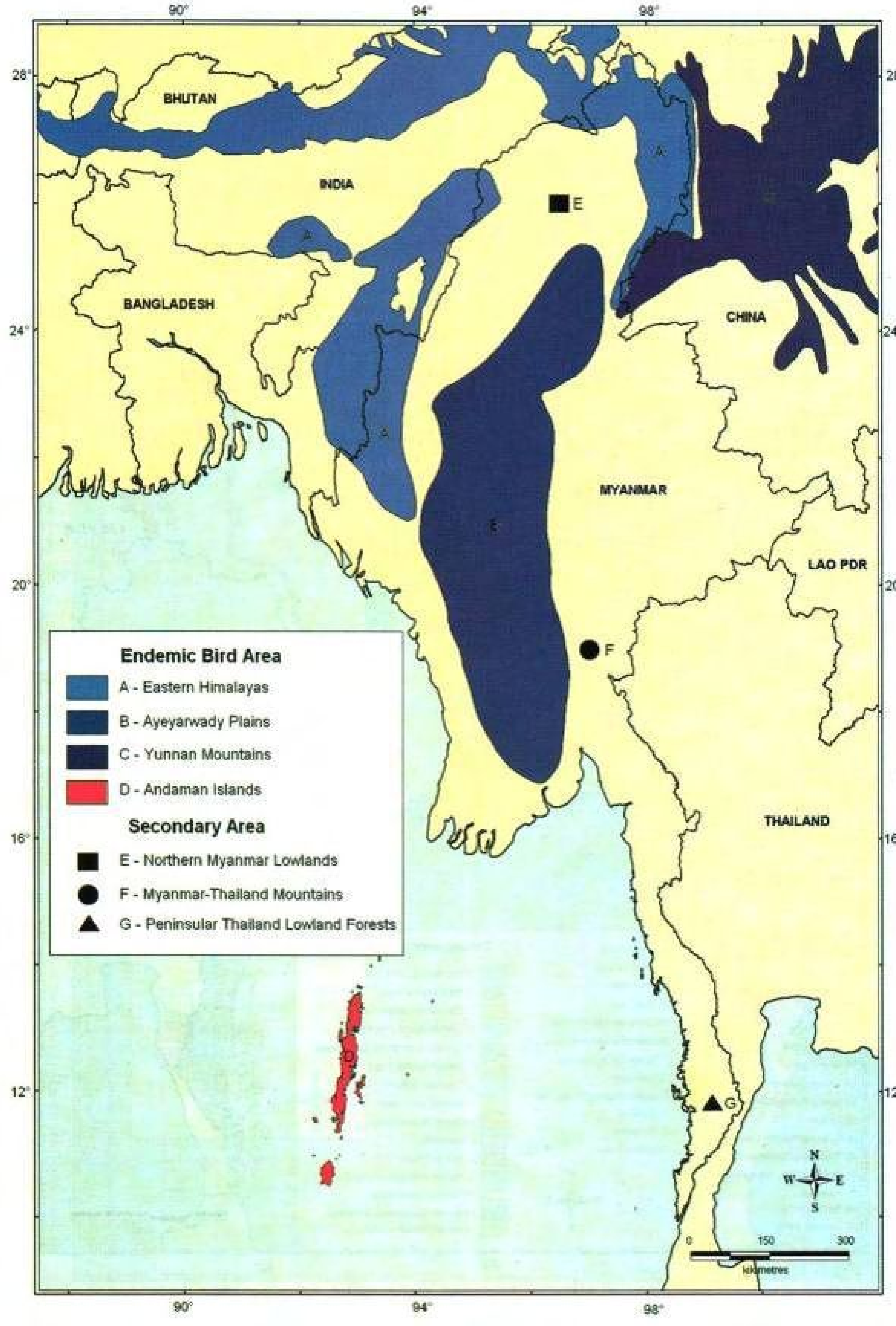
An Endemic Bird Area is defined as an area which compasses the over lapping breeding ranges of restricted-range bird species, such that the complete ranges of two or more restricted-range species are entirely included within the boundary of the EBA. This does not necessarily mean that the complete ranges of all of an EBA's restricted-ranges species are entirely included within the boundary of that single EBA, as some species may be shared between EBAs.

4.6. EBAs in Myanmar

The Union of Myanmar lies in the range of four EBAs namely

1. Andaman Islands (EBA no 125)
2. Eastern Himalayas (EBA no 130)
3. Irrawaddy plains (EBA no 132)
4. Yunnan mountains (EBA no 139)

These four EBA hosts at least 42 species of restricted range species of birds out of which 27 species are found in Myanmar.


90°
94°
98°
28°
24°
20°
16°
12°
BHUTAN
INDIA
BANGLADESH
CHINA
MYANMAR
LAO PDR
THAILAND
E
F
G
Endemic Bird Area
A - Eastern Himalayas
B - Ayeyarwady Plains
C - Yunnan Mountains
D - Andaman Islands
Secondary Area
E - Northern Myanmar Lowlands
F - Myanmar-Thailand Mountains
G - Peninsular Thailand Lowland Forests
N
W
E
S
0
150
300
kilometres

4.7. Secondary Areas

Definition

A secondary area is an area which supports one or more restricted-range bird species, but does not qualify as an EBA because fewer than two species are entirely confined to it. Typical Secondary Areas include singles restricted-range species which do not overlap in distribution with any other such species, and places where they are widely disjunct records of one or more restricted-range species.

4.8. Secondary areas in Myanmar

Myanmar is located within 3 secondary areas which are

1. North Myanmar lowlands (s079)
2. Myanmar Thailand mountains (s080)
3. Peninsular Thailand lowland forest (s086)

These three areas are home to three restricted range bird species.

In total, Union of Myanmar hosts 30 species of restricted range bird species. More than 50% of these birds are globally threatened and have a high priority status for conservation.

4.9. EBAs and secondary areas in the study area

The study area of "EIA special investigations on Hydropower development of Ayeyarwady Basin above Myitkyina" lies in the range of three endemic bird areas and one secondary area namely;

1. Eastern Himalayas EBA no 130
2. Irrawaddy plains EBA no 132
3. Yunnan mountains EBA no 139
4. North Myanmar lowlands (Secondary area)

13 species of birds from these EBA occur in the study area. They are birds that cannot be found anywhere in the world. Out of these species four are classified as vulnerable and two near threatened.

4.10. Vulnerable species found in the study area.

1. Chestnut-breasted Partridge (EBA 130)

   Arborophila mandellii

2. Blyth's Tragopan (EBA 130)

   Tragopan blythii

3. Sclater's Monal (EBA 130)

   Lophophorus sclateri

4. Hooded Treepie (EBA 132)

   Crypsirina cucullata

4.11 Near Threatened species

1. Grey Sibia (EBA 130)

Heterophasia gracilis

2. Yellow-vented Warbler (EBA 130)

Phylloscopus cantator

4.12. Important bird areas IBA (BirdLife International conservation series No: 13)

Definition

An Important Bird Area IBA is an area where -

1. The site is known or thought regularly to hold significant numbers of a globally threatened species.

2. The site is known or thought to hold a significant component of a group of species whose breeding distributions define an Endemic Bird Area (EBA) or a Secondary Area (SA).

3. The site is known or thought to hold a significant component of the group of species whose distributions are largely or wholly confined to one biome.

4. A site may qualify as an IBA under any one or more of the four criteria listed below:

- The site is known or thought to hold, on a regular basis, 1% or more of a biogeographic population of a congregatory waterbird species.

- The site is known or thought to hold, on a regular basis, 1% or more of the global population of a congregatory seabird or terrestrial species.

- The site is known or thought to hold, on a regular basis, at least 20,000 waterbirds, or at least 10,000 pairs of seabird, of one or more species.

- The site is known or thought to be a "bottleneck site" where at least 20,000 raptors (*Accipitriformes and Falconiformes*) and/or cranes *(Gruidae)* pass regularly during spring and/or autumn migration.

4.13. IBAs in Myanmar

IBA inventory for Myanmar is still under way. But in reference to IBA in Asia (BirdLife International Conservation Series No 13) there are 53 IBA in Myanmar. (See map)

4.14. IBAs in tha Kachin state

There are 12 IBAs in the Kachin state namely

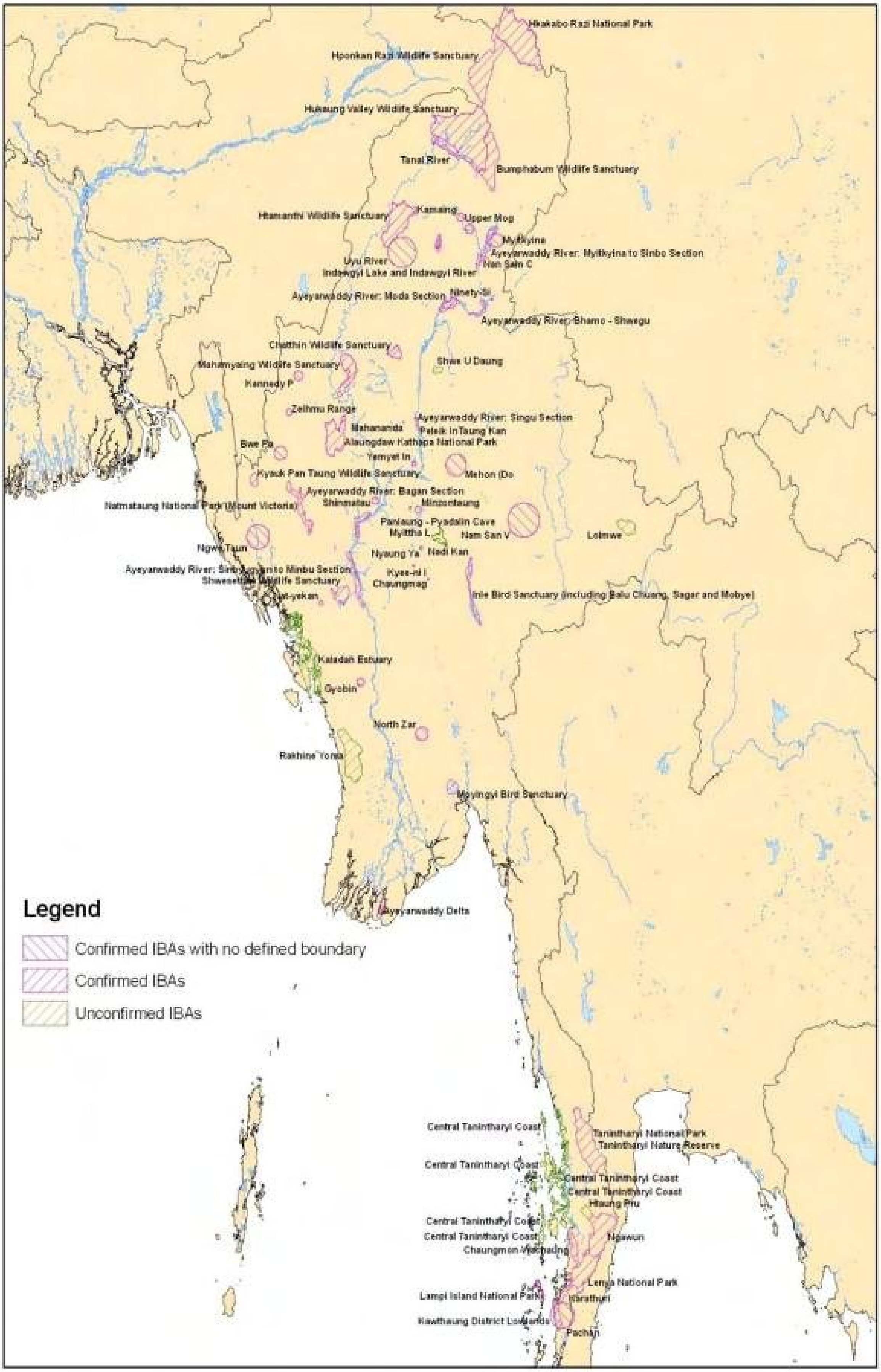
1. Hkakaborazi National Park.
2. Hponkanrazi Wildlife Sanctuary
3. Bumphabum Wildlife Sanctuary
4. Hukaung valley Tiger reserve
5. Kamine area
6. Tanai River
7. Upper Mokaung Chaung
8. Ayeyarwaddy river Myikyina to Sinbo section
9. Nansam Chaung

10. Ninety six Inns
11. Ayeyarwaddy river Bhamaw to Singu section
12. Indawgyi lake and Indawgyi river

4.15. IBAs in the study area

The study area lies adjacent to 3 IBAs namely

1. Hkakaborazi National Park
2. Hponkanrazi Wildlife Sanctuary
3. Bumphabum Wildlife Sanctuary


Hkakabo Razi National Park
Hponkan Razi Wildlife Sanctuary
Hukaung Valley Wildlife Sanctuary
Tanai River
Bumphabum Wildlife Sanctuary
Htamanthi Wildlife Sanctuary
Kamaing
Upper Mog
Myitkyina
Ayeyarwaddy River: Myitkyina to Sinbo Section
Nan Sam C
Uyu River
Indawgyi Lake and Indawgyi River
Ayeyarwaddy River: Moda Section
Ayeyarwaddy River: Bhamo - Shwegu
Chatthin Wildlife Sanctuary
Shwe U Daung
Mahamyaing Wildlife Sanctuary
Kennedy P
Zeihmu Range
Ayeyarwaddy River: Singu Section
Mahananda
Peleik InTaung Kan
Alaungdaw Kathapa National Park
Bwe Pa
Yemyet In
Kyauk Pan Taung Wildlife Sanctuary
Mehon (Do
Ayeyarwaddy River: Bagan Section
Shinmatau
Minzontaung
Natmataung National Park (Mount Victoria)
Panlaung - Pyadalin Cave
Myittha L
Nam San V
Loimwe
Ngwe Taun
Nyaung Ya
Nadi Kan
Kyee-ni I
Chaungmag
Inle Bird Sanctuary (including Balu Chuang, Sagar and Mobye)
Kaladan Estuary
Gyobin
North Zar
Rakhine Yoma
Moyingyi Bird Sanctuary
Ayeyarwaddy Delta
Legend
Confirmed IBAs with no defined boundary
Confirmed IBAs
Unconfirmed IBAs
Central Tanintharyi Coast
Tanintharyi National Park
Tanintharyi Nature Reserve
Central Tanintharyi Coast
Central Tanintharyi Coast
Central Tanintharyi Coast
Htaung Pru
Central Tanintharyi Coast
Central Tanintharyi Coast
Ngawun
Lenya National Park
Lampi Island National Park
Karathuri
Kawthaung District Lowlands
Pachan

These three IBAs together form an important portion of priority corridor for conservation in Myanmar known as Northern Mountains Forest complex. (Investment Opportunities in Biodiversity Conservation 2005, CEPF, UNDP BirdLife International) This corridor includes a wide range of natural habitats which is home to many species of globally threatened plants and animals.

These IBAs also host many endemic and globally threatened bird species which are of important conservation value.

The water shed areas of both Mayhka and Malihka rivers originate from these IBAs.

5. PAS (Protected area system) in Myanmar

The Union of Myanmar possess 43 areas of protected systems which is approximately 5% of the area of the country. (See Map)

There are four PAS around the study area namely

1. Hkakaborazi National park,
2. Phonganrazi Wildlife Sanctuary
3. Hugaung Valley Tiger Reserve
4. Bumphabum Wildlife sanctuary

These four PAS together form the Northern Mountain Forest Complex. These areas are the origin of the Ayeyarwaddy river.

The northern border of the reservoir of Yenam hydropower dam borders a relatively large portion of Hkakaborazi National Park. (See map)

6. BIRDS OF GLOBAL IMPORTANCE IN THE STUDY AREAS

The study area not only lies around the northern forest complex but also is home to White-bellied Heron *Ardea insignis* which is classified as Critically Endangered by BirdLife International.

6.1. White-bellied Heron (*Ardea insignis*)

This heron is classified as Critically Endangered because it has an extremely small and rapidly declining population. This decline is projected to increase in the near future as a result of the loss and degradation of lowland forest and wetlands, and through direct exploitation and disturbance.

Family/Sub-family Ardeidae

Species name author Hume, 1878

Taxonomic source(s) Sibley and Monroe (1990, 1993)

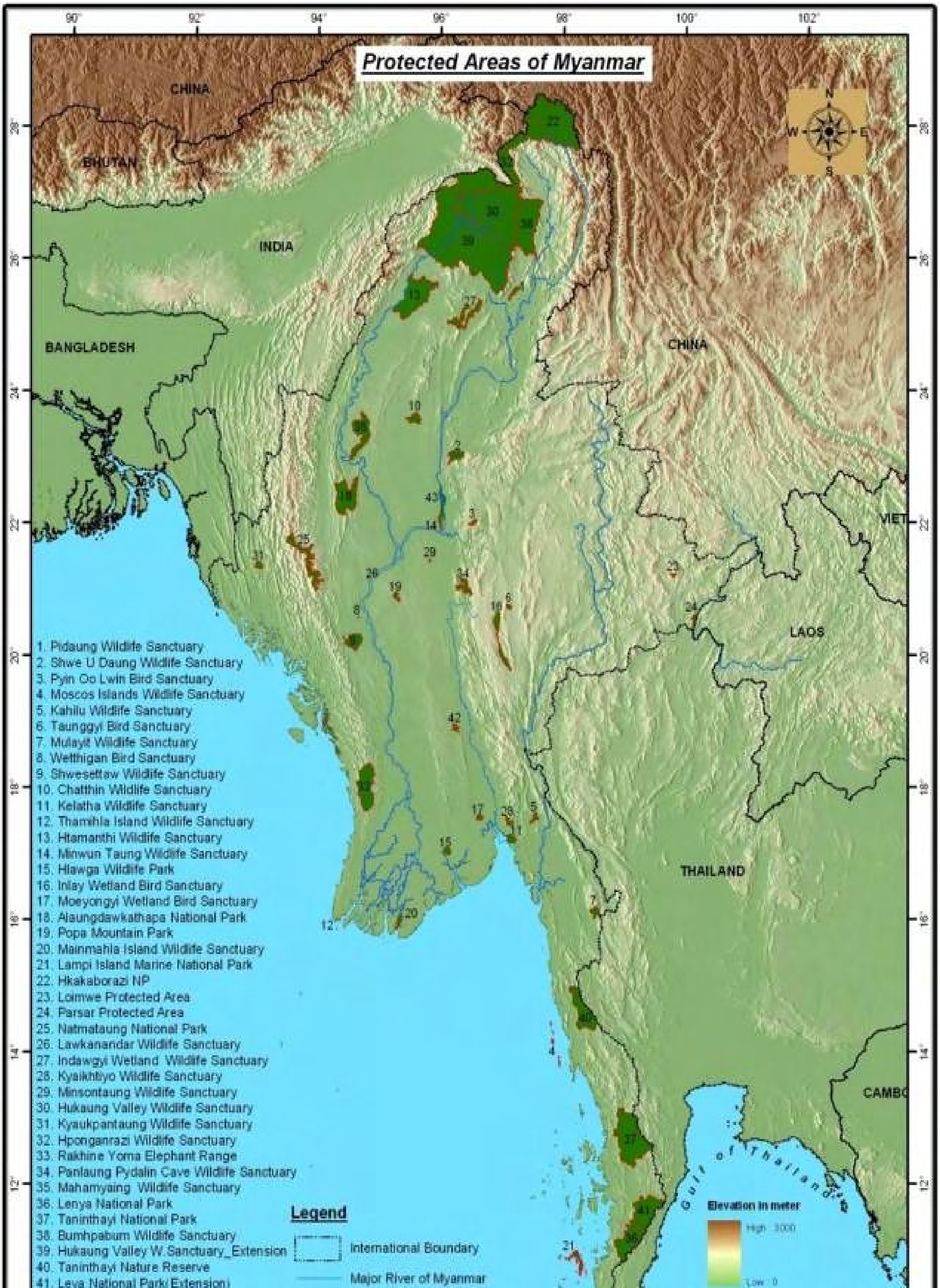
Synonyms *Ardea imperialis* Collar and Andrew (1988)

Identification: 127 cm. Very large, long-necked heron. Mostly dark greyish with contrasting white throat, belly and vent, and white-streaked scapulars, foreneck and upper breast. Both male and female have two lace-like white-plumes on nape. Juvenile is browner-tinged with smaller plumes. **Voice:** Loud, deep croaking *ock ock ock ock urrrrrr*.

Population estimate	Population trend	Range Estimate (breedig/resident)	Country endemic
50-249	decreasing	56,300 km^2	Non

Range & population: *Ardea insignis* is known from the eastern Himalayan foothills in **Bhutan** and north-east **India** to the hills of **Bangladesh**, north **Myanmar** and, historically at least, across west and central Myanmar. It may also occur in south-east Tibet, China, but is now extinct in Nepal. Birds visit the Brahmaputra lowlands in winter. Historical reports suggest it was common in Myanmar and, although it remains locally distributed there, it hasevidently declined throughout its range. Most of the few recent records come from five or six sites in Assam and Arunachal Pradesh, India, one or two sites in Bhutan, and parts of Myanmar. In Bhutan, there is a small population of 30 known individuals (with six juveniles) as of July 2007. The birds were observed along the Phochu, confluence of Phochu-Mochu, Punatsangchhu, Kamechu (Digchu), Zawa, Ngagshina and Burichu confluence. Six active nests were recorded in Bhutan in 2007, two from a new site, by 26 July 2007 they held six chicks in total. Due to the natural forest fire, three nests were abandoned. Six breeding sites from two rivers of central Bhutan have been recorded. Most of the few recent records come from five or six sites in Assam and Arunachal Pradesh, India, one or two sites in Bhutan, and parts of Myanmar. In Bhutan, there is a small population of30 known individuals (with six juveniles) as of July 2007. The birds were observed along the Phochu, confluence of Phochu-Mochu, Punatsangchhu, Kamechu (Digchu), Zawa, Ngagshina and Burichu confluence. Six active nests were recorded in Bhutan in 2007, two from a new site, by 26 July 2007 they held six chicks in total. Due to the natural forest fire, three nests were abandoned. Six breeding sites from two rivers of central Bhutan have been recorded. Eastern part of the country has not been thoroughly surveyed. In Myanmar, the 21,700 km^2 Hukaung Valley tiger reserve (the largest area of suitable habitat within the species's range) is believed to support approximately 30-40 individuals[4], and Hponkan Razi Wildlife Sanctuary and Hkakabo Razi National Park hold small populations. White-bellied heron has been recorded along rivers elsewhere in Kachin State, such as the Nam Sam Chaung, although little is known about its status in these areas[3]. Despite an increase in survey effort within the species' range in Myanmar there has been no corresponding increase in the number of records and the species was apparently absent from large areas of suitable habitat. One recent repeat survey failed to record the species in an area where it had been seen in 1998. The findings of field surveys have also been supported by reports from local people which suggest that the species has declined in the region in recent years[1]. This evidence suggests there may be fewer than 250 individuals remaining[1,2].

Ecology: It is primarily recorded from small or large rivers, usually with sand or gravel bars, often within or adjacent to subtropical broadleaved forest, from the lowlands up to at least 1,500 m. The species was reported from an inland lake[3]. It is generally solitary but may aggregate into small flocks during winter[1] and tends to frequent inaccessible and undisturbed areas. The species is known to breed and roost in Chir Pine forest[1,3]. In Bhutan, during the breeding season, adults and juveniles were observed feeding in small forest streams while the non-breeding adults remained in larger rivers.



Threats: The main threats are presumed to be widespread loss, degradation and disturbance of forest and wetlands. Wetlands have become degraded as a result of pollution, rapid growth of aquatic vegetation, and the over-exploitation of resources. Increasing disturbance and habitat degradation from settlement, conversion to agriculture, harvesting of wetland resources and, more locally, poaching are thought to present significant threats in key protected areas (e.g. Namdapha National Park) in north-east India, Bhutan and Myanmar[4]. In Bhutan, hydroelectric power developments and road improvements may result in habitat degradation in the future. Rivers act as busy transport routes for the human population, exacerbating disturbance of this species[1,4].

Conservation measures underway: It probably breeds in Namdapha Tiger Reserve (last surveyed in 2005-2006)[8] and it occurs seasonally in several other protected areas, including Kaziranga, Dibru-Saikhowa and Manas National Parks, and Pabitora Wildlife Sanctuary, India. In Myanmar a small population occurs within the Hukaung Tiger Reserve[4], and Hpon Razi Wildlife Sanctuary. A project studying White-bellied Heron began in Bhutan in 2003, and is run in conjunction with the Royal Society for the Protection of Nature, the World Wildlife Fund, the Felburn Foundation and the International Crane Foundation. Recognising the importance of the riverbed in Punakha-Wangdue as a primary feeding ground for this species, the Royal Government of Bhutan has declared the area as protected habitat for White-bellied Herons.

Conservation measures proposed: Conduct extensive surveys for the species in north-east India, Myanmar and also south-east Tibet, to establish its distribution, population status and ecological requirements, particularly in breeding areas. Support proposals to provide more effective protection for Namdapha National Park, including creation of buffer zones. Support requests to maintain habitat and minimise disturbance along the Manas river and around Ada lake, Bhutan. Initiate conservation awareness programmes in areas supporting populations, particularly in Myanmar and north-east India, using it as a flagship species. Consider satellite tagging individuals to improve current understanding of the species's movements and habitat preferences[2]. Improve conservation of protected areas in Myanmar.

Special attention was given to look out for this species of bird throughout the investigation period. At least 3 sightings were probably made of a single bird or two in this investigation.

6.2. Naungmon Scimitar Babbler (*Jabouilleia naungmungensis*)

This is a species that needs to be studied carefully in the study site not only because it is a newly recorded species for science but also because no one has ever made studied comprehensive studies of this bird before. It was discovered by a group of Myanmar and American scientists in 2004 during their ornithological expedition to that area. (Rappole *et al.*2005).

In February 2004, a group of scientists from Myanmar forest department Nature and wildlife conservation division together with ornithologists from Smithsonian Institution of the United States of America, made a survey of the areas around the town of Naungmung on the Nam Tisang River in the extreme northern portion of Kachin State, Myanmar. The town is located in the sub-Himalayan region of the country at 27°29’N, 97°48’E, elevation 540 m, 118 km south of the Tibetan border and 53 km west of the border with Yunnan Province, China.

References BirdLife International(2001). **1.** D. Wilson *in litt*. (2006). **2.** J. Eames *in litt*. (2006). **3.** A. W. Tordoff *in litt*. (2006). **4.** W. Duckworth *in litt*. (2006). **5.** M. Crosby *in litt*. (2006). **6.** Pradhan (2007). **7.** www.rspnbhutan.org (2007). **8.** Maheswaran (2007).

Scimitar-babblers that appeared to be representatives of the genus *Jabouilleia* were captured by mist nets. An additional individual of the taxon was captured in the same vicinity on 8 February 2004. These were the first records of Jabouilleia from Myanmar, and subsequent investigation showed that these specimens are members of a previously undescribed species, and was designated as *Jabouilleia naungmungensis*, the Naung Mung Scimitar-Babbler. *Received 1 October 2004, accepted 2 July 2005.*

Another group of scientists from Smithsonian returned to the Naung Mung area in March of 2006, and were able to collect additional information on *J. Naungmungensis*. In addition, another small group visited the region in June–July 2006. The purpose of this paper is to present new data on the species, and to place them in the context of what is known concerning related species. (Observations on a new species: the Naung Mung Scimitar-Babbler *Jabouilleia naungmungensis* J H rappole et al, Ibis, 2008)

However the team only discovered the new species but was not able to make any detailed studies due to limited time available. Very little was known about its ecological behaviour, its status and range. More studies need to be carried out to obtain comprehensive information of this species.

7. ORNITHOLOGY SURVEY TEAM

Team members were Thet Zaw Naing, Saw Moses, Sao Myo Zaw, Lay Ko Ko , Ye Win, Tin Aung Htun, Thiri Daewi Aung and Ma Nyunt Shwe.

7.1. Itinerary

The detail itinerary is shown in table - 1

8. MATERIALS AND METHODS

Taxonomy, sequence and nomenclature follows *An annotated checklist of the Birds of the Oriental Region* (Inskip et al 1996) which is almost identical to *Distribution and Taxonomy of Birds of the World* (Sibley and Monroe 1990) while names of places, villages, minor rivers and wetlands are local. The ornithological regions of Myanmar follow those used by Robson (2005), which, in turn, follow (with revisions) those of King *et al.* (1975).

8.1. Equipments used

1. Binoculars (Minox 8x40 mm, Celestron (Eagle optics) 8x40 mm, RSPB 8 x 40 mm, Nikon Monarch 8 x 40 mm, Swarovski 8.5 x 40 mm, all roof prism)
2. Telescopes (Kowa 20 x 60 mm)
3. Sanyo cassette recorders
4. Sony speakers
5. Unidirectional microphones.
6. Locally made bamboo whistle
7. Garmin 60 CSX, Garmin E-trek legend Cx, Garmin map 76s (Global Positioning Systems)
8. Icon IC-V8 hand held radio transmitters and speakers
9. Digital cameras, Canon EOS 50 B with 300 mm lens, Nikon Cool pix L18, Sony Cybershot DCS-S730

8.2. Time of surveys

Special instructions were given to ornithologists from the teams to be out in the field in early morning first light to coincide with the time when the birds are most active. Late afternoon surveys when bird activity is high were also conducted. Recorded birds were noted down together with GPS coordinates and significant facts such as habitats, number of birds, time and distance of record marked.

8.3. Methods

Preferred-text-book-site selection and method for ornithological survey in these flooded areas were impossible because of time limitation and terrain of the area. Since there were no good motor roads travelling time to the area usually takes longer, about double and sometimes even more than the time available for survey. Most of the time, the scientists have to walk to reach the area they were investigating. On account of that, special attention was made to get a good transect of the site including as many habitats occurring there. Random recordings were also made along the tract to the flooded areas. As steep slopes of more than 60 degrees in flooded areas made such cross transects impossible longitudinal transects were made. Visual sighting with binoculars and auditory surveys along trails and inundated areas were done. In areas where habitat is likely to host special birds, pre-recorded calls and songs of birds likely to be in that habitat were played. The bird which responded and showed up to the calls was carefully studied by the scientists using binoculars. The indentified birds were then noted down on a prepared form. Whenever unidentified bird calls were heard those calls and songs were recorded by tape recorder using zoom microphone and the calls played back. Birds that responded were properly studied. Attracting small birds with owlet calls was also done. Each bird identified was noted down and if there was more than a bird, quantity was also recorded. Moreover, sex of the bird was categorized if possible. The scientists would then together make a list of all birds recorded by the end of the day.

Mist nets were used whenever possible. Birds caught in the nets were carefully taken out the net, identified, photographed and released back after identification.

Bird species were identified in reference to

1. "Field guide to the birds of Southeast Asia and Thailand" by Craig Robson 2005, 2008.
2. "Birds of India, Pakistan, Nepal, Bangladesh, Bhutan, Sri Lanka and the Maldives by Richard Grimmett, Tim and Carol Inskipp (1999).
3. "Birds of South Asia The Ripley Guide" by Pamela Rasmussen 2005.
4. "Bird of China" by John Mc Cannon and Karen Phillips.

The status of birds is this report is in reference to

1. "Red Data Book, Threatened Birds of Asia" by Niger Collar *et al.* BirdLife International (2001)
2. "Threatened Birds of the World" BirdLife International (2008).
3. "Saving Asia's Threatened birds" BirdLife International (2004)
4. "Endemic Bird Areas of the World" BirdLife International (1998)
5. "Important Bird Areas of Asia" BirdLife International

9. RESULTS

Species abundance: A total of 529 bird species, from 47 families and 18 orders were recorded. One family of order Galliformes, two families of Anseriformes and Piciformes, seven families of Coraciiformes, two families of Cuculiformes, one family of Trogoniformes and Psittaciformes, two families of Apodiformes and Strigiformes, one family of Caprimulgiformes and Columbiformes, two families of Gruiformes, two families of Charadriiformes and Falconiformes, one family of Podicipendiformes, two families of Pelecaniformes, three families of Ciconiformes and fourteen families of Passerformes were recorded (Appendix 2).The maximum number of family (14 families) were recorded in the order Passerformes and the minimum number of family (one family) were recorded in order Galliformes, Trogoniformes, Psittaciformes, Caprimulgiformes, Columbiformes, and Podicipediformes. The greatest species richness (338) species was recorded in the family Sylviidae and the least (one species) was recorded in the family Podicipedidae, Anhingidae, Gruidae, Tytonidae and Hemiprochidae (Table 3).

Species abundance in relation to the elevation ranges of study area were shown in Figure 1. The highest altitude was found in Khyaunglanphu, study area VI, and the lowest altitude in Myitsone, study area I. The greatest abundance of species was recorded in study area I, which was observed for the greatest number of days.

Bird species (total numbers collected) were recorded in or on or near or around the following microhabitats in the percentages indicated in brackets: water (7.16); bamboo (11.3), bush (21.72), ground (5.86), cultivation (0.118),tree trunk (1.657), top, middle and lower canopy (40.41), banana tree (0.059) and building (0. 059) (Table 5 and Figure 2).

9.1. Myitsone (study area I)

Species abundance: A total of 273 bird species under 44 families were recorded. The richest (42 species) is the family sylviidae and the poorest is (one species) recorded from the family Upupidae, Trogonidae, Hemiprocndae, Tytonidae,k Gruidae, Podicipedidae, Anhingidae , Phalacrocoracidae and Alautidae (Appendix 3). Among them, the maximum number of individual (693 birds) was recorded in the species Asian Palm Swift *Cypsiurus balasiensis* and the minimum number of individual (one bird) was recorded in the 25 bird species (Appendix 3).

Bird species (total numbers collected) were recorded in or on or near or around the following microhabitats in the percentages indicated in brackets: water (11.82), flight (16.29), bamboo (12.78), bush (12.14), ground (3.834), cultivation (0.639), tree trunk (3.195), top, middle and lower canopy (37.7) and banana tree (0.958) in flight – not a real microhabitat (Table .5, Figure 3).

New recorded bird species for North Myanmar: Total of 9 species of birds was recorded as new recorded for North Myanmar (Table 7).

Threats: Habitat for bird species was degraded by logging and gold dredging. Logging was noted in Bam-bane village, Thei-wine and especially found in Jubali. Much illegal logging has resulted in the forest being totally destroyed. Gold mining was also found.

Conservation Status: Reference to IUCN Red list, 5 species of globally threatened species were recorded in Myisone study area I. They are one species of vulnerable Ruferous- necked Hornbill *Aceros nipalensis* and four species of near- threatened, 1. Great Hornbill *Buceros bicornis*, 2. Lesser Fish Eagle *Ichthyophaga bumills*, 3. Oriental

Darter *Anhinga melanogaster* and Chestnut- backed Laughingthrush *Garrulax nuchalis*. (See table 6)

9.2 Lasa (study area II)

Species abundance: A total of 197 bird species under 38 families were recorded. The greatest species richness (36 species) was recorded in the family sylviidae and the least (one species) was recorded in the family Anatidae, Upupidae, Coiraciidae, Halcyonidae, Apodidae, Caprimulgidae, Rallidae, Phalacrocoracidae and Ciconidae (Appendix 4). Among them, the maximum number of individual (644 birds) was recorded in the species Asian Palm Swift *Cypsiurus balasiensis* and the minimum number of individual (one bird) was recorded in the 28 bird species (Appendix.4)

Bird species (total numbers collected) were recorded in or on or near or around the following microhabitats in the percentages indicated in brackets: water (7.34), flight (17.5), bamboo (16.4), bush (17.1), ground (5.24), tree trunk (1.4), top, middle and lower canopy (33.2) and banana tree (1.75) in flight – not a real microhabitat (Table .5, Figure. 4).

New recorded bird species for North Myanmar: Total of 3 species of birds were recorded as new recorded for North Myanmar (see table 7).

Threats: Habitat for bird species was degraded by logging and gold dredging. Logging was noted in Bam-bane village, Thei-wine and especially found in Jubali. Much illegal logging has resulted in the forest being totally destroyed. Gold mining was also found.

Conservation Status: According to IUCN Red list, 7 species were recorded in study area II. Among them, one species of Critically Endangered (White- bellied Heron *Ardea* insignis), two species of Vulnerable (Ruferous- necked Hornbill *Aceros nipalensis* Pallas's Fish Eagle *Haliaeetrs leucoryphus*) and four species of Near- threatened (Great Hornill *Buceros bicornis*, Blyth's Kingfisher *Alcedo hercules,* Grey- headed Fish Eagle *Ichthyophaga ichthyaetus*, and Chestnut- backed Laughingthrush *Garrulax nuchalis* were recorded (Table 6).

9.3. Chibwe (study area III)

Species abundance: A total of 251 bird species under 24 families were recorded. The greatest species richness (65 species) was recorded in the family sylviidae and the least (one species) was recorded in the family Upupidae, Trogonidae, Cerylidae, Psittacidae, Caprimulgidae, Rallidae, Ciconidae, Irendidae, Cinclidae and Zosteropidae (Appendix. 5). Among them the maximum number of individual (96 birds) was recorded in the species Red- whiskered Bulbul *Pycninotus jocosus* and the minimum number of individual (one bird) was recorded in the 27 bird species (Appendix.5)

Bird species (total numbers collected) were recorded in or on or near or around the following microhabitats in the percentages indicated in brackets: water (4.31), flight (9.493),bamboo (8.621), bush (17.1), ground (8.621), tree trunk (0.862), top, middle and lower canopy (42.82) and building (0.287) in flight – not a real microhabitat (Table .5, Figure.5).

New recorded bird species for North Myanmar: Total of 3 species of birds were recorded as new recorded for North Myanmar (see table 7).

Threats: Habitat for bird species was degraded by logging. Chinese people from China take out logs by truck every day. Much illegal logging has resulted in the forest being totally destroyed. Gold mining was also found.

Conservation Status: According to IUCN Red list, 6 species were recorded in study area III. Among them, two species of Vulnerable (Ruferous- necked Hornbill *Aceros nipalensis* Beautiful Nuthatch *Sitta formusa* and four species of Near- threatened (Great Hornill *Buceros bicornis*, Blyth's Kingfisher *Alcedo hercules,* Rusty- bellied Shortwing *Brachypteryx* hyperythra and Chestnut- backed Laughingthrush *Garrulax nuchalis* were recorded (Table .6).

9.4. Wusot (study area IV)

Species abundance: A total of 117 bird species under 24 families were recorded. The greatest species richness (31 species) was recorded in the family sylviidae and the least (one species) was recorded in the family Trogonidae, Alcedinidae, Cerylidae, Meropidae, Scolopacidae, Phalacrocoracidae, Irenidae, and Cisticolidae (Appendix. 6). Among them, the maximum number of individual (50 birds) was recorded in the species Black Bulbul *Hypsipetes leucocephalus* and the minimum number of individual (one bird) was recorded in the 23 bird species (Appendix.6)

Bird species (total numbers collected) were recorded in or on or near or around the following microhabitats in the percentages indicated in brackets: water (5.594), flight (11.19). bamboo (4.196), bush (27.27), ground (3.497), tree trunk (1.399) and top, middle and lower canopy (46.85) in flight – not a real microhabitat (Table.5, Figure .6).

New recorded bird species for North Myanmar: Total of 3 species of birds were recorded as new recorded for North Myanmar (Table. 7).

Threats: Habitat for bird species was degraded by logging. Logging was noted in Bam-bane village, Thei-wine and especially found in Jubali. Much illegal logging has resulted in the forest being totally destroyed. Gold mining was also found.

Conservation Status: According to IUCN Red list, 5 species were recorded in study area IV. Among them, three species of Vulnerable (Ruferous- necked Hornbill *Aceros nipalensis* Wood snipe *Gallinagp nemoricola* , Beautiful Nuthatch *Sitta Formosa* and two species of Near- threatened (Great Hornill *Buceros bicornis*, Chevron- breasted Babbler *Sphenocichla roberti* were recorded (Table 6).

9.5. Pisa (study area V)

Species abundance: A total of 97 bird species under 20 families were recorded. The greatest species richness (33 species) was recorded in the family sylviidae and the least (one species) was recorded in the family Upupidae, Halcyonidae, Strigidae, Falconidae, Pittidae, Cisticolidae and Zosteropidae (Appendix.7). Among them, the maximum number of individual (50 birds) was recorded in the species Black Bulbul *Hypsipetes leucocephalus* and the minimum number of individual (one bird) was recorded in the 11 bird species (Appendix.7)

Bird species (total numbers collected) were recorded in or on or near or around the following microhabitats in the percentages indicated in brackets: water (4), flight (2). bush (32), ground (6), tree trunk (2) and top, middle and lower canopy (54) in flight – not a real microhabitat (Table.5, Figure.7).

Threats: Habitat for bird species was degraded by logging, timber production and a few cutting cultivation.Much illegal logging has resulted in the forest being totally destroyed. Gold mining was not found.

Conservation Status: According to IUCN Red list, only one species was recorded in study area V. That species is White- cheeked Patridge *Arboraphila atrogularis* which is considered Near threatened (Table .6).

9.6. Khaulangphu (study area VI)

Species abundance: A total of 226 bird species under 31 families were recorded. The greatest species richness (78 species) was recorded in the family sylviidae and the least (one species) was recorded in the family Upupidae, Trogonidae, Alcedinidae, Cerylidae, Falconidae, Sturnidae and Alautidae. (Appendix.8). Among them, the maximum number of individual (336 birds) was recorded in the species Nepal Fulvetta *Alcippe nipalensis* and the minimum number of individual (one bird) was recorded in the 49 bird species (Appendix.8)

Bird species (total numbers collected) were recorded in or on or near or around the following microhabitats in the percentages indicated in brackets: water (7.143), flight (7.54),bamboo (9.524), bush (23.81), ground (5.556), tree trunk (2.381) and top, middle and lower canopy (4.05) in flight – not a real microhabitat (Table.5, Figure.8).

New recorded bird species for North Myanmar: Total of 3 species of birds were recorded as new recorded for North Myanmar (Table. .7).

Threats: Habitat for bird species was degraded by logging and gold dredging. Much illegal logging has resulted in the forest being totally destroyed. Gold mining was also found.

Conservation Status: According to IUCN Red list, 8 species were recorded in study area VI. Among them, four species of Vulnerable (Blyth's Tragopan *Tragopan boythii,* Ruferous- necked Hornbill *Aceros nipalensis* Beautiful Nuthatch *Sitta formusa* and snowy- throated Babbler and four species of Near- threatened (Great Hornill *Buceros bicornis*, Lesser Fish Eagle *Ichthyophagp bumills,* Chevron - breasted Babler *Sphenocichla* and Chestnut- backed Laughingthrush *Garrulax nuchalis* were recorded (Table .6).

9.7. Yenam (study area VII)

Species abundance: A total of 162 bird species under 27 families were recorded. The greatest species richness (53 species) was recorded in the family sylviidae and the least (one species) was recorded in the family Anatidae, Upupidae, Trogonidae, Cerylidae, Apopidae, Columbidae, Falconidae, Phalacrocoracidae and Sittidae (Appendix.9). Among them, the maximum number of individual (166 birds) was recorded in the species Himalayan swiftlet *Collocalia brevirostris* and the minimum number of individual (one bird) was recorded in the 25 bird species(Appendix.9)

Bird species (total numbers collected) were recorded in or on or near or around the following microhabitats in the percentages indicated in brackets: water (7.2), flight (7.6),bamboo (17.6), bush (24.8), ground (6.8), tree trunk (0.4) and top, middle and lower canopy (35.6) in flight – not a real microhabitat (Table .5, Figure.9).

New recorded bird species for North Myanmar: Total of 3 species of birds was recorded as new recorded for North Myanmar (Table. 7).

Threats: Habitat for bird species was degraded by logging and gold dredging. Timber production and a few cutting cultivation were also found. Local people depend on taungya cultivation. Much illegal logging has resulted in the forest being totally destroyed. Gold mining was also found.

Conservation Status: According to IUCN Red list, 7 species were recorded in study area VII. Among them, two species of Vulnerable (Ruferous- necked Hornbill *Aceros nipalensis* and Beautiful Nuthatch *Sitta formusa* five species of Near - threatened (White- cheeked Patridge *Arborophila atrogularis* , Great Hornill *Buceros bicornis*, Blyth's Kingfisher *Alcedo Hercules,* Grey- headed Fish Eagle *Ichthyophagp ichthyaetus* and Chestnut- backed Laughingthrush *Garrulax nuchalis* were recorded (Table 6).

10. SIGNIFICANT RECORDS

Of all the birds recorded the followings are of global importance and are described in details.

10.1. White- bellied Heron *Ardea insignis* (Critical Endangered)

One bird of this species was found feeding on the stone near the Malikha River MaliYang Village, Lasa area on the May 2009. Another two birds were seen flying neat the river at the same area on the 22nd May 2009.

Around 1 km upriver of the point where the White- bellied Heron was seen was a large gold dredging machine, and consequently, the colour of the river was extremely turbid.

The detail of this critically endangered species is already described.

10.2. Blyth's Tragopan *Tragopan blythii* (Vulnerable)

This species is one of the endemics of Eastern Himalyan Endemic bird area. Six birds of this species were found feeding on the ground in a bamboo forest at 1052 meters along the way to Khaunlanhpu survey area on the 20th May. (Table.6)

Justification This species qualifies as Vulnerable because its total population is believed to be small, declining and scattered in small subpopulations within a severely fragmented range. Widespread high levels of hunting and continuing habitat destruction will inevitably exacerbate this situation.

Family/Sub-family Phasianidae

Species name author (Jerdon, 1870)

Taxonomic source(s) Sibley and Monroe (1990, 1993)

Identification Male 65-70 cm, female 58-59 cm. Typical tragopan with distinctive, greyish lower breast and belly. **Similar spp.** Male differs from other Tragopans by yellow facial skin and grey belly patch. Female can be confused with Satyr Tragopan *T. satyra* and Temminck's Tragopan *T. temminckii*, but differs from both by yellowish eye-ring and paler, greyer belly, additionally from latter by less distinct pale spots and streaks on underparts. Juvenile initially like female, male gradually attains orange-red on neck during first year. **Voice** Male territorial call is loud, moaning *ohh ohhah ohaah ohaaah ohaaaha ohaaaha ohaaaha*.

Population estimate	Population trend	Range estimate (breeding/resident)	Country endemic?
2,500-9,999	decreasing	42,400 km^2	No

Ecology: It inhabits subtropical and temperate, evergreen oak and rhododendron forests, generally preferring a dense understorey, often dominated by bamboos or ferns, in steep or rocky terrain. Its documented altitudinal range is from 1,400 m (winter) up to 3,300 m (summer), but the majority of records come from a rather narrower band (1,800-2,400 m).

Threats In north-east India, deforestation is a significant threat, primarily as a result of shifting cultivation. Together with fuelwood-collection and commercial timber extraction, this is rapidly fragmenting suitable habitat, even within protected areas, where enforcement of regulations is often absent or impossible. Hunting for food is the other major threat, particularly in Nagaland and Arunachal Pradesh, where large-scale snaring of pheasants and partridges by local people is an increasing problem. Little data on the exploitation of this species is available from Myanmar, making it difficult to assess the severity of the threat there[3]. Even in Bhutan, high levels of grazing and slash-and-burn agriculture are potentially significant problems.

Conservation measures underway CITES Appendix I. The species is legally protected in all countries. It occurs in several protected areas, including: two small wildlife sanctuaries and a community reserve in Nagaland[2]; the Blue Mountain National Park in Mizoram; Mouling National Park[2], Sessa Orchid Sanctuary[1], Eaglenest Mehao and Dibang Wildlife Sanctuaries in Arunachal Pradesh; Thrumsing La National Park, Bhutan; Gaoligongshan National Park in China[4]; and Natma Taung National Park, Myanmar. Surveys for the species have been conducted in many areas in north-east India. An international studbook exists documenting the captive population held at locations in North America and Europe; however, recent analysis found the captive population is declining, ageing and highly inbred and requires new founders if it is not to be lost as a conservation resource for the species[5].

Conservation measures proposed Design and implement monitoring projects in Nagaland, Manipur and Mizoram. Initiate a conservation awareness programme with communities in range areas, focusing on the effects of over-exploitation. Continue (or initiate) surveys to establish its distribution, status and habitat requirements in Myanmar, Arunachal Pradesh, Bhutan, Yunnan and south-east Tibet. Review the adequacy of the current protected areas system, to evaluate whether new areas in Myanmar, north-east India and south-east Tibet could be feasibly and usefully protected. Promote the careful management of existing captive populations and introduce new founders.

10.3. Rufous-necked Hornbill *Aceros nipalensis* (Vulnerable)

Two birds of this species were sighted flying while surveying Myitson area on the 17th of January 2009. Another one was seen on a tree at the same area on the 22nd. Three were sighted flying and one bird perching on a big tree in Lasa area on the 16th of April.6 birds were sighted flying across the river in Chibwe area on the 7th of April.

Another group of four was also sighted flying across the river on the 13th of April also in Chibwe area. Two birds were sighted flying across the river in Wusot area on 19 th of April. Two birds were sighted flying across the forest in Khaunglanphu on the 28 th of February. Another bird was seen perching on top of canopy of the big tree on 13 th of March. Three birds were recorded flying across the forest in Renam 14 th of February.

This large hornbill qualifies as Vulnerable because it has a small, rapidly declining population as a result of destruction of evergreen forest and hunting.

Family/Sub-family Bucerotidae

Species name author (Hodgson, 1829)

Taxonomic source(s) Sibley and Monroe (1990, 1993)

Identification 117 cm. Large hornbill with distinctive rufous head and underparts. Males are black above with white-tipped outer primaries, white tail with black basal half, pale yellowish bill with row of vertical dark ridges on upper mandible and almost no casque, blue orbital skin and red gular skin. Female has black head, neck and underparts and slightly duller orbital skin. Juvenile is like male but bill smaller without dark ridges, tail feathers may be narrowly dark-tipped. **Voice** Loud barking *kup* or *kok* notes.

Population estimate	Population trend	Range estimate (breeding/resident)	Country endemic?
2,500-9,999	decreasing	285,000 km^2	No

Ecology: It inhabits mature broadleaved forests, generally between 600-1,800 m (maximum altitude 2,200 m), but locally down to 150 m. It has also been recorded in dry woodland[4]. It nests (usually March-June) in tall, wide-girthed trees. Evidence suggests that some populations make seasonal movements between forested areas in response to variations in the abundance of fruiting trees.

Threats Its dependence on large trees for feeding and nesting makes it especially susceptible to deforestation and habitat degradation through logging, shifting cultivation and clearance for agriculture. Furthermore, viable populations require vast tracts of forest to survive, exacerbating its susceptibility to habitat fragmentation. These problems are compounded by widespread hunting and trapping for food, and trade in pets and casques.

Conservation measures underway CITES Appendix I and II. The following protected areas support important populations: Xishuangbanna Nature Reserve, China, Thrumshing La National Park, Bhutan, Namdapha National Park, Arunachal Pradesh, India, Nakai-Nam Theun National Biodiversity Conservation Area, Laos, and Um Phang and Maewong National Parks and Huai Kha Khaeng and Thung Yai Wildlife Sanctuaries, Thailand.

Conservation measures proposed Conduct further surveys to clarify its distribution and status. Monitor trends in selected key populations. Protect remaining extensive tracts of forest, extend existing protected areas where appropriate, and strictly control hunting in protected areas. Lobby for improved logging practices that leave patches of old growth or large trees. Design and implement hornbill conservation programmes aimed at reducing hunting levels.

10.4 Pallas's Fish Eagle *Alcedo Hercules* (Vulnerable)

Only one bird of this species was sighted flying while surveying Lasa area on the 23th of April 2009.

This species has a small, declining population as a result of widespread loss, degradation and disturbance of wetlands and breeding sites throughout its range. It therefore qualifies as Vulnerable.

Family/Sub-family Accipitridae

Species name author (Pallas, 1771)

Taxonomic source(s) AERC TAC (2003), Cramp and Simmons (1977-1994), Sibley and Monroe (1990, 1993)

Identification 76-84 cm. Large eagle with pale brownish hood and black-and-white tail. Adult dark brown, with warm buffish to whitish head, neck and upper mantle and blackish tail with broad, white central band. Juvenile more uniformly dark, with all-dark tail, but in flight shows strongly patterned underwing, with whitish band across coverts and prominent, whitish primary flashes. **Similar spp.** Grey-headed Fish Eagle *Ichthyophaga ichthyaetus* and White-tailed Eagle *H. albicilla* both lack combination of dark body, contrasting pale hood and black-and-white tail pattern. Grey-headed is also much smaller. **Voice** Loud, guttural *kha-kha-kha-kha* or *gao-gao-gao-gao,* and sometimes high-pitched, excited yelping. Hoarse guttural continuous kook-kook-kook is commonest call.

Population estimate	Population trend	Range estimate (breeding/resident)	Country endemic?
2,500-9,999	Decreasing	5,270,000 km^2	No

Ecology: It is closely associated with wetlands, principally large lakes and rivers, from the lowlands to 5,000 m. It generally nests in trees near water.

Threats Key threats are habitat loss, degradation and disturbance. Across the Indian subcontinent, and probably most of its range, wetlands have been drained or converted for agriculture and human settlements. The felling of large trees near wetlands has reduced the availability of nest and roost sites. The spread of water hyacinth *Eichhornia crassipes* is a problem in India, as is the siltation of lakes due to catchment deforestation. Pollution of wetlands with pesticides and industrial effluents reduces breeding success. Habitat loss and degradation are compounded by disturbance of wetlands. Reductions in the prey base, primarily through hunting and over-fishing, are further consequences of increasing human pressure. In Myanmar, the development of oil and gas fields is a threat and, in China, hunting is a localised problem.

Conservation measures underway CITES Appendix II, CMS Appendix II. It occurs in many protected areas across its range such as Corbett, Kaziranga and Manas, India and Chitwan, Nepal.

Conservation measures proposed Conduct surveys in central Asia and Myanmar to establish its status, distribution and threats. Establish protected areas for key populations. Encourage sustainable management of wetland resources. Limit the use of pesticides and control of industrial discharges around wetlands. Control water hyacinth at important breeding/feeding-sites. Protect remaining nest-trees and re-establish them around wetlands. Protect nest-sites (and adjacent feeding-sites) from disturbance. Promote rural education programmes concerned with wetland birds.

10.5. Wood snipe *Gallinago nemoricola* (Vulnerable)

One bird of this species was sighted feeding on the ground while surveying Wusot area on the 15th of April 2009.

This secretive snipe has a small, declining population, as a result of widespread loss of wetlands habitats in its breeding and wintering grounds. It may only occur in a single population and has precautionarily been treated as such here, therefore it qualifies as Vulnerable.

Family/Sub-family Scolopacidae

Species name author Hodgson, 1836

Taxonomic source(s) Sibley and Monroe (1990, 1993)

Identification 28-32 cm. Dark snipe. Relatively short and broad-based bill. Buff and blackish head-stripes, broad buff stripes on blackish mantle and scapulars. Warm buff neck and breast with brown streaking. Dense, dark bars on underwing-coverts. Greenish legs. Juvenile has whiter fringing on mantle and scapulars and pale buff fringes to median coverts. **Similar spp.** Solitary Snipe *G. solitaria* is smaller and less boldly marked with less striking head pattern, white spotting on ginger-brown breast and rufous barring on mantle and scapulars. **Voice** May give guttural croak or *che-dep che-dep.* On breeding-grounds, utters long series of nasal notes *check-check-check* and *che-dep che-dep che-dep ip-ip-ip ock ock* during display-flight.

Population estimate	Population trend	Range estimate (breeding/resident)	Country endemic?
2,500-9,999	decreasing	102,000 km^2	No

Ecology: It breeds from April-June, in alpine meadows and marshes with scattered low bushes, or in dwarf scrub in barren, boulder strewn areas, generally between 3,000 and 5,000 m, at least occasionally down to 2,100 m, and with one historical breeding record from 1,200 m. In winter, it frequents swampy ground in and at the edge of evergreen forest and marshy grassland and scrub, below 3,000 m, sometimes down to lowland plains (<100 m). Populations are partially migratory, with some birds travelling from the Himalayas to south India.

Threats During the early 20th century, hunting was probably a major cause of decline. It remains a local threat, particularly in China and South-East Asia. Habitat loss is now the key threat, with substantial losses and degradation of evergreen forest, wooded wetlands, marshes and swamps in its wintering areas as a result of drainage, clearance for tea plantations, and conversion to both commercial and shifting agriculture.

Conservation measures underway CMS Appendix II. It has been recorded in numerous protected areas, but many are remote and lack sufficient resources to provide adequate protection. Amongst the most important are Wolong Biosphere Reserve (China), Langtang, Shey-Phoksundo and Sagarmatha National Parks (Nepal) and Hoang Lien Nature Reserve (Vietnam).

Conservation measures proposed Conduct extensive surveys throughout its breeding and wintering ranges to establish its current distribution, status, seasonal movements and major threats. Identify key sites and campaign for their protection where appropriate. Research its ecological and habitat requirements, particularly its tolerance of habitat degradation in wintering areas. Promote conservation awareness campaigns to reduce hunting in and around protected areas known to support populations.

10.6. Beautiful Nuthatch *Sitta Formosa* (Vulnerable)

Seven Nuthactches were sighted perching on the middle canopy of the tree while surveying Chibwe area on the 10th of April 2009. Five birds were sighted feeding on the tree trunk of the tree in Wusot area on the 19th of April 2009. Three were also found feeding on the lower canopy of the big tree in Khaunglanphu area on the 2 nd of March 2009. Nine birds were occurred feeding on the lower canopy of the tree in Pan- nan-din, Renam area on the 28 th of February 2009 (Table.6).

This nuthatch has a small, declining, severely fragmented population as a result of loss, degradation and fragmentation of evergreen and semi-evergreen forest. It therefore qualifies as Vulnerable.

Family/Sub-family Sittidae

Species name author Blyth, 1843

Taxonomic source(s) Sibley and Monroe (1990, 1993)

Identification 16.5 cm. Dazzling, large nuthatch. Black upperside with brilliant blue to white streaks on crown, nape and mantle, broad blue band along scapulars to back and rump and two narrow, white wing-bars. Dull rufous-buff underparts with paler throat and head-sides. **Voice** Rapid high, tremulous *chit'it'it'it'it'it'it'it* and shorter, hesitant *chit-it chit-it chit-it* and *chit'it-it*, *chirririt-it*. **Hints** Check mixed-species flocks foraging in large trees at high altitude.

Population estimate	Population trend	Range estimate (breeding/resident)	Country endemic?
2,500-9,999	decreasing	376,000 km^2	No

Ecology: It occurs in mature broadleaved forests, although it has been reported from open country with scattered trees in Myanmar. It frequents the middle and upper canopies of large trees draped in mosses, lichens, orchids and other epiphytes. In central Laos it appears to be associated with *Fokienia* trees. It is essentially resident, but occurs from 1,500-2,400 m in the breeding season, descending at other times, generally not below 600 m, although it has been recorded as low as 300 m in the eastern Himalayas.

Threats The main threat is forest loss, degradation and fragmentation, predominantly as a result of shifting cultivation, but more locally large-scale timber extraction (e.g. logging of the valuable *Fokienia hodginsii* in central Laos and north Vietnam), and overgrazing, burning and wood cutting (north-east India). High hunting pressure in parts of its range is unlikely to be more than a minor threat.

Conservation measures underway Populations are known to occur in several protected areas, including Thrumshing La National Park (Bhutan), Namdapha National Park, Eagle's Nest Wildlife Sanctuary, Sessa orchid Sanctuary and Buxa Tiger Reserve (India), Nakai-Nam Theun, Nam Xam and Phou Louay National Biodiversity Conservation Areas (Laos), and also Huanglianshan Nature Reserve (China).

Conservation measures proposed Conduct further surveys for the species in current "gaps" within its broad range to clarify its current distribution and population status. Identify sites supporting key populations of this and other threatened montane species, and make recommendations for their establishment as protected areas, proposing linkage to existing reserves where possible. Campaign against further large-scale montane timber extraction within its range. Promote widespread conservation awareness initiatives in hill and mountain communities aimed at reducing habitat loss and fragmentation resulting from shifting agriculture.

10.7. Snowy- throated Babbler *Stachyris oglei* (Vulnerable)

Six birds of this species were sighted in a bush of the forest in Khaunglanphu on 17 th March 2009 (Table.6).

This species has a small, severely fragmented, declining range and population because of loss of scrub and forest through logging, conversion to tea plantations and shifting cultivation. These factors qualify it as Vulnerable.

Family/Sub-family Timaliidae

Species name author (Godwin-Austen, 1877)

Taxonomic source(s) Sibley and Monroe (1990, 1993)

Identification 16 cm. Medium-small, distinctive babbler with broad white supercilium, cheeks and throat. Grey breast and black mask. Warm brown crown and rest of upperparts, wings and tail finely barred dark brown. **Similar spp.** Spot-necked Babbler *S. striolata* has black malar line. **Voice** Rapid, metallic rattles when agitated.

Population estimate	Population trend	Range estimate (breeding/resident)	Country endemic?
2,500-9,999	decreasing	16,500 km^2	No

Range & population *Stachyris oglei* is endemic to the Patkai and Mishmi Hills of eastern Arunachal Pradesh, north-east **India** and adjacent northern **Myanmar**. It is rather poorly known, in part because little ornithological work has been conducted within its range. Historical collectors considered it rare and very local. However, a healthy population has recently been discovered in Namdapha National Park (Arunachal Pradesh), suggesting that it may be locally common.

Ecology: It breeds April-May in moist, dense scrub in rocky ravines up to 1,800 m, and winters from 400 m to at least 900 m in bamboo and undergrowth of primary evergreen forest on rocky hillsides. It is generally encountered in winter in monospecific flocks of up to 20 individuals and is quite vocal, but wary and skulking.

Threats Its tolerance of habitat degradation is not known, making identification of specific threats difficult. However, habitat loss, degradation and fragmentation as a result of commercial logging, clearance for tea cultivation and shifting agriculture are all possible threats. Forest in and around Namdapha National Park is becoming increasingly denuded owing to overgrazing of domestic livestock and collection of firewood. In 1992, an estimated 61% of Arunachal Pradesh remained forested, but rates of habitat destruction have increased along with the growing tribal population within the state, which doubled between 1970 and 1990.

Conservation measures underway The only known substantial population is in Namdapha National Park, Arunachal Pradesh, although it probably occurs in adjacent Kamlang WildLife Sanctuary.

Conservation measures proposed Conduct surveys in suitable habitat to establish its range, distribution and population status and to assess its habitat requirements and main threats. Make recommendations for its conservation, based on survey findings, including the establishment of protected areas, linked to existing reserves where appropriate. Discourage further large-scale montane timber extraction within its range. Promote widespread conservation awareness initiatives in hill and mountain communities, aimed at reducing shifting agriculture.

10.8. White- cheeked Patridge *Arborophila atrogularis* (Near threatened)

Two birds of this species were feeding on the ground or the forest in Pisa area on 17th April 2009.One bird was also found on the ground to the Bamboo forest in Renam area on 10th March 2009. (See Table.6)

This poorly known species is probably locally common where forest persists and where it is not hunted; however such places are becoming scarcer and its population is now likely to be moderately small, and continuing to decline. For these reasons it is classified as Near Threatened.

Family/Sub-family Phasianidae

Species name author (Blyth, 1850)

Taxonomic source(s) Sibley and Monroe (1990, 1993)

Population estimate	**Population trend**	**Range estimate (breeding/resident)**	**Country endemic?**
	decreasing	-	No

Range & population *Arborophila atrogularis* is resident in north-east **India** (locally common in Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram and Tripura)[1], **Bangladesh** (very local in the north-east, could still occur in the Chittagong Hill Tracts) and **Myanmar** (widespread, uncommon to common resident) and **China** (local in Yingjiang area of west Yunnan to west of Salween river). However, given the size of its range and the paucity of fieldwork conducted within it, the species is currently likely to be more abundant than records suggest.

Ecology: It inhabits dense undergrowth of broadleaved primary and secondary evergreen forest, sometimes adjacent scrub, bamboo, grassland and cultivation, most frequently below 750 m in India, but usually between 610-1,220 m in South-East Asia.

Threats It is principally threatened by habitat loss and persecution. Within its range, hill forests are diminishing rapidly in extent and becoming fragmented because of shifting agriculture and logging. Hunting and snaring of galliformes is common and ongoing within its range.

Conservation measures underway None is known.

Conservation measures proposed Survey to assess population size. Conduct searches in suitable habitat to confirm the persistence of all subpopulations. Control hunting where possible. Protect large areas of primary and old secondary forest within its range.

Great hornbill *Buceros bicornis* (Near- threatened)

Five birds or this bird species were flying on the forest in Myitsone area on 23rd January 2009. And four were flying on the reverin Teyunzip Village, Myitsone area on 27th January 2009. Three birds were perching middle canopy of the Big tree in Bambane, Myitsone area on 1st February 2009. Two birds also found in Top canopy of the tree in Banbane, Myitsone area on 5th February 2009. Five were flying area the Makha river,Myitsone area on 11st February 2009. Six Birds were sighted flying over the Makkha river near the MaliYang village, Lasa area on 25 th April 2009. Three birds were sighting flying on the forest of the Chebwe area on 7th April 2009. And one bird was found in middle canopy of the tree near Mangi village, Chebwe area on 13th April 2009. (See Table.6)

Two birds of this species were seen on top canopy of a tree on Wusot area on 21st April 2009. Five birds were found flying on the forest of Reddim, Khaunglanphu area on 2nd February 2009. And three were also found flying near the river in Khaunglanphu area on 2nd March 2009. Five were also sighted flying near the river on the forest of Nantamai, Renam area on 27th February 2009. Hunting of this species was observed in areas of forest along the Maykha and Malikha river at the Myitsone area. Feathers of this species and Oriental Hornbill were obtained from the hunters. Although it has a large range, it occurs at low densities and is patchily distributed. It is likely to be declining moderately rapidly throughout its range, and is therefore considered Near Threatened.

Family/Sub-family Bucerotidae

Species name author Linnaeus, 1758

Taxonomic source(s) Sibley and Monroe (1990, 1993)

Population estimate	Population trend Country endemic?	Range estimate (breeding/resident)	
	decreasing	2,950,000 km^2	No

Range & population *Buceros bicornis* has a wide distribution, occurring in **China** (rare resident in west and south-west Yunnan and south-east Tibet), **India** (locally fairly common, but declining), **Nepal** (local and uncommon, largely in protected areas), **Bhutan** (fairly common), Bangladesh (vagrant), **Myanmar**(scarce to locally common resident throughout), **Thailand** (widespread, generally scarce but locally common), **Laos** (formerly common; currently widespread but scarce and a major decline has clearly occurred), **Vietnam** (rare and declining resident), **Cambodia** (rare), Peninsular **Malaysia** (uncommon to more or less common) and **Indonesia** (uncommon on Sumatra).

Ecology: This species frequents evergreen and mixed deciduous forests, ranging out into open deciduous areas to visit fruit trees and ascending slopes to at least 1,560 m. The abundance of this species tends to be correlated with the density of large trees, and it is therefore most common in unlogged forest.

Threats Logging is likely to have impacted this species throughout its range, particularly as it shows a preference for forest areas with large trees that may be targeted by loggers. Forest clearance for agriculture is also likely to have contributed to declines. It is particularly susceptible to hunting pressure as it is large, visits predictable feeding sites (such as fruiting trees) and its casques are kept or sold as trophies.

Conservation measures underway CITES Appendix I.

Conservation measures proposed Monitor populations across the range to determine the magnitude of declines and rates of range contraction. Campaign for the protection of remaining extensive tracts of lowland forest throughout the range.

10.10. Blyth's Kingfisher *Alcedo hercules* (Near – threatened)

One bird of these species was sighted perching on the stone near the river in Lasa area on 14^{th} February 2009. One bird was found flying near the river on Chibwe area on 26^{th} Aprill 2009.

One bird was found again perching on the stone near the river at west Manton, Renam area.

Justification This species has a naturally low population size as a result of its narrow habitat requirements, and is likely to be declining as a result of human developments throughout the It is therefore considered Near Threatened.n 17^{th} March 2009.

Family/Sub-family Alcedinidae

Species name author Laubmann, 1917

Taxonomic source(s) Sibley and Monroe (1990, 1993)

Population estimate	Population trend	Range estimate (breeding/resident)	Country endemic?

	decreasing	-	No

Range & population *Alcedo hercules* occurs in southern **China** (rare), eastern Nepal (vagrant), **Bhutan** (rare), north-east **India** (rare), Bangladesh (vagrant), **Myanmar** (scarce to fairly common in the north, west and south), north-west **Thailand** (very rare visitor), **Laos** (uncommon to locally common in the north and Annamite mountains, scarce further south) and **Vietnam** (locally fairly common in west Tonkin and Annam). Given its linear distribution along rivers, and thus restricted extent of occurrence, the total population size is possibly relatively small.

Ecology: This species is found along streams in evergreen forest and adjacent open country from 200-1,200 m, mainly at 400-1,000 m.

Threats This species is still widespread at low densities within its historical range, although deforestation is reducing and fragmenting its habitat and human disturbance and river pollution are possibly also threats.

Conservation measures proposed Conduct repeated surveys throughout the range to clarify its current population status, as well as assess population trends and rates of range contraction. Conduct ecological studies to identify habitat associations and potential threats. Grant protection to areas of suitable habitat. Enforce laws against river pollution where applicable. Strengthen legislation against aquatic pollution throughout the species's range.

10.11. Grey- headed Fish Eagle *Ichthyophaga ichthyaetus* (Near – threatened)

Two birds of this species seen on 22nd April flying on the forest, one bird on 24th April flying near the Makha river and two birds on 26th April flying on the river were sighted in Ma Li Yang village, Lasa area. Only one bird was sighted flying near the Makha river, in Yenam area on 18th March 2009.

Justification This species is thought to be undergoing a moderately rapid population reduction owing to habitat degradation, pollution and over-fishing. Although widespread, it is now only locally common and is therefore classified as Near Threatened.
Family/Sub-family Accipitridae

Species name author (Horsfield, 1821)

Taxonomic source(s) Sibley and Monroe (1990, 1993)

Population estimate	Population trend	Range estimate (breeding/resident)	Country endemic?
1,000 - 10,000	decreasing	-	No

Range & population *Icthyophagus icthyaetus* occurs in **India** (widespread and locally frequent in the north-east, scarce and local in the peninsula, **Nepal** (now rare and local, mainly below 250 m), **Sri Lanka** (rare in the dry lowlands), **Bangladesh** (widely distributed but uncommon and local), **Myanmar** (rare to scarce resident), **Philippines**

(formerly quite common in the north and east, now rare and apparently declining), **Thailand** (formerly a widespread resident, now absent from north and centre, rare and local in the south), **Laos** (now rare), **Vietnam** (scarce in south, disappearing from north), **Cambodia** (scarce and declining[1], Lake Tonle Sap holds an important population[2]), Peninsular **Malaysia** (previously common, now uncommon and sparse, perhaps 40 pairs remaining), east Malaysia, **Singapore** (scarce), **Brunei** (scarce), and the Greater Sundas and Sulawesi, **Indonesia** (widely distributed but uncommon in Sumatra and Borneo, and now very rare in Java). Although widely distributed, the species is local and declining in most parts of its range through loss of forested wetlands. However, historical and even recent records are difficult to interpret, in South-East Asia at least, due to identification difficulties between this species and Lesser Fish-eagle *I. humilis*.

Ecology: It is found near slow-moving rivers and streams, lakes, reservoirs and tidal lagoons in wooded country, usually in lowlands but ascending locally to 1,525 m.

Threats The most pertinent threats are the loss of undisturbed wetlands, over-fishing, siltation, pollution and persecution. The construction of dams on the Mekong River has potential negative implications for the flood regime of Lake Tonle Sap and the Fish-eagle population there.

Conservation measures underway None is known.

Conservation measures proposed Survey to reveal important areas and regularly monitor at various sites throughout its range. Protect forest in areas known to be important to the species. Conduct awareness campaigns involving local residents to engender pride in the species and encourage better care of wetland habitats.

10.12. Lesser Fish Eagle *Ichthyophaga bumills* (Near – threatened)

One bird was found flying on the forest in Lay Ain Su village, Myitsone area on 19th February 2009. Another bird was sighted flying across the river in Khaunglanphu area on 15th March 2009.

Justification This species depends on forest-fringed waterbodies with good stocks of fish. It is thought to be undergoing a moderate population reduction owing to forest degradation, over-fishing and perhaps especially, pollution. It is consequently classified as Near Threatened

Family/Sub-family Accipitridae

Species name author (Müller & Schlegel, 1841)

Taxonomic source(s) Sibley and Monroe (1990, 1993

Population estimate	Population trend	Range estimate (breeding/resident)	Country endemic?
10,000	decreasing	-	No

Range & population *Ichthyophaga humilis* occurs in **India** (restricted to Himalayan foothills and north-east, with an additional small population in Karnataka state in the south[2]; declining in range and population), **Bangladesh, Nepal** (rare and local in lowlands), **Bhutan** (very rare at lower altitudes), **China** (rare visitor to Hainan), **Myanmar** (widespread, scarce to locally fairly common), **Thailand** (rare in west and south), **Cambodia** (recently recorded - status unclear[1]), **Laos** (small numbers persist in several catchments, although fragmentation of populations and their small size renders them vulnerable to local extinction), **Vietnam** (rare to locally fairly common in west Tonkin and south Annam), Peninsular **Malaysia** (previously common; now scarce to locally fairly common but declining) and east Malaysia, **Brunei** (scarce), **Indonesia** (uncommon in Sumatra and Borneo; locally common in south-east Sulawesi, uncommon to rare elsewhere, and in the Sula islands and Buru).

Ecology: It frequents large forested rivers and wetlands in the lowlands and foothills up to 2,400 m, but usually below 1,000 m.

Threats Loss of forest habitat along rivers, siltation, over-fishing and increasing human disturbance of waterways are causing widespread declines. It is also declining in Uttar Pradesh, India, partly because of pesticide use and this is presumably relevant throughout much of its range.

Conservation measures underway CITES Appendix II.

Conservation measures proposed Survey to reveal important areas and regularly monitor at various sites throughout its range. Protect forest in areas known to be important to the species. Research the link between pesticide use and the decline.

10.13.Oriental Darter ***Anhinga melanogaster*** **(Near – threatened)**

Two birds were sighted perching on the stone in the Ayeyarwaddy River in Myitsone area 22nd January 2009. One bird was also found on the stone in the Makha River in Myitsone area on 2nd February 2009.

Justification This species is classified as Near Threatened because its population is declining moderately rapidly owing to pollution, drainage, hunting and collection of eggs and nestlings.

Family/Sub-family Anhingidae

Species name author Pennant, 1769

Taxonomic source(s) Sibley and Monroe (1990, 1993)

Population estimate	**Population trend**	**Range estimate (breeding/resident)**	**Country endemic?**
11,200	decreasing	-	No

Range & population *Anhinga melanogaster* occurs in **Pakistan** (fairly widespread but local year-round resident and irregular visitor to Sind and Punjab), **India** (widespread resident, locally common in Assam, current status poorly known but apparently declining), **Nepal** (uncommon resident and non-breeding visitor), **Sri Lanka** (common resident in dry lowlands, scarce visitor elsewhere), **Bangladesh** (local resident in northern and coastal regions), **Myanmar** (previously a widespread resident, now scarce to locally fairly common in south, status uncertain elsewhere), **Thailand** (formerly widespread, now very rare and possibly no longer breeds, although sightings are increasing in frequency due perhaps to increased protection of breeding colonies in Cambodia), **Laos** (previously widespread and numerous but numbers have plummeted with only a few sporadic recent records), **Vietnam** (previously widespread breeder, once locally common but now almost extinct), Cambodia (scarce visitor, probably still breeds), **Cambodia** (abundant in early 1960s with flocks reported to be totalling several thousand observed on the Mekong; currently a local resident in small numbers), Peninsular **Malaysia** (vagrant in west, possibly former resident), **Singapore**, **Brunei** (widespread), **Indonesia** (locally common breeder on Borneo, Java and Sulawesi, vagrant to other islands in the Lesser Sundas and Moluccas) and **Timor-Leste** (uncommon resident). The species is generally uncommon and declining throughout Asia, with the global population estimated at 4,000 individuals[1].

Ecology: It inhabits shallow inland wetlands including lakes, rivers, swamps and reservoirs.

Threats In common with many other Asian waterbirds, it is primarily threatened by habitat loss (both degradation of foraging areas and felling of trees used for breeding), pollution, disturbance (at feeding grounds and colonies), hunting and pollution.

Conservation measures underway It occurs in a number of protected areas.

Conservation measures proposed Survey to discover new colonies. Regularly monitor known colonies throughout the species range. Ensure complete and permanent protection of all breeding congregations. Conduct awareness campaigns involving local residents to engender pride in the species and other large waterbirds and prevent hunting.

10.14. Rusty- bellied Shortwing *Brachypteryx hyperythra* (Near – threatened)

Only one bird was sighted feeding in deep vegetation under a bush of the Manse, Chibwe area on 25th April 2009.

Justification Recent surveys have found this species to be commoner and more widespread than was previously thought. Nevertheless, it is believed to have a moderately small population within its small range, and numbers are suspected to be declining as a consequence of habitat loss. However, the range is not yet severely fragmented or restricted to few locations. For these reasons, the species is classified as Near Threatened.

Family/Sub-family Turdidae

Species name author Jerdon & Blyth, 1861

Taxonomic source(s) Sibley and Monroe (1990, 1993)

Identification 13 cm. Small, chat-like bird with rufous-orange throat and underparts. Male dark blue above with thin white eyebrow. Female dark olive-brown above and duller below. Both sexes show whitish belly-centre. **Similar spp.** Female Lesser Shortwing *B. leucophrys* is paler above and lacks pale rufous-orange on underparts.

Voice Song is high-speed, slurred warble which ends abruptly and is introduced by spaced *tu-tiu* or *wi-tu*.

Population estimate	Population trend	Range estimate (breeding/resident)	Country endemic?
10,000-19,999	decreasing	19,800 km^2	No

Ecology: In May and June (the presumed breeding season) it has been found in dense undergrowth and *Arundinaria* ("ringal") bamboo in broad-leaved evergreen forest from 1,800-3,000 m. During winter, it frequents dense reeds, thick secondary scrub, forest undergrowth and well-vegetated gulleys, from foothills at 450 m to at least 2,950 m. It has recently been recorded at much lower elevations down to c.150 m, inhabiting tall "elephant type" grass[2,3]. It is probably resident, making seasonal altitudinal movements, although it possibly migrates short distances.

Threats Without a more complete knowledge of its habitat preferences and breeding and wintering ranges, it is difficult to identify particular threats. However, forest loss and degradation owing to logging, smaller-scale cutting for fuelwood, clearance for tea plantations, shifting agriculture and livestock-grazing of forest understorey are all problems within its known range, especially at lower altitudes.

Conservation measures underway It occurs in Namdapha National Park and the Mehao, Dibang and Kamleng Wildlife Sanctuaries in north-east India, and in Hponkanrazi and Hukaung Valley Wildlife Sanctuaries in northern Myanmar.

Conservation measures proposed Study the ecology and threats that may face this species Identify key areas/important populations and recommend their integration into protected areas if necessary. Support initiatives seeking to reduce levels of forest destruction and degradation.

10.15. Chevron-breasted Babbler *Sphenocichla roberti* (Near- threatened)

Two birds of this species were sighted in the bush of the forest in Wusot area on 21st April 2009. Only one bird was also seen in the bush of the forest in Khaunglanphu area on 11st March 2009.

Justification This newly split species has been classified as Near Threatened owing to concerns that its small population is declining moderately rapidly owing to ongoing clearance of forest for shifting agriculture.

Family/Sub-family Timaliidae

Species name author Godwin-Austen & Walden, 1875

Taxonomic source(s) Collar (2006)

Taxonomic note *Sphenocichla humei* (Sibley and Monroe 1990, 1993) has been split into *S. humei* and *S. roberti* following Collar (2006).

Population estimate	Population trend	Range estimate (breeding/resident)	Country endemic?
2,500-9,999	decreasing	-	No

Range & population *Spenocichla roberti* occurs in north-east **India** from eastern Arunachal Pradesh south to Assam, Nagaland and north Manipur, north **Myanmar** and adjacent **China** (western Yunnan). Although it appears to be rare throughout, this impression is at least partly exaggerated because of the infrequency with which its range is visited by ornithologists.

Ecology: It occurs in evergreen forest with large trees and bamboo on the edge of dense jungle, at 300-2,010 m. It occurs in small parties and feeds on insects, particularly woodlice and boring beetles. It breeds in May-June; its nest is a pad of moss.

Threats While the high altitudes favoured by this species are relatively free from habitat loss, shifting cultivation and logging are nevertheless reducing forest cover, at least in north-east India and north Myanmar.

Conservation measures underway None is known.

Conservation measures proposed Study its ecological requirements and its tolerance of habitat degradation. Monitor trends in habitat loss. Protect large areas of suitable habitat at key sites, in both strictly protected areas and community managed multiple use areas.

10.16. Chestnut-backed Laughingthrush *Garrulax nuchalis* (Near- threatened)

Six birds of this species were sighted in the bush of the paddy field in Myitsone area on 20th January 2009. Five birds were also recorded in the bamboo forest in Bambain, Myitsone area on 4th February 2009. Another five were also found in the bush of the forest at Jubali, Myitsone area on 10th May 2009. Fourteen birds of this species were sighted feeding in the bush of the forest in Hpa Wun village, Lasa area on 13th April 2009. Another fifteen birds were recorded in the bush of the forest Hpung Ing Yang village, Lasa area on 17th April and, twelve were also found in secondary vegetation at Ma Li Yang village, Lasa area on 24th April 2009. Seven birds were recorded on the ground in bush of the forest in Chibwe area 10th May 2009. Eight were sighted in thick vegetation in Redam-Khaunglanphu area on 18th March 2009. Six were recorded in the bush of the forest at the junction of Mayhka and Hton River, near A Li Aung village, Renam area on 12th February 2009.

This species is very poorly known, but its range is moderately small and it is likely to have a small global population size. Population trends are unknown, but it is tolerant of secondary and scrub habitats, suggesting that it is not at imminent risk. Further studies are urgently needed, however, in order to clarify the situation. It is currently considered Near Threatened.

Family/Sub-family Timaliidae

Species name author Godwin-Austen, 1876

Taxonomic source(s) Sibley and Monroe (1990, 1993)

Range & population *Garrulax nuchalis* occupies a restircted range in Arunachal Pradesh, Assam and Nagaland, north-east **India** and northern **Myanmar**. There have been few recent records and its current status is poorly known, although this is at least in part because much of its range is infrequently visited by ornithologists.

Ecology: This species inhabits secondary growth, thickets, tall grasslands with scattered shrubs or dense bushes in stony scrub-covered ravines and hills, from the lowlands up to c.900 m.

Threats Little is known of the status of this species. It may be threatened by habitat degradation through increased grazing and agricultural conversion, as well as firewood cutting.

Conservation measures proposed Surveys are required to establish its current distribution and population size, the extent of habitat and threats faced by this species. Protect areas of suitable habitat.

10.17. New species records for North Myanmar

Of all the bird species recorded a total of 14 species are new for North Myanmar.

Out of these 42 birds of 9 species were recorded in Myitsone area, 11 birds of 3 species were recorded in Lasa area, 20 birds of 3 species in Chibwe area, 18 birds of 3 species in Wusot area, 10 birds of 3 species in Khaunglanphu, and 3 birds of 2 species in Yenam area. (See Table .7)

10.17. 1. Ruddy Kingfisher *Halcyon Coromanda*

A single bird was seen perching on the lower canopy of the tree in Myitsone area on 22nd January, 2009.

10.17.2. Hodgson's Hawk Cuckoo *Hiercoccyx fugax*

Three birds of this species were observed in the middle and lower canopy of the tree in Chibwe area on 10th May, 2009. Another one bird was recorded flying on the forest in Wusot area on 21st April, 2009.

10.17.3. Blossom- headed Parakeet *Psittacula roseata*

Seven on 17th January, five on 5th February in Bambain and six birds on 19th February 2009 in Myitsone area.

10.17.4. Chinese Sparrow Hawk *Accipites sloensis*

One bird was recorded perching on top canopy of the tree in Myitsone area on 20th January 2009.

10.17.5. Japanese Sparrow Hawk *Accipites gularis*

One bird was observed perching on top canopy of the tree in Myitsone area on 21st January and another one was found flying near the Makha River in Bambain, Myitsone area on 5th February 2009.

10.17.6. Grey- faced Buzzard *Butastur indicus*

Only one bird was observed flying on the Makha River, of Myitsone area on 19th February 2009.

10.17.7. Bonelle's Eagle *Hieraaetus fasciatus*

Only one bird was found flying on the Ayeyarwaddy River on 15th February 2009.Another two birds were found flying on the river of Khaunglanphu area on 14th March 2009.

10.17.8. Blue- winged Pitta *Pitta moluccensis*

One bird on 16th February, two birds on 18th February, three birds on 12th May, two birds on 13th May 2009 in Myitsone area. One bird on 9th April, two birds on 17th April, one bird on 25th April 2009 in Lasa area . Only one bird was seen perching on a middle canopy of the tree in Renam area on 17th March, 2009.

10.17.9. Black- napped Oriole *Oriolus chinensis*

Three birds were sighted perching on the middle canopy of the tree in Myitsone area on 19th January, 6 birds on 4th Feburary 2009.

10.17.10. Indochinese Cuckoo Shrike *Coracina polioptera*

One bird was found perching in the lower canopy of a tree in Jubali, Myitsone area, on 10th May 2009. Three birds were found on the middle canopy of the tree in Lasa area on 18th April 2009. Two birds on 6th April, three birds on 3rd May, five on 9th May and six birds on 11th May 2009 in Chebwe area were observed. Four birds was recorded on 15th April, three birds on 18th April and 3 birds on 22nd April 2009 in Wusot area.Two birds were perching on the top canopy of the tree which was sighted in Khaunglanphu area on 16th March 2009.

10.17.11. Ashy Minivet *Pericrocotus divaricatus*

Four birds were observed in lower canopy of the tree in Lasa area on 18th April 2009.

10.17.12. Green Cochoa *Cochoa viridis*

Seven birds were observed perching and feeding on the branch of the tree in Wusot area on April 2009. And another six were recorded feeding on the middle and lower canopy of the tree in Khaunglanphu area on 17th March 2009.

10.17.13. Mountain Leaf Warbler *Phylloscopus trivirgalus*

Two birds were observed feeding in the bush of the forest in West Manhton, Yenam area on 2nd March 2009.

11. CONCLUSIONS

Apart from Wusok and Pisa most of the flooded areas are covered with secondary vegetation. Pristine primeval forests are found only in high elevations and at the edges of flooded area. Flood plains of Myitsone and Lasa area are relatively flat. The remaining areas are located within deep gorges with a minimum of 40 degrees slopes. The gradient of the rivers flowing between the gorges is high and the flow very rapid making it impossible to navigate. In the further north the mountains become higher sometimes cover with snow. These snow capped mountains are seen in Pisa, Wusok, Khaunglanhpu and Yenam dam sites. Forest areas close to human settlements are also degraded because of permanent cultivation. Slash and burn methods for shifting cultivation add more destruction to the habitats.

12. ON GOING THREATS

1. Excessive logging which is transported across the border to neighbouring country by armed groups.
2. Over exploitation of non timber forest products eg charcoal, bamboo. Conversion of forest area to agriculture land (rubber, agar wood, orange orchards)
3. Excessive mining along the banks and in the major rivers.
4. Waste disposal from mineral processing plant into major drainage especially in Ngawchanhka river.
5. Wildlife trading to neighbouring country.
6. Pratice of shifting cultivation with slash and burn methods.

13. DISCUSSION

The area in which the investigations were carried out is clearly an important area for conservation. The outstanding biodiversity there is so unique that it would be a shame for it to be neglected. There are a few areas for biodiversity conservation like this in the world that is of critical importance.

This area also possesses 4 IBAs and is in the region of 3 endemic bird areas. Loss of biodiversity in this area would be a tremendous loss to the Union of Myanmar. Extinction of flora and fauna is forever and never can be brought back.

Therefore in the mitigation measures, priority should be given to conservation of biodiversity in this area. It will be best these areas are nominated and gazetted as protected area system rather than conventional watershed area management. They should either be protected as individual protected areas or in a landscape scale.

These results of these surveys could not be considered comprehensive because of time limitation. The Myanmar team's original plan was to conduct surveys simultaneously in at least four areas with four teams taking a longer period for studies in each place. The survey time formerly planned was to be 7 months. But the Chinese counterparts with their institutional duties could not have that time and because their intention was to have a Chinese Myanmar joint team carrying out surveys in collaboration the time was limited to 5 months. Because of that the Myanmar team had to readjust their plan and conduct the surveys accordingly and thus resulted in a shorter time for the surveys.

The White-bellied Heron which is the only critically endangered species recorded from this area is not only important but also needs special attention as its status has recently been promoted to the critical from endangered. The reason is that their population is declining very rapidly at an alarming rate within the recent ten years because of habitat degradation and fragmentation. The presence of a flagship species like White-bellied Heron in the study area shows that some good habitats are still left in the study area. On the other hand having recorded only one or probably two birds of this species means that only a few areas with good habitat are left. They prefer medium to small size rapid flowing rivers in remote areas with surrounding good quality primary forests. More studies are needed to find out the population status of this species in the study area. As there are many areas like that in the study area, more studies would help to find out the actual relation about that species and their habitat which would in turn help to shape out the mitigation measures.

Other globally threatened species like Blyth's Tragopan and Beautiful Sibia also need special attention. They are species which are not only globally threatened but also found only in this part of the world (Eastern Himalayan endemic birds). Their habitats will not be directly affected by the flood immediately after construction of dams. But in the long term the locals there will certainly extend their slash and burn to forests located at higher elevations resulting in loss of habitat of these globally threatened species. Therefore control of slash and burn and shifting cultivation should be seriously considered. Proper land usage like terrace farming and growing of perennial crops should be encouraged and introduced. Awareness raising and environmental education to locals should be carried out so that they know how to effectively use their land.

Special attention is required for Naungmon Scimitar Babbler which is a new species discovered from that area. No one knows whether this species is endemic to that area or extends to areas beyond that. The research done by Smithsonian was confined only to the areas around Naungmon. They did not extend their research beyond that. If that bird happens to be endemic to the areas around Nuangmon only, its status will be serious, i.e either critical or endangered. But if its area extends beyond Naungmon then its status is not seriously threatened. More research for stating the actual status of that bird needs to be done.

Subsistence hunting is commonly practiced in the investigation area. Bush meat obtained is a livelihood dependent, sustainable and usually shared among neighbours and friends, and if there is surplus, sold to visitors. It has been known that the people crossing the border from neighbouring China are particularly fond of bush meat. At the moment this seems to have a little effect to the fauna of that area. But when construction starts there will be a big influx of Chinese as well as Myanmar workers and there will certainly be a higher demand of bush meat. Because of that hunting will increase and fauna biodiversity will be seriously affected. Hunting by locals will change from subsistence to commercial hunting. Globally threatened species like Blyth's Tragopan and Slater's Monal which meat is considered a delegacy will be in a serious threat. Therefore proper control of hunting should be seriously enforced in that area. But in an area with complicated governance that cannot be expected to be an easy task. The team should include all stakeholders such as responsible persons from all ethnic tribes of that area, persons from the regional armed groups, conservation NGOs and relevant government authorities. Conventional watershed area management will not be effective. The area should have an effective protected area system (PAS) status for control of hunting and wildlife to be effective.

Livestock breeding in that area is scarce. Few locals living there rare livestock and most of them are small pigs and Mythuns. These will not be sustainable if there the area is going to be developed. Therefore in earlier stages of construction imported labours and staff should import meat from their country. During that stage, commercial livestock breeding should be introduced with high quality parental stocks so that in the later stages people working there could rely on their livestock products.

After construction of dams implementation of proper watershed area is usually practiced in Myanmar. Soon after water starts impounding in the reservoir accessibility into the forest improves, resulting in over harvesting of timber and non timber forest products. The flooded area becomes an easy route to take out all the forest products. Bigger and larger amount of forest products like timber and bamboo are easily carried out by boats and rafts rather than bullock carts and cars. Jack hunting with boats for nocturnal wildlife becomes easy mean for poachers. All this eventually leads to destruction of forest and biodiversity. To prevent all these proper watershed management in the form of protected area system should be in place before the dams start impounding water.

Serious control of logging also should be carried out. When construction starts there will be an increase demand of timber for construction and that will bring a significant threat to forest in that area which has been seriously degraded by excessive logging from our neighbouring country. If uncontrolled there will be no forest left in that extremely biodiversity rich area. Slash and burn methods of shifting cultivation which is normally practiced in that area would only add a dramatic effect on this and eventually bring landslides and erosion resulting in increase sedimentation in the reservoir severely shortening the life of the dams.

To prevent all these threats an ordinary and orthodox method of water shed management system would not be effective. Watershed management system in the form of a protected area system should be implemented. It will be best if that should be in the form of a landscape Protected Area System PAS combining all national parks and wildlife sanctuaries in that area together with the watershed area management systems of all dams. The financial need for these measures would be far greater than conventional conservation measures. Therefore the budget should be the form of a separate compensation measures funded by the project.

14. RECOMMENDED MITIGATION MEASURES

1. Carry out more ornithological studies with sufficient time to obtain comprehensive information of the endemics, newly discovered, critical and vulnerable species of birds found in the study area together with status and the condition of their habitats which will in turn shape out effective mitigation measures.
2. Implement an effective protected area management system in watershed areas of all dams in a landscape scale in which the management committee should involve all stake holders from that area. That should be funded by the constructors.
3. Import meat from China for labours and workers in the earlier period of construction.
4. Improve livelihoods of communities living in that area by finding alternative ways of livelihoods. Effective livestock breeding should be introduced with good quality parental stocks and launched as soon as possible. They should be in place when the construction works start.
5. Stop logging and charcoal making as soon as possible in all areas of the project.
6. Avoid further habitat loss by strictly restricting usage of firewood and charcoal for cooking. Gas stoves should be imported from China and all workers should only use gas for cooking.
7. Carry out awareness educational programs for locals living in the area, educating them on how to use their forest and land effectively in order to sustain their livelihoods.
8. Expand IBA list of Myanmar by adding surveyed area where a critically endangered species is found.
9. Monitor continuously and regularly for all the above measures.
10. Conduct a comprehensive biodiversity survey of all recommended watershed areas.
11. Monitor biodiversity richness in all watershed area (PAS) regularly.
12. Promote sustainable forms of upland agriculture that do not result in net loss of natural forest
13. Develop sustainable, community-based forest management.
14. Prevent conversion to agriculture and plantations within protected areas.
15. Enforce logging bans from China and promote similar bans elsewhere in the region
16. Establish community forests to provide non-timber forest products, and develop sustainable alternatives to wood as a source of fuel

15. IRRELAVENT ISSUES

1. Conduct a proper Social Impact Assessment SIA so as to find out the actual attitude of locals in the project area. Disclose all relevant facts to the public before conducting SIA.

2. Find an alternative dam site or dam sites to avoid flooding of the confluence i.e Myitsone which is considered cultural heartland of the Kachin state.

3. Discuss with responsible authorities from both countries on a profit sharing basis for locals in the projected area.

Table 1. Schedule of ornithology team in all surveyed areas

Myitsone area (I)	Lasa area (II)	Chipwi Area (III)	Wusot Area (IV)	Pisa Area (V)	Khaunglanphu Area (VI)	Renam Area (VII)
16-1 to 28-1-09	**6-4 to 30-4-09**	**3-4 to12-5-09**	**6-4 to 13-5-09**	**15-4 to 18-4-09**	**20-2 to 29-3-09**	**20-2 to 29-3-09**
Saw Moses	Thet Zaw Naing	Saw Moses	Saw Moses	Saw Moses	Saw Moses	Thet Zaw Naing
Tin Aung Tun	Lay Ko Ko	Sa Myo Zaw	Sa Myo Zaw	Sa Myo Zaw	Sa Myo Zaw	Thiri Dawei Ag
Lay Ko Ko	Nyunt Shwe	Lay Win	Lay Win	Lay Win	Tin Aung Tun	Nyunt Shwe
Nyunt Shwe	Thiri Dawei Ag	Tin Ag Tun	Tin Ag Tun	Tin Ag Tun		
Thiri Dawei Ag						
30-1 to 12-2-09						
Thet Zaw Naing						
Saw Moses						
Tin Aung Tun						
Lay Ko Ko						
Nyunt Shwe						
Thiri Dawei Ag						
17-2 to 21-2-09						
Lay Win						
Lay Ko Ko						
6-5 to 13-5-09						
Thet Zaw Naing						
Lay Ko Ko						
12-5 to 14-5-09						
Thiri Dawei Ag						
Nyunt Shwe						

Table 2. Study sites and habitats in Myitsone area

Study area	Site		Location	Elev (m)	Date	Forest type
I	a	Myitsone	25˚ 42' 30.5" N 97˚ 29' 48.1"E	132	15 - 23.1/ 12 & 13.5. 2009	Semievergreen (Secondary, Bamboo & Degraded Forests), Plantation, Cultivation, Riverbed
I	b	Teyunzup	25˚ 58' 21" N 97˚ 32' 02.3"E	151	24 - 27.1.2009	Semievergreen (Primary, Secondary & Bamboo Forests), Riverbed

I	c	Bambane	25˚ 42’ 03.2” N 97˚ 54’ 50.6” E	224	31. 1 /1- 6. 2. 2009	Semievergreen (Primary, Secondary, Bamboo & Degraded Forests), Plantation, Cultivation, Riverbed
I	d	Thewai	25˚ 41’ 56.7” N 97˚ 36’ 52.8” E	295	7 - 11.2.2009	Semievergreen (Primary, Secondary, Bamboo & Degraded Forests), Plantation, Cultivation, Riverbed
I	e	Lay Ain Su	25°35’47.1” N 97°47’52.7” E	184	18 - 20. 2. 2009	Semievergreen (Primary, Secondary, Bamboo & Degraded Forests), Plantation, Cultivation, Riverbed
I	f	Jubali	25˚ 42’ 58.5” N 97˚ 51’ 37.1” E	206	7 - 12. 5. 2009	Semievergreen (Primary, Secondary, Bamboo & Degraded Forests), Plantation, Cultivation

Study sites and habitats in Lasa area

Study area	Site		Location	Elev (m)	Date	Forest type
II	a	Sum Pyi Yang	26˚ 52’ 30.6” N 97˚ 38’ 52.3” E	331	8- 9. 4. 2009	Semievergreen (Secondary, Bamboo & Degraded Forests), Plantation, Cultivation, Riverbed
II	b	Hpa Wun	26˚ 53’ 40” N 97˚ 42’ 42.5” E	334	11 - 14. 4.2009	Semievergreen (Primary, Secondary & Bamboo Forests), Riverbed
II	c	Hpung Ing Yang	26˚ 43’ 42.7” N 97˚ 38’ 15.5” E	341	16- 18. 4. 2009	Semievergreen (Primary, Secondary, Bamboo & Degraded Forests), Plantation, Cultivation, Riverbed
II	d	Ma Li Yang	26˚ 34’ 40.0” N 97˚ 41’ 20.7” E	250	21 - 27. 4. 2009	Semievergreen (Primary, Secondary, Bamboo & Degraded Forests), Plantation, Cultivation, Riverbed

Study sites and habitats in Chibwe area

Study area	Site		Location	Elev (m)	Date	Forest type
III	a	Chibwe	26˚ 04’ 38.2” N 98˚ 12’ 08.1” E	405	5 - 7 / 30. 4/ 2 -7/ 9-12.5.2009	Secondary, Bamboo & Degraded Forests, Plantation, Cultivation, Riverbed
III	b	Mangi	26˚ 16’ 08.9” N 98˚ 18’ 55.8” E	507	9 -13/ 23 -28. 4. 2009	Primary, Secondary & Bamboo Forests, Riverbed

Study sites and habitats in Wusot area

Study area	Site		Location	Elev (m)	Date	Forest type
IV	a	Wusot	26˚ 24’ 35.7” N 98˚ 17’ 45.6” E	410	14 - 19/ 21-22. 4.2009	Secondary, Bamboo & Degraded Forests, Plantation, Cultivation, Riverbed

Study sites and habitats in Pisa area

Study area	Site		Location	Elev (m)	Date	Forest type
V	a	Pisa (ChoneTan)	26˚ 42' 26.7" N 98˚ 23, 06.4" E	1157	15- 17. 4.2009	Secondary, Bamboo & Degraded Forests, Plantation, Cultivation, Riverbed

Study sites and habitats in Khaunglanphu area

Study area	Site		Location	Elev (m)	Date	Forest type
VI	a	Redam - Kaunglanphu	27˚ 03' 04.3" N 98˚ 22' 07.5" E	1492	28.2/ 1- 4/17- 9.3. 2009	Secondary, Bamboo & Degraded Forests, Plantation, Cultivation, Riverbed
VI	b	Zegone	27˚ 04' 00" N 98˚ 22' 50.5" E	1287	5/7/8/10- 15. 3. 2009	Primary, Secondary & Bamboo Forests, Riverbed
VI	c	Junction	27˚ 02' 22" N 98˚ 22' 06" E	996	6/9/11/ 16. 3.2009	Primary, Secondary, Bamboo & Degraded Forests, Plantation, Cultivation, Riverbed
VI	d	Wuni	27˚ 01' 16.6" N 98˚ 22' 06" E	1085	13. 3. 2009	Semievergreen (Primary, Secondary, Bamboo & Degraded Forests, Plantation, Cultivation, Riverbed

Study sites and habitats in Yenam area

Study area	Site		Location	Elev (m)	Date	Forest type
VII	a	Nantamai	27˚ 43' 35.4" N 97˚ 52' 19.4" E	1004	27- 28. 2/ 20.3. 2009	Secondary, Bamboo & Degraded Forests, Plantation, Cultivation, Riverbed
VII	b	Mayhka	27˚ 43' 31.2" N 97˚ 56' 27.3" E	970	1- 3/19. 3. 2009	Primary, Secondary & Bamboo Forests, Riverbed
VII	c	Mayhka	27˚ 42' 07.0" N 98˚ 02' 15.8" E	1052	5 - 10/ 15- 17. 3. 2009	Primary, Secondary, Bamboo & Degraded Forests, Plantation, Cultivation, Riverbed
VII	d	Junction of Mayhka & Hton	27˚ 42' 12.9" N 98˚ 07' 44.7" E	995	11-14. 2. 2009	Semievergreen (Primary, Secondary, Bamboo & Degraded Forests, Plantation, Cultivation, Riverbed

Table 3. List of bird families and respective numbers of species in all survey areas

No.	FAMILY	I	II	III	IV	V	VI	VII	ALL
1	Phasianidae	5	2	6	3	6	4	4	30
2	Anatidae	8	1				2	1	12
3	Picidae	13	9	9	6	4	6	5	52
4	Megalaimidae	4	2	3	3	2	3	4	21
5	Bucerotidae	4	3	2	2		2	3	16
6	Upupidae	1	1	1		1	1	1	6
7	Trogonidae	1		1	1		1	1	5
8	Coraciidae	2	1						3
9	Alcedinidae	2	3	3	1		1	2	12

10	Halcyonidae	2	1	2		1			6
11	Cerylitae	2	2	1	1		1	1	8
12	Meropidae	4		2	1				7
13	Cuculidae	6	5	9	5	3	2	2	32
14	Centropadidae	2	2	2					6
15	Psittacidae	3	2	1					6
16	Apodidae	3	1	2			3	1	10
17	Hemiprocnidae	1							1
18	Tytonidae	1							1
19	Strigidae	5	4	3		1	5	4	22
20	Caprimulgidae	1	1	1			2		5
21	Columbidae	7	9	9	4	3	8	1	41
22	Gruidae	1							1
23	Rallidae	8	1	1					10
24	Scolopacidae		2	3	1				6
25	Burhinidae		5						5
26	Accipitridae	12	9	9	5		9	7	51
27	Falconidae	4	2	3		1	1	1	12
28	Podicipedidae	1							1
29	Anhingidae	1							1
30	Phalacrocoracidae	1	1		1		3	1	7
31	Ardeidae	5	6	5	2			3	21
32	Pittidae	3	3	4		1			11
33	Ciconidae		1	1	3				5
34	Irenidae	4	2	1	1	2	2	3	15
35	Laniidae	34	24	28	13	9	17	18	143
36	Cinclidae			1			1	2	4
37	Muscicapidae	33	15	30	18	11	32	18	157
38	Sturnidae	6	7	2			1	1	17
39	Sittidae	9	5	7	4	4	8	4	41
40	Aegithalidae			2		2	3		7
41	Pycnonotidae	7	7	8	4	4	7	6	43
42	Cisticolidae	3	3	2	1	1	2	2	14
43	Zosteropidae	2	2	1		1	2		8
44	Sylviidae	42	36	65	31	33	78	53	338
45	Alautidae	1					1		2
46	Nectariniidae	8	7	6	2	7	6	13	49
47	Passeridae	12	10	15	4		12		53
	Total	273	197	251	117	97	226	162	1323

I= Myitsone area, II= Lasa area, III= Chebwe area, IV= Wusot area, V= Pisa area, VI= Khaunglanphu, VII= Yenam area

Table 4. Summary on information of bird species recorded in the seven study areas

	I	II	III	IV	V	VI	VII	ALL
Elevation (range)-(m)	132-295	250-341	405-507	410	1157	996-1492	970-1052	–
Elevation	213.5	295.5	456	410	1157	1244	1011	4787
Observed days	36	16	25	8	3	18	20	126
Family	44	38	24	24	20	31	27	
Species	273	197	251	117	97	226	162	
Species in per cent (%)	20.63492	14.89040	18.97203	8.84354	7.33182	17.08239	12.24490	100.00000
Critical Endangered	0	1	0	0	0	0	0	1
Endangered Species	0	0	0	0	0	0	0	0
Vulnerable Species	1	2	2	3	0	4	2	14
Near-Threatened	4	4	4	2	1	4	5	24

I= Myitsone area, II= Lasa area, III= Chebwe area, IV= Wusot area, V= Pisa area, VI= Khaunglanphu, VII= Yenam area

	I	II	III	IV	V	VI	VII
Family	44	38	24	24	20	31	27
Species	273	197	251	117	97	226	162
Elevation -(m)	213.5	295.5	456	410	1157	1244	1011

I= Myitsone area, II= Lasa area, III= Chebwe area, IV= Wusot area, V= Pisa area, VI= Khaunglanphu, VII= Yenam area

Figure 1. The relationship between bird families, species abundance and elevations (max) of study areas.

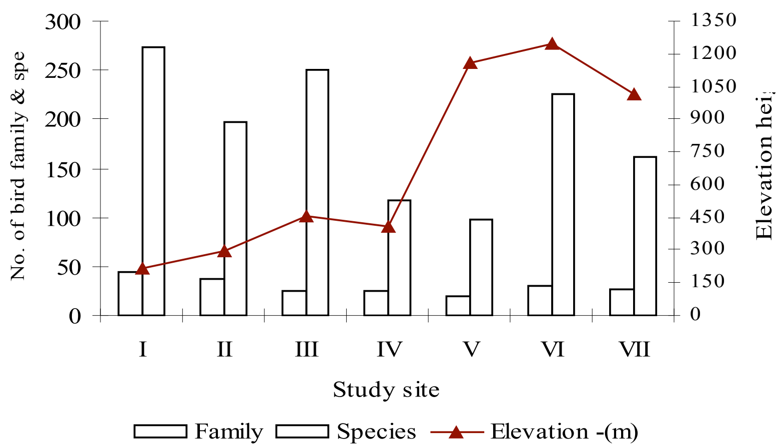


Table 5. Distribution of birds recorded among microhabitats in each survey area (figures given as percentages of total in that area)

No.	Micro-habitat	I	per cent	II	per cent	III	per cent	IV	per cent	V	per cent	VI	per cent	VII	per cent	ALL	per cent
1	in/near/around water	37	11.82	21	7.3	15	4.31	8	5.59	4	4	18	7.14	18	7.2	121	7.16
2	flight	51	16.29	50	17.5	33	9.48	16	11.19	2	2	19	7.54	19	7.6	190	11.24
3	bamboo	40	12.78	47	16.4	30	8.62	6	4.20			24	9.52	44	17.6	191	11.3
4	bush	38	12.14	49	17.1	87	25	39	27.27	32	32	60	23.81	62	24.8	367	21.72
5	ground	12	3.83	15	5.2	30	8.6	5	3.5	6	6	14	5.6	17	6.8	99	5.858
6	Cultivat:	2	0.64													2	0.118
7	tree trunk	10	3.19	4	1.4	3	0.86	2	1.40	2	2	6	2.38	1	0.4	28	1.657
8	top, middle & lowers canopy	118	37.7	95	33.2	149	42.8	67	46.85	54	54	111	44.1	89	35.6	683	40.41
9	banana tree	3	0.96	5	1.8											8	0.473
10	building					1	0.29									1	0.059

I= Myitsone, II= Lasa, III=Chebwe, IV= Wusot, V= Pisa, VII= Khaunglanphu, VII= Yenam

Table. 6. Recorded threatened species in all study sites

No	Species	IUCN 2008	I	II	III	IV	V	VI	VII
1	White-cheeked Partridge *Arborophila atrogularis*	NT					2		1
2	Blyth's Tragopan *Tragopan blythii*	VU						6	
3	Great Hornbill *Buceros bicornis*	NT	19	6	4	2		8	5

4	Rufous-necked Hornbill *Aceros nipalensis*	VU	3	4	10	2		3	3
5	Blyth's Kingfisher *Alcedo hercules*	NT		1	1				1
6	Wood Snipe *Gallinago nemoricola*	VU				1			
7	Pallas's Fish Eagle *Haliaeetus leucoryphus*	VU		1					
8	Grey-headed Fish Eagle *Ichthyophaga ichthyaetus*	NT		5					1
9	Lesser-Fish Eagle *Ichthyophaga bumills*	NT	1					1	
10	Oriental Darter *Anhinga melanogaster*	NT	4						
11	White-bellied Heron *Ardea insignis*	CR		2					
12	Rusty-bellied Shortwing *Brachypteryx hyperythra*	NT			1				
13	Beautiful Nuthatch *Sitta formosa*	VU			7	5		3	17
14	Chestnut-backed Laughingthrush *Garrulax nuchalis*	NT	16	41	7			8	6
15	Chevron-breasted Babbler *Sphenocichla roberti*	NT				2		1	
16	Snowy-throated Babbler *Stachyris oglei*	VU						6	

I= Myitsone, II= Lasa, III= Chebwe, IV= Wusot, V= Pisa, VI= Khaunglanphu, VII= Yenam

Table. 7. New records for north Myanmar from all sites

No	Species	I	II	III	IV	VI	VII
1	Ruddy Kingfisher *Halcyon coromanda*	1					
2	Hodgson's Hawk Cuckoo *Hiercoccyx fugax*			3	1		
3	Blossom-headed Parakeet *Psittacula roseata*	18					
4	Chinese Sparrow Hawk *Accipites sloensis*	1					
5	Japanese Sparrow Hawk *Accipiter gularis*	2					
6	Grey-faced Buzzard *Butastur indicus*	1					
7	Bonelli's Eagle *Hieraaetus fasciatus*	1				2	
8	Blue-winged Pitta *Pitta moluccensis*	8	4	1			
9	Slender- billed Oriole *Oriolus tenuirostris*						1
10	Black-naped Oriole *Oriolus chinensis*	9					
11	Indochinese Cuckooshrike *Coracina polioptera*	1	3	16	10	2	
12	Ashy Minivet *Pericrocotus divaricatus*		4				
13	Green Cochoa *Cochoa viridis*				7	6	
14	Mountain Leaf Warbler *Phylloscopus trivirgatus*						2
	Total	42	11	20	18	10	3

I= Myitsone, II= Lasa, III= Chebwe, IV= Wusot, VI= Khaunglanphu, VII= Yenam

Figure 2. Distribution of birds observed during the survey among various microhabitats

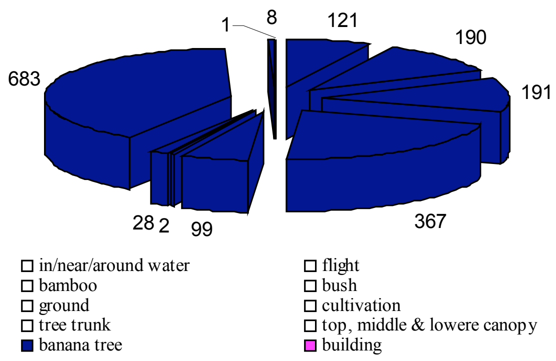


Figure 3. Distribution of birds observed during the survey among various microhabitats (as percentages of total observed) in Myitsone area

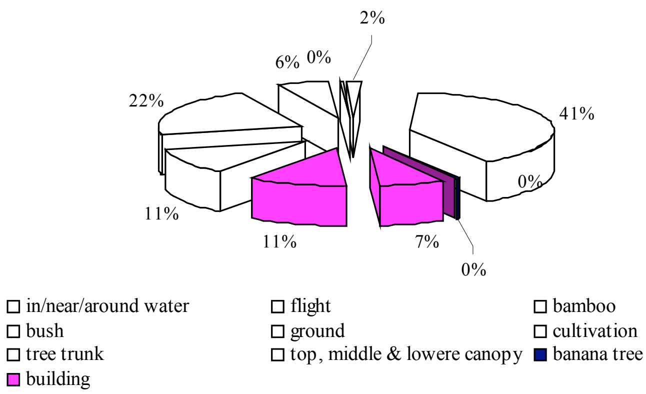


Figure 4. Distribution of birds observed during the survey among various microhabitats (as percentages of total observed) in Lasa area

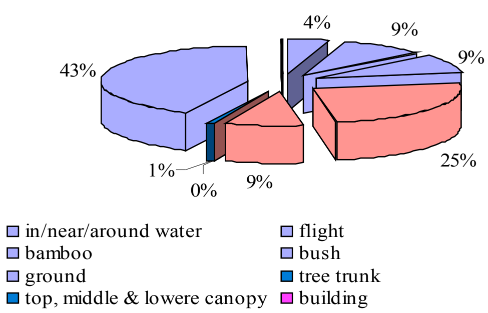


Figure 5. Distribution of birds observed during the survey among various microhabitats (as percentages of total observed) in Chebwe area

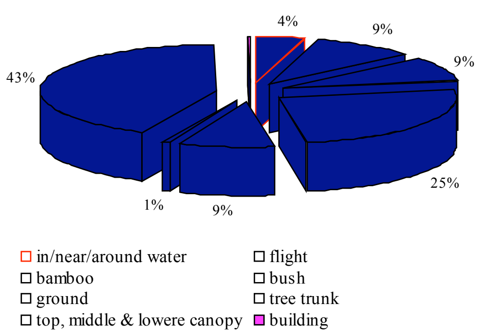


Figure 6. Distribution of birds observed during the survey among various microhabitats (as percentages of total observed) in Wusot area

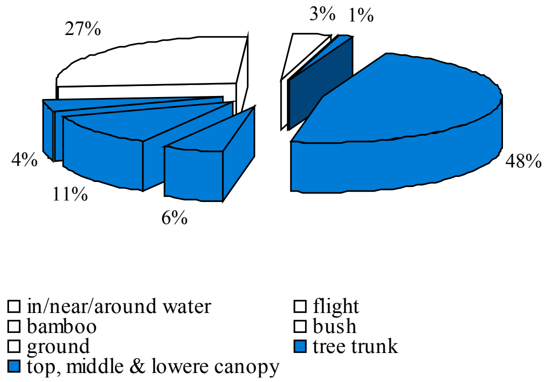


Figure 7. Distribution of birds observed during the survey among various microhabitats (as percentages of total observed) in Pisa area

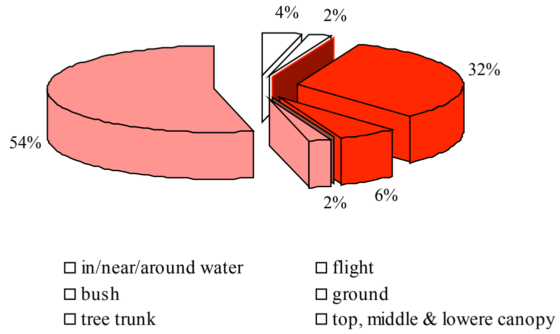


Figure 8.Distribution of birds observed during the survey among various microhabitats (as percentages of total observed) in Khaunglanphu area

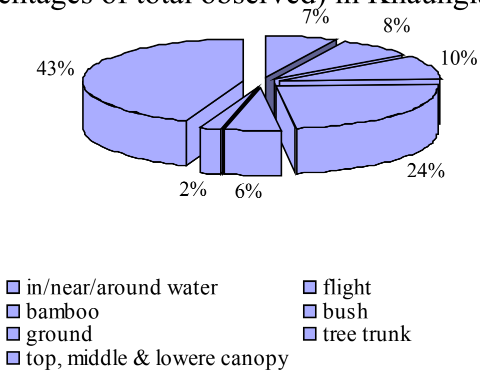


Figure 9. Distribution of birds observed during the survey among various microhabitats (as percentages of total observed in Renam area)

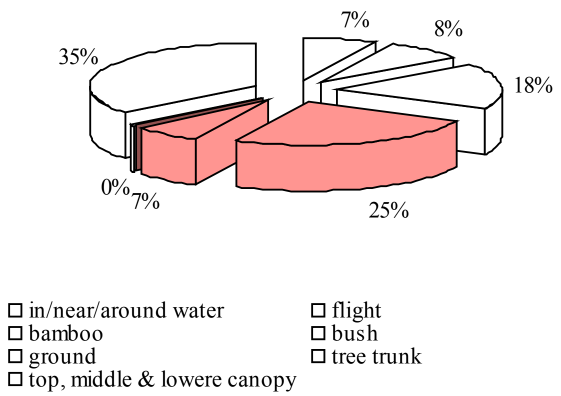
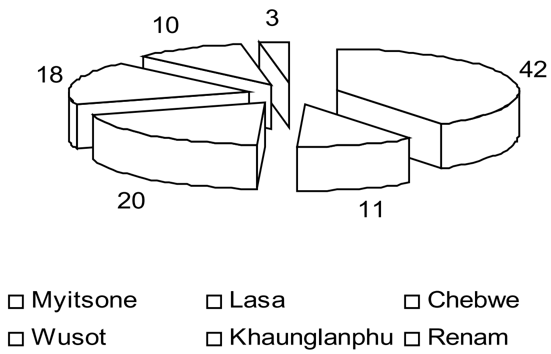


Figure 10. Total number of new records for North Myanmar from all study sites



Appendix 1. Bird species recorded in all study area

No.	Common Name	Species Name	I Quant.	II Quant.	III Quant.	IV Quant.	V Quant.	VI Quant.	VII Quant.	Total Quant.	IUCN 2009
	PHASIANIDAE										
1	Chinest Francolin	*Francolinus pintadeanus*	2							2	
2	Red Junglefowl	*Gallus gallus*	12	12	9		2			35	
3	Rufous-throated Partridge	*Arborophila rufogularis*	3		4	6	20	4	7	44	
4	Hill Partridge	*Arborophila torqueola*			2		2			4	
5	Mountain Bamboo Partridge	*Bambusicola fytchii*			14		2	6		22	

6	White-cheeked Partridge	*Arborophila atrogularis*					2		1	3
7	Blyth's Tragopan	*Tragopan blythii*						6		6
8	Kalij Pheasant	*Lophura leucomelanos*	2			1		14	2	19
9	Silver Pheasant	*Lophura nycthemera*			2		2			4
10	Grey Peacock Pheasant	*Polyplectron bicalcaratum*	1	5	11	2			6	25
	ANATIDAE: Anatini									
11	Common Merganser	*Mergus merganser*	65						4	69
12	Bar-headed Goose	*Anser indicus*	1					3		4
13	Mallard	*Anas platyrhynchos*	1							1
14	Spot- billed Duck	*Anas poecilorhyncha*	38							38
15	Nothern Pintail	*Anas acuta*	3							3
16	Tufted Duck	*Aythya fuligula*	4							4
17	Gadwall	*Anas strepera*	22							22
18	Ruddy Shelduck	*Tadorna ferruginea*	218					2		220
	DENDROCYGNIDAE									
19	Lesser Whistling-Duck	*Dendrocygna javanica*		1						1
	PICIDAE									
20	Eurasian Wryneck	*Jynx torquilla*			4					4
21	Speckled Piculet	*Picumnus innominatus*	16	5		1		2	1	25
22	White-browed Piculet	*Sasia ochracea*	12	10	3	1		3	5	34
23	Grey- capped Pygmy Woodpecker	*Dendrocopos canicapillus*	2		2					4
24	Crimson - breasted Woodpecker	*Dendrocopos cathpharius*						2	2	4
25	Fulvous-breasted Woodpecker	*Dendrocopos macei*	8	3		4				15
26	Rufous Woodpecker	*Celeus brachyurus*		6	8					14
27	Lesser Yellownape	*Picus chlorolophus*	3		1	1		1		6
28	Greater Yellownape	*Picus flavinucha*	2	1	2			1	2	8
29	Great Spotted Woodpecker	*Dendrocopos major*					2			2
30	Grey-headed Woodpecker	*Picus canus*	4	1	7		2			14
31	Himalayan Flameback	*Dinopium shorii*	4				2			6
32	Common Flameback	*Dinopium javanense*	1				2			3
33	Greater Flameback	*Chrysocolaptes lucidus*	15	4	1	2				22
34	Pale-headed Woodpecker	*Gecinulus grantia*	6	1						7
35	Bay Woodpecker	*Blythipicus pyrrhotis*	14	5	13	3		12	1	48
	MEGALAIMIDAE									
36	Great Barbet	*Megalaima virens*			11	4	3	39	24	81
37	Lineated Barbet	*Megalaima lineata*	69						8	77
38	Golden- throated Barbet	*Megalaima franklimii*			11	6		17	13	47
39	Blue-throated Barbet	*Megalaima asiatica*	400	73	41	7		2	5	528
40	Coppersmith Barbet	*Megalaima haemacephala*	32				2			34
41	Blue-eared Barbet	*Megalaima australis*	23	5						28
	BUCEROTIDAE									
42	Wreathed Hornbill	*Aceros undulatus*	23						4	27
43	Oriental Pied Hornbill	*Anthracoceros albirostris*	80	10						90

44	Great Hornbill	*Buceros bicornis*	19	6	4	2		8	5	44	NT
45	Rufous-necked Hornbill	*Aceros nipalensis*	3	4	10	2		3	3	25	V
	UPUPIDAE										
46	Common Hoopoe	*Upupa epops*	2	5	8		3	2	1	21	
	CORACIIDAE										
47	Indian Roller	*Coracias benghalensis*	71							71	
48	Dollarbird	*Eurystomus orientalis*	4	8						12	
	TROGONIDAE: Harpactini										
49	Red- headed Trogon	*Harpactes erythrocephalus*	11		8	3		3	2	27	
	ALCEDINIDAE										
50	Blyth's Kingfisher	*Alcedo hercules*		1	1				1	3	NT
51	Common Kingfisher	*Alcedo atthis*	19	8	3	1		1	1	33	
52	Blue-eared Kingfisher	*Alcedo meninting*	1							1	
53	Black-backed Kingfisher	*Ceyx erithacus*		1	10					11	
	HALCYONIDAE										
54	Ruddy Kingfisher	*Halcyon coromanda*	1							1	
55	White-throated Kingfisher	*Halcyon smyrnensis*	85	17	4		2			108	
56	Black- capped Kingfisher	*Halcyon pileata*			4					4	
	CERYLIDAE										
57	Crested Kingfisher	*Megaceryle lugubris*	18	9	1	1		1	4	34	
58	Pied Kingfisher	*Ceryle rudis*	27	5						32	
	CUCULIDAE										
59	Green- billed Malkoha	*Phaenicophaeus tristis*	18		4		2			24	
60	Asian Koel	*Eudynamys scolopacea*	11							11	
61	Chestnut-winged Cuckoo	*Clamator coromandus*		3	22					25	
62	Large Hawk Cuckoo	*Hierococcyx sparverioides*		16	9	6	1	2	3	37	
63	Hodgson's Hawk Cuckoo	*Hiercoccyx fugax*			3	1			1	5	
64	Eurasian Cuckoo	*Cuculus canorus*			3					3	
65	Oriental Cuckoo	*Cuculus saturatus*	1		3					4	
66	Plaintive Cuckoo	*Cacomantis merulinus*	4	10			1			15	
67	Banded Bay Cuckoo	*Cacomantis sonneratii*			5	3		5		13	
68	Indian Cuckoo	*Cuculus micropterus*	20	29	18	5			1	73	
69	Drongo Cuckoo	*Surniculus lugubris*	13	22	14	13				62	
	CENTROPADIDAE										
70	Greater Coucal	*Centropus sinensis*	27	12	2					41	
71	Lesser Coucal	*Centropus bengalensis*	4	1	2					7	
	MEROPIDAE										
72	Blue- beared Bee-eater	*Nyctyornis athertoni*	21		7	1				29	
73	Green Bee-eater	*Merops orientalis*	151							151	
74	Chestnut-headed Bee-Eater	*Merops leschenaulti*	13		13					26	
75	Blue- tailed Bee- eater	*Merops philipinus*	1							1	
	PSITTACIDAE										
76	Grey-headed Parakeet	*Psittacula finschii*	135	3	9					147	

77	Red-breasted Parakeet	*Psittacula alexandri*	218	10						228
78	Blossom- headed Parakeet	*psittacula roseata*	20							20
	APODIDAE									
79	Himalayan Swiftlet	*Collocalia brevirostris*	19					49	166	234
80	Brown-backed Needletail	*Hirundapus giganteus*			3					3
81	Asian Palm Swift	*Cypsiurus balasiensis*	693	644	92			22		1451
82	Brown-backed Needletail	*Hirundapus giganteus*	2							2
83	House Swift	*Apus affinis*						6		6
	HEMIPROCNIDAE									
84	Crested Treeswift	*Hemiprocne coronata*	3							3
	TYTONIDAE									
85	Barn Owl	*Tyto alba*	1							1
	STRIGIDAE									
86	Mountain Scops Owl	*Otus spilocephalus*	4	2	11			2	2	21
87	Collared Scops Owl	*Otus bakkamoena*	3				1	1	1	6
88	Oriental Scops Owl	*Otus sunia*		1				1		2
89	Collared Owlet	*Glaucidium brodiei*	7	5	1			6	25	44
90	Tawny fish Owl	*Ketupa flavipes*	1							1
91	Asian Barred Owlet	*Glaucidium cuculoides*	10	4	1			1	2	18
	CAPRIMULGIDAE: CAPRIMULGINAE									
92	Grey Nightjar	*Caprimulgus indicus*			4					4
93	Large-tailed Nightjar	*Caprimulgus macrurus*						1		1
94	Great-eared Nightjar	*Eurostopodus macrotis*	6	1				1		8
	COLUMBIDAE									
95	Oriental Turtle Dove	*Streptopelia orientalis*	82	13	9		2	10		116
96	Ashy Wood Pigeon	*Columba pulchricollis*				1				1
97	Spotted Dove	*Streptopelia chinensis*	141	46	19	1		4		211
98	Eurasian Collared Dove	*Streptopelia decaocto*			2					2
99	Barred Cuckoo Dove	*Macropygia unchall*	2					1		3
100	Emerald Dove	*Chalcophaps indica*	21	3	7	2		1		34
101	Pompadour Green Pigeon	*Treron pompadora*	75	9	3			6		93
102	Thick-billed Green Pigeon	*Treron curvirostra*	8	101						109
103	Pin-tailed Green Pigeon	*Treron apicauda*	1	45	73	6				125
104	Wedge-tailed Green Pigeon	*Treron sphenura*		4	4			5		13
105	Green Imperial Pigeon	*Ducula aenea*		1	4		1			6
106	Mountain Imperial Pigeon	*Ducula badia*		5	36		4	27	2	74
	GRUIDAE									
107	Common Crane	*Grus grus*	154							154
	RALLIDAE									
108	White-breasted Waterhen	*Amaurornis phoenicurus*	4	2	7					13
	SCOLOPACIDAE: TRINGINAE									
109	Wood Snipe	*Gallinago nemoricola*				1				1
110	Common Greenshank	*Tringa nebularia*		1						1

111	Common Sandpiper	*Actitis hypoleucos*	26	7				2		35	
	BURHINIDAE										
112	Great Thick-Knee	*Esacus recurvirostris*		3						3	
	CHARADRIINAE										
113	Little- ring Plover	*Charadrius dubius*	4							4	
114	River Lapwing	*Vanellus duvaucelii*	11	7	4					22	
115	Grey-headed Lapwing	*Vanellus cinereus*		9	4					13	
116	Red-wattled Lapwing	*Vanellus indicus*	17	2						19	
	GLAREOLINAE										
117	Small Pratincole	*Glareola lactea*	188	117	5					310	
	Laridae: Larini										
118	Pallas's Gull	*Larus ichthyaetus*	9							9	
119	Brown-headed Gull	*Larus brunnicephalus*	1							1	
	ACCIPITRIDAE: ACCIPITRINAE										
120	Jerdon's Baza	*Aviceda jerdoni*	1							1	
121	Oriental Honey-Buzzard	*Pernis ptilorhyncus*	11	1				1		13	
122	Pallas's Fish Eagle	*Haliaeetus leucoryphus*		1						1	V
123	Lesser-Fish Eagle	*Ichthyophaga bumills*	1					1		2	NT
124	Grey-headed Fish Eagle	*Ichthyophaga ichthyaetus*		5					1	6	NT
125	Black-shouldered Kite	*Elanus caeruleus*			1					1	
126	Crested Serpent Eagle	*Spilornis cheela*	24	9	7	1		1	2	44	
127	Hen Harrier	*Circus cyaneus*			1					1	
128	Crested Goshawk	*Accipiter trivirgatus*	10	1	4	1		3	1	20	
129	Besra	*Accipiter virgatus*		1	1					2	
130	Shikra	*Accipiter badius*	4		1			1		6	
131	Chinese Sparrow Hawk	*Accipites sloensis*	1							1	
132	Japanese Sparrow Hawk	*Accipiter gularis*	2							2	
133	Eurasian Sparrowhawk	*Accipiter nisus*		1					1	2	
134	Grey-faced Buzzard	*Butastur indicus*	1							1	
135	Common Buzzard	*Buteo buteo*	8	3	2	1		4	2	20	
136	Bonelli's Eagle	*Hieraaetus fasciatus*	1					2		3	
137	Black Eagle	*Ictinaetus malayensis*	11	3	2	3		4	5	28	
138	Mountain Hawk Eagle	*Spizaetus nipalensis*			1	2		2	1	6	
	FALCONIDAE										
139	Common Kestrel	*Falco tinnunculus*	33	1	2		1	2		39	
140	Collared Falconet	*Microhierax caerulescens*	4						1	5	
141	Oriental Hobby	*Falco severus*	9		1					10	
142	Peregrine Falcon	*Falco peregrinus*	7	1	1					9	
	PODICIPEDIDAE										
143	Great Crested Grebe	*Podiceps cristatus*	1							1	
	ANHINGIDAE										
144	Oriental Darter	*Anhinga melanogaster*	4							4	
	PHALACROCORACIDAE										

145	Great Cormorant	*Phalacrocorax carbo*	94	22		4		9	18	147	
146	Little Cormorant	*Phalacrocorax niger*					1			1	
	ARDEIDAE										
147	Little Egret	*Egretta garzetta*	5	2	8	1				16	
148	Great Egret	*Casmerodius albus*	4		2					6	
149	Cattle Egret	*Bubulcus ibis*	144		1					145	
150	White-bellied Heron	*Ardea insignis*		2						2	CR
151	Intermediate Egret	*Mesophoyx intermedia*		1						1	
152	Chinese Pond Heron	*Ardeola bacchus*		3	1	1				5	
153	Pond Heron	*Ardeola* spp.	8	2						10	
154	Little Heron	*Butorides striatus*	5	6	2				5	18	
	CICONIIDAE: CICONIINAE										
155	Black Stork	*Ciconia nigra*		4	1	5				10	
	PITTIDAE										
156	Hooded Pitta	*Pitta sordida*		1	7					8	
157	Blue-naped Pitta	*Pitta nipalensis*	1							1	
158	Blue-winged Pitta	*Pitta moluccensis*	8	4	1					13	
	EURYLAIMINAE										
159	Long-tailed Broadbill	*Psarisomus dalhousiae*	21	69	18	13	2	21	1	145	
160	Silver- breasted Broadbill	*Serilophus lunatus*			2	2		2	4	10	
	IRENIDAE										
161	Asian Fairy Bluebird	*Irena puella*	68						2	70	
162	Blue-winged Leafbird	*Chloropsis cochinchinensis*	56				4	2		62	
163	Golden-fronted Leafbird	*Chloropsis aurifrons*	101	5					5	111	
164	Orange-bellied Leafbird	*Chloropsis hardwickii*	38	19	25	9	4	19	3	117	
	LANIIDAE										
165	Brown Shrike	*Lanius cristatus*	25		3					28	
166	Long-tailed Shrike	*Lanius schach*	5	2	10		2	2	4	25	
167	Grey-backed Shrike	*Lanius tephronotus*	43	7	4			2	4	60	
	CORVINAE: Corvini										
168	Red-billed Blue Magpie	*Urocissa erythrorhyncha*		7	4					11	
169	Common Green Magpie	*Cissa chinensis*	12	5	10	3	3	3	3	39	
170	Rufous Treepie	*Dendrocitta vagabunda*	17							17	
171	Grey Treepie	*Dendrocitta formosae*	74	64	44	2		8	10	202	
172	Collared Treepie	*Dendrocitta frontalis*	17	48	11	6		3	5	90	
173	House Crow	*Corvus splendens*	12		4					16	
174	Large-billed Crow	*Corvus macrorhynchos*	139	87	9		2	56	5	298	
	Artamini										
175	Ashy Woodswallow	*Artamus fuscus*	61	5	18	5				89	
	Oriolini										
176	Maroon Oriole	*Oriolus traillii*	12	13	23	12		16	6	82	
177	Black-hooded Oriole	*Oriolus xanthornus*	46		2					48	
178	Black-naped Oriole	*Oriolus chinensis*	9							9	

179	Slender- billed Oriole	*Oriolus tenuirostris*							1	1
180	Large Cuckooshrike	*Coracina macei*	12		3				2	17
181	Indochinese Cuckooshrike	*Coracina polioptera*	1	3	16	10		2		32
182	Black-winged Cuckooshrike	*Coracina melaschistos*	9							9
183	Grey- chinned Minivet	*Pericrocotus solaris*	15		7			11	4	37
184	Ashy Minivet	*Pericrocotus divaricatus*		4						4
185	Long-tailed Minivet	*Pericrocotus ethologus*	30	36	16	2	2		33	119
186	Short-billed Minivet	*Pericrocotus brevirostris*	33		8		4			45
187	Scarlet Minivet	*Pericrocotus flammeus*	144	55	21	15		8		243
188	Bar-winged Flycatcher-Shrike	*Hemipus picatus*	74	17	12	3		12	21	139
	DICRURINAE: Rhipidurini									
189	Yellow-bellied Fantail	*Rhipidura hypoxantha*	54	5	7			3	8	77
190	White-throated Fantail	*Rhipidura albicollis*	23	1	1		3	7	9	44
	Dicrurini									
191	Black Drongo	*Dicrurus macrocercus*	21	2						23
192	Ashy Drongo	*Dicrurus leucophaeus*	46	20	26	4	4	1	2	103
193	Bronzed Drongo	*Dicrurus aeneus*	126	38	15	2		18	41	240
194	Lesser Racket-tailed Drongo	*Dicrurus remifer*	15	4	10	4		1	3	37
195	Spangled Drongo	*Dicrurus hottentottus*	125	27	25					177
196	Greater Racket-tailed Drongo	*Dicrurus paradiseus*	19		6					25
	Monarchini									
197	Asian Paradise-flycatcher	*Terpsiphone paradisi*		33	15					48
198	Black-naped Monarch	*Hypothymis azurea*	6	24			2			32
	AEGITHININAE									
199	Common Iora	*Aegithina tiphia*	6				1			7
	MALACONOTINAE: Vangini									
200	Large Woodshrike	*Tephrodornis gularis*	35		17	3		8	1	64
201	Common Woodshrike	*Tephrodornis pondicerianus*	7	2						9
	CINCLIDAE									
202	White- throated Dipper	*Cinclus cinclus*							2	2
203	Brown Dipper	*Cinclus pallasii*			4			1	9	14
	MUSCICAPIDAE: TURDINAE									
204	Blue Rock Thrush	*Monticola solitarius*	15	2	2			1	4	24
205	Chestnut-bellied Rock Thrush	*Monticola rufiventris*					6	5		11
206	Scaly Thrush	*Zoothera dauma*	1							1
207	Eyebrowed Thrush	*Turdus obscurus*	3							3
208	Chestnut Thrush	*Turdus rubrocanus*	2							2
209	Blue Whistling Thrush	*Myophonus caeruleus*	14	2	11	2		1	11	41
210	Orange-headed Thrush	*Zoothera citrina*	1		5	1				7
211	Plain-backed Thrush	*Zoothera mollissima*			1			2		3
212	Grey-winged Blackbird	*Turdus boulboul*			3					3
213	Green Cochoa	*Cochoa viridis*				7		6		13

214	Lesser Shortwing	*Brachypteryx leucophrys*			1			2		3	NT
215	Rusty-bellied Shortwing	*Brachypteryx hyperythra*			1					1	
216	White-browed Shortwing	*Brachypteryx montana*				1	2	2		5	
217	Eurasian Blackbird	*Turdus merula*							4	4	
	MUSCICAPINAE: Muscicapini										
218	Ferruginous Flycatcher	*Muscicapa ferruginea*			2					2	
219	Rufous-gorgeted Flycatcher	*Ficedula strophiata*						8		8	
220	White- gorgeted Flycatcher	*Ficedula monileger*						2	2	4	
221	Snowy-browed Flycatcher	*Ficedula hyperythra*	3			1		2		6	
222	Little Pied Flycatcher	*Ficedula westermanni*	5		2			1	4	12	
223	Slaty-blue Flycatcher	*Ficedula tricolor*	2					1		3	
224	Verditer Flycatcher	*Eumyias thalassina*			7	1		1	3	12	
225	Brown-breasted Flycatcher	*Muscicapa muttui*				1				1	
226	Red-throated Flycatcher	*Ficedula parva*	13	34	14	5	2			68	
227	Large Niltava	*Niltava grandis*	1		3		4	13	22	43	
228	Small Niltava	*Niltava macgrigoriae*	18	2	8	5		2		35	
229	Rufous-bellied Niltava	*Niltava sundara*	1					1		2	
230	Blue-throated Flycatcher	*Cyornis rubeculoides*	88	44	16			1	2	151	
231	Pale Blue Flycatcher	*Cyornis unicolor*	3		7	11				21	
232	Pygmy Blue Flycatcher	*Muscicapella hodgsoni*	4							4	
233	Hill Blue Flycatcher	*Cyornis banyumas*			7	7				14	
234	Tickell's Blue Flycatcher	*Cyornis tickelliae*	2	2	2				1	7	
235	Grey-headed Canary Flycatcher	*Culicicapa ceylonensis*	137	21	13	3	4	2	24	204	
	Saxicolini										
236	Siberian Rubythroat	*Luscinia calliope*	19		5					24	
237	Orange-flanked Bush Robin	*Tarsiger cyanurus*	1					2		3	
238	Golden Bush Robin	*Tarsiger chrysaeus*						3		3	
239	Oriental Magpie Robin	*Copsychus saularis*	32	31	25		2			90	
240	White-rumped Shama	*Copsychus malabaricus*	31	10			1			42	
241	Hodgson's Redstart	*Phoenicurus hodgsoni*	4	1	2	2		2	2	13	
242	Daurian Redstart	*Phoenicurus auroreus*	6				1	1		8	
243	Blue-fronted Redstart	*Phoenicurus frontalis*						2		2	
244	White-capped Water Redstart	*Chaimarrornis leucocephalus*	14	8	16	11		2	10	61	
245	Plumbeous Water Redstart	*Rhyacornis leucocephalus*	14		10	5		2	21	52	
246	White-bellied Redstart	*Hodgsonius phaenicuroides*			1					1	
247	White-tailed Robin	*Myiomela leucura*	3	1						4	
248	Little Forktail	*Enicurus scouleri*			3		2	1	2	8	
249	Black-backed Forktail	*Enicurus immaculatus*	32	3	3	2		1	7	48	
250	Slaty- backed Forktail	*Enicurus schistaceus*	14		3	6	2	2	3	30	
251	White- crowned Forktail	*Enicurus leschenaulti*	2					1	2	5	
252	Spotted Forktail	*Enicurus maculatus*			4			1		5	
253	Siberian Stonechat	*Saxicola maura*	8	9	10	5		1	3	36	
254	Pied Bushchat	*Saxicola caprata*	3							3	

255	Grey Bushchat	*Saxicola ferrea*	16	6	6		2	4		34	
	STURNIDAE: Sturnini										
256	Spot-winged Starling	*Saroglossa spiloptera*						1		1	
257	Asian Pied Starling	*Sturnus contra*	28	20						48	
258	Chestnut-tailed Starling	*Sturnus malabaricus*	281	118	61				1	461	
259	Black-collared Starling	*Sturnus nigricollis*	58							58	
260	Vinous-breasted Starling	*Sturnus burmannicus*	146	3						149	
261	Common Myna	*Acridotheres tristis*		7						7	
262	White-vented Myna	*Acridotheres grandis*		7						7	
263	Collared Myna	*Acridotheres albocinctus*	505	35						540	
264	Hill Myna	*Gracula religiosa*	53	2	1					56	
	SITTIDAE: SITTINAE										
265	Chestnut-vented Nuthatch	*Sitta nagaensis*			4	2	2			8	
266	Chestnut-bellied Nuthatch	*Sitta castanea*	16	23	7			3		49	
267	Beautiful Nuthatch	*Sitta formosa*			7	5		3	17	32	V
268	Velvet-fronted Nuthatch	*Sitta frontalis*	30	19	5	3	2	2		61	
	TROGLODYTINAE										
269	Winter Wren	*Troglodytes troglodytes*						1		1	
	PARINAE										
270	Green- backed Tit	*Parus monticolus*			3			10	6	19	
271	Yellow-browed Tit	*Sylviparus modestus*					12	4		16	
272	Yellow- cheeked Tit	*parus spilonotus*			10		5	8	81	104	
273	Sultan Tit	*Melanochlora sultanea*	49		7			6	7	69	
	AEGITHALIDAE										
274	Black-throated Tit	*Aegithalos concinnus*			2		6	11		19	
275	Black-browed Tit	*Aegithalos bonvaloti*					4			4	
	HIRUNDININAE										
276	Plain Martin	*Riparia paludicola*	13	55						68	
277	Barn Swallow	*Hirundo rustica*	44	45				18		107	
278	Asian House Martin	*Delichon dasypus*						29		29	
279	Red-rumped Swallow	*Hirundo daurica*	149			6				155	
280	Striated Swallow	*Hirundo striolata*	15		24					39	
281	Wire-tailed Swallow	*Hirundo smithii*	51	5						56	
282	Asian House Martin	*Delichon dasypus*	89							89	
	PYCNONOTIDAE										
283	Crested Finchbill	*Spizixos canifrons*			16		4	15		35	
284	Black-crested Bulbul	*Pycnonotus melanicterus*	62				5			67	
285	Red-whiskered Bulbul	*Pycnonotus jocosus*	416	170	96	20			17	719	
286	Striated Bulbul	*Pycnonotus striatus*			2			6	16	24	
287	Brown-breasted Bulbul	*Pycnonotus xanthorrhous*		3				77		80	
288	Red-vented Bulbul	*Pycnonotus cafer*	357	136						493	
289	Flavescent Bulbul	*Pycnonotus flavescens*			10					10	
290	White-throated Bulbul	*Alophoixus flaveolus*	104	101	53	30	13	19	12	332	

291	Olive Bulbul	*Iole virescens*	59	3					39	101
292	Ashy Bulbul	*Hemixos flavala*	56	61	41	47		17	45	267
293	Mountain Bulbul	*Hypsipetes mcclellandii*			23			24		47
294	Black Bulbul	*Hypsipetes leucocephalus*	305	176	92	50	50	99	23	795
	CISTICOLIDAE									
295	Rufescent Prinia	*Prinia rufescens*	34							34
296	Striated Prinia	*Prinia criniger*					2		1	3
297	Hill Prinia	*Prinia superciliaris*		1	8	6		14	18	47
298	Grey-breasted Prinia	*Prinia hodgsonii*	8	16	12			4		40
299	Yellow-bellied Prinia	*Prinia flaviventris*	2	3						5
	ZOSTEROPIDAE									
300	Chestnut-flanked White-Eye	*Zosterops erythropleurus*					8			8
301	Oriental White-eye	*Zosterops palpebrosus*	25	8				30		63
302	Japanese White-eye	*Zosterops japonicus*	100	52	35			45		232
	SYLVIIDAE: ACROCEPHALINAE									
303	Slaty- bellied Tesia	*Tesia olivea*	5		1		2	5	2	15
304	Grey- bellied Tesia	*Tesia cyaniventer*	7				8	1	16	32
305	Chestnut-headed Tesia	*Tesia castaneocoronata*					2	1		3
306	Pale foodted Bush Warbler	*Cettia pallidipes*					3			3
307	Brownish- flanked Bush Warbler	*Cettia fortipes*			5			7	11	23
308	Aberrant Bush Warbler	*Cettia flavolivacea*			4			2		6
309	Brown Bush Warbler	*Bradypterus luteoventris*					3			3
310	Thick-billed Warbler	*Acrocephalus aedon*	2		3					5
311	Mountain Tailorbird	*Orthotomus cuculatus*	4	4			1	2	38	49
312	Common Tailorbird	*Orthotomus sutorius*	73	40	6	6		2	2	129
313	Dark-necked Tailorbird	*Orthotomus atrogularis*	17	14						31
314	Dusky Warbler	*Phylloscopus fuscatus*	19	15	5	1		2	1	43
315	Buff-barred Warbler	*Phylloscopus pulcher*	3				2	1		6
316	Buff-throated Warbler	*Phylloscopus subaffinis*		3						3
317	Ashy-throated Warbler	*Phylloscopus maculipennis*					4	2		6
318	Lemon-rumped Warbler	*Phylloscopus chloronotus*					2	2		4
319	Yellow-browed Warbler	*Phylloscopus inornatus*	24				2	2		28
320	Two-barred Warbler	*Phylloscopus plumbeitarsus*	13					4		17
321	Greenish Warbler	*Phylloscopus trochiloides*	19	4						23
322	Tickell's Leaf Warbler	*Phylloscopus affinis*			2					2
323	Blyth's Leaf Warbler	*Phylloscopus reguloides*	6		1	3		1	3	14
324	White- tailed Leaf Warbler	*Phylloscopus davisoni*	4				4		12	20
325	Yellow-vented Warbler	*Phylloscopus cantator*		20	2	10		1	15	48
326	Mountain Leaf Warbler	*Phylloscopus trivirgatus*							2	2
327	Grey-hooded Warbler	*Seicercus xanthoschistus*					4			4
328	White- spectacled Warbler	*Seicercus affinis*	41				4		1	46
329	Grey- cheeked Warbler	*Seicercus poliogenys*	6		2		3	8	68	87
330	Chestnut- crowned Warbler	*seicercus castaniceps*	1		7			4	6	18

331	Broad-billed Warbler	*Tickellia hodgsoni*						2		2	
332	Rufous-faced Warbler	*Abroscopus albogularis*	35	43	16	13		43	108	258	
333	Black-faced Warbler	*Abroscopus schisticeps*					3			3	
334	Yellow-bellied Warbler	*Abroscopus superciliaris*	224	45	61	4		9	64	407	
	MEGALURINAE										
335	Striated Grassbird	*Megalurus palustris*	2	6	2		4			14	
	GARRULACINAE										
336	White-crested Laughingthrush	*Garrulax leucolophus*	152	143	32	14	16	8	87	452	
337	Lesser Necklaced Laughingthrush	*Garrulax monileger*	59	1	26	4		4		94	
338	Greater Necklaced Laughingthrush	*Garrulax pectoralis*	85	14	27	17		9	6	158	
339	Striated Laughingthrush	*Garrulax striatus*						6	83	89	
340	Scaly Lasughingthrush	*Garrulax subunicolor*						2	6	8	
341	White-browed Laughingthrush	*Garrulax sannio*			12			6		18	
342	Blue-winged Laughingthrush	*Garrulax squamatus*			8			1		9	
343	Chestnut- crowned Laughingthrush	*Garrulax erythrocephalus*					14	8	6	28	
344	Red- tailed Laughingthrush	*Garrulax milnei*			1		10	16	12	39	
345	Chestnut-backed Laughingthrush	*Garrulax nuchalis*	16	41	7				6	70	NT
346	Rufous-necked Laughingthrush	*Garrulax ruficollis*	15	6	5				28	54	
347	Spotted Laughingthrush	*Gusulax Ocellatus*			2					2	
348	Grey-sided Laughingthrush	*Gurrulax caerulatus*			2					2	
349	Red-faced Liocichla	*Liocichla phoenicea*			9	6		14		29	
	SYLVINAE: Timaliini										
350	Buff-breasted Babbler	*Pellorneum tickelli*		3	4	2				9	
351	Spot-throated Babbler	*Pellorneum albiventre*		12				1	7	20	
352	Puff-throated Babbler	*Pellorneum ruficeps*	70	41	10	2	2	7		132	
353	Spot-breasted Scimitar Babbler	*Pomatorhinus erythrocnemis*			5					5	
354	Streak-breasted Scimitar Babbler	*Pomatorhinus ruficollis*			5		2	9		16	
355	White-browed Scimitar Babbler	*Pomatorhinus schisticeps*	18	17	2			3	31	71	
356	Red-billed Scimitar Babbler	*Pomatorhinus ochraceiceps*	60	7	23					90	
357	Coral-billed Scimitar Babbler	*Pomatorhinus ferruginosus*	8	6	12	3		11	19	59	
358	Slender-billed Scimitar Babbler	*Xiphirhynchus superciliaris*			1					1	
359	Long- billed Wren Babbler	*Rimator malacoptilus*						1	2	3	
360	Cachar Wedge-billed Babbler	*Sphenocichla roberti*				2		1		3	NT
361	Eyebrowed Wren Babbler	*Napothera epilepidota*						8		8	
362	Scaly-breasted Wren Babbler	*Pnoepyga albiventer*					3	1		4	
363	Pygmy Wren Babbler	*Pnoepyga pusilla*	6	4	2		2	3	1	18	
364	Spotted Wren Babbler	*Spelaeornis formosus*			6	2		1		9	
365	Long-tailed Wren Babbler	*Spelaeornis chocolatinus*			2	2		1		5	
366	Rufous-capped Babbler	*Stachyris ruficeps*	36		4			2		42	
367	Rufous-fronted Babbler	*Stachyris rufifrons*	41	8			5	5	10	69	
368	Golden Babbler	*Stachyris chrysaea*	33	50	4	9		81	117	294	
369	Grey- throated Babbler	*Stachyris nigriceps*	31		16	9		30	57	143	
370	Snowy-throated Babbler	*Stachyris oglei*						6		6	

371	Chestnut-capped Babbler	*Timalia pileata*	4					2		6
372	Spot-necked Babbler	*Stachyris striolata*		5						5
	Chevron-breasted Babbler	*Sphenocichla roberti*						1		1
373	Striped Tit Babbler	*Macronous gularis*	104	25						129
374	Yellow-eyed Babbler	*Chrysomma sinense*	7							7
375	Silver-eared Mesia	*Leiothrix argentauris*	111		18	16		302	138	585
376	Red-billed Leiothrix	*Leiothrix lutea*			16			9	2	27
377	Cutia	*Cutia nipalensis*			6			3	4	13
378	White-browed Shrike Babbler	*Pteruthius flaviscapis*			9			16	2	27
379	Black-eared Shrike Babbler	*Pteruthius melanotis*			3		3	21	2	29
380	Black-headed Shrike Babbler	*Pteruthius rufiventer*						2		2
381	Chestnut-fronted Shirke Babbler	*Pteruthius aenobarbus*							3	3
382	Rusty-fronted Barwing	*Actinodura egertoni*					6	20	35	61
383	Streak-throated Barwing	*Actinodura waldeni*						4		4
384	Blue-winged Minla	*Minla cyanouroptera*			7	7		6	4	24
385	Chestnut-tailed Minla	*Minla strigula*						8		8
386	Red-tailed Minla	*Minla ignotincta*						8	10	18
387	White-hooded Babbler	*Gampsorhynchus rufulus*	82	22	33	8				145
388	Yellow-throated Fulvetta	*Alcippe cinerea*						38	18	56
389	Rufous-winged Fulvetta	*Alcippe castaneceps*			3			8	15	26
390	White-browed Fulvetta	*Alcippe vinipectus*						5		5
391	Rufous-throated Fulvetta	*Alcippe rufogularis*	16	7					3	26
392	Grey-cheeked Fulvetta	*Alcippe morrisonia*			12			6	100	118
393	Brown-cheeked Fulvetta	*Alcippe poioicephala*	463	19	12					494
394	Nepal Fulvetta	*Alcippe nipalensis*		18	48	32	14	336	129	577
395	Rufous-backed Sibia	*Heterophasia annectens*			2	5		4	15	26
396	Grey Sibia	*Heterophasia gracilis*			13					13
397	Black-headed Sibia	*Heterophasia desgodinsi*			5					5
398	Beautiful Sibia	*Heterophasia pulchella*		1	8		10	7	3	29
399	Long-tailed Sibia	*Heterophasia picaoides*			28		13	12		53
400	Striated Yuhina	*Yuhina castaniceps*		38	84	21	20	55	119	337
401	White-naped Yuhina	*Yuhina bakeri*			11	11		18	171	211
402	Whiskered Yuhina	*Yuhina flavicollis*			3	12		83	9	107
403	Rufous-vented Yuhina	*Yuhina occipitalis*			8					8
404	Black-chinned Yuhina	*Yuhina nigrimenta*		4	6	3		12		25
405	White-bellied Yuhina	*Yuhina zantholeuca*	21	25	8	7		3		64
406	Spot-breasted Parrotbill	*Paradoxornis guttaticollis*						14		14
407	Black-throated Parrotbill	*Paradoxornis nipalensis*				5		32		37
408	Brown-winged Parrotbill	*Paradoxornis brunneus*			7			25		32
409	Grey-headed Parrotbill	*Paradoxornis gularis*			11				4	15
410	Lesser Rufous-headed Parrotbill	*Paradoxornis atrosuperciliaris*	27	4	20	2	8	14	19	94
411	Greater Rufous-headed Parrotbill	*Paradoxornis ruficeps*		10	18	10	6	7	5	56
	ALAUDIDAE									

412	Oriental Skylark	*Alauda gulgula*	3					1		4
	NECTARINIIDAE: NECTARINIINAE									
413	Yellow-vented Flowerpecker	*Dicaeum chrysorrheum*	4	3					6	13
414	Fire-breasted Flowerpecker	*Dicaeum ignipectus*			4			2	20	26
415	Plain Flowerpecker	*Dicaeum concolor*	55	26						81
416	Scarlet-backed Flowerpecker	*Dicaeum cruentatum*	2							2
	Nectariniini									
417	Ruby-cheeked Sunbird	*Anthreptes singalensis*	16	4						20
418	Green-tailed Sunbird	*Aethopyga nipalensis*					1	2	1	4
419	Mrs Gould's Sunbird	*Aethopyga gouldiae*			4					4
420	Black-throated Sunbird	*Aethopyga saturata*	55	17	18	12	2	25	67	196
421	Crimson Sunbird	*Aethopyga siparaja*	46	55	6			1		108
422	Little Spiderhunter	*Arachnothera longirostra*	45	20	2			2	1	70
423	Streaked Spiderhunter	*Arachnothera magna*	34	35	19	1	2	7	20	118
	PASSERIDAE: PASSERINAE									
424	Russet Sparrow	*Passer rutilans*		29	7	4		4		44
425	House Sparrow	*Passer domensticus*	8							8
426	Eurasian Tree Sparrow	*Passer montanus*	115	160	10			11		296
	MOTACILLINAE									
427	White Wagtail	*Motacilla alba*	61	38	17	3	5	10	9	143
428	Citrine Wagtail	*Motacilla citreola*	4	5	3					12
429	Yellow Wagtail	*Motacilla flava*		1	3					4
430	Grey Wagtail	*Motacilla cinerea*			6					6
431	Paddyfield Pipit	*Anthus rufulus*			2					2
432	Richard's Pipit	*Anthus richardi*	6	1						7
433	Olive-backed Pipit	*Anthus hodgsoni*	39	29	12	29		19	9	137
434	Rosy Pipit	*Anthus roseatus*			2					2
	PRUNELLINAE: Accentors									
435	Maroon -backed Accentor	*Prunella immaculata*						1		1
	ESTRILDINAE: Estrildini									
436	White-rumped Munia	*Lonchura striata*	156	23	44			28	8	259
437	Scaly-breasted Munia	*Lonchura punctulata*	93		6	3				102
	Carduelini									0
438	Tibetan Siskin	*Carduelis thibetana*					30	142		172
440	Gold- naped Finch	*pyrrhoplectes epauletta*						4	3	7
441	Scarlet Finch	*Haematospiza sipahi*							16	16
442	Common Rosefinch	*Carpodacus erythrinus*	27	4	5		2			38
443	Spot-winged Grosbeak	*Mycerobas melanozanthos*			9				2	11
	EMBERIZINAE: Emberizini									
444	Tristram's Bunting	*Emberiza tristrami*						2		2
445	Yellow-throated Bunting	*Emberiza elegans*						4		4
446	Little Bunting	*Emberiza pusilla*	25	13	15		6	62	4	125
447	Chestnut Bunting	*Emberiza rutila*	17							17

448	Black-faced Bunting	*Emberiza spodocephala*	31	5	7	43

I= Myitsone, II= Lasa, III= Chebwe,IV= Wusot,V= Pisa,VI= Khaunglanphu, VII= Yenam

Appendix 2. Order, family, genus and species of bird recorded in all study area

No.	Order	Family	Common Name	Scientific name
1	**GALLIFORMES**	**PHASIANIDAE**	Chinest Francolin	*Francolinus pintadeanus*
2			Red Junglefowl	*Gallus gallus*
3			Rufous-throated Partridge	*Arborophila rufogularis*
4			Hill Partridge	*Arborophila torqueola*
5			Mountain Bamboo Partridge	*Bambusicola fytchii*
6			White-cheeked Partridge	*Arborophila atrogularis*
7			Blyth's Tragopan	*Tragopan blythii*
8			Kalij Pheasant	*Lophura leucomelanos*
9			Silver Pheasant	*Lophura nycthemera*
10			Grey Peacock Pheasant	*Polyplectron bicalcaratum*
11	**ANSERIFORMES**	**ANATIDAE: Anatini**	Common Merganser	*Mergus merganser*
12			Bar-headed Goose	*Anser indicus*
13			Mallard	*Anas platyrhynchos*
14			Spot- billed Duck	*Anas poecilorhyncha*
15			Nothern Pintail	*Anas acuta*
16			Tufted Duck	*Aythya fuligula*
17			Gadwall	*Anas strepera*
18			Ruddy Shelduck	*Tadorna ferruginea*
19		**DENDROCYGNIDAE**	Lesser Whistling-Duck	*Dendrocygna javanica*
20	**PICIFORMES**	**PICIDAE**	Eurasian Wryneck	*Jynx torquilla*
21			Speckled Piculet	*Picumnus innominatus*
22			White-browed Piculet	*Sasia ochracea*
23			Grey- capped Pygmy Woodpecker	*Dendrocopos canicapillus*
24			Crimson - breasted Woodpecker	*Dendrocopos cathpharius*
25			Fulvous-breasted Woodpecker	*Dendrocopos macei*
26			Rufous Woodpecker	*Celeus brachyurus*
27			Lesser Yellownape	*Picus chlorolophus*
28			Greater Yellownape	*Picus flavinucha*
29			Great Spotted Woodpecker	*Dendrocopos major*
30			Grey-headed Woodpecker	*Picus canus*
31			Himalayan Flameback	*Dinopium shorii*
32			Common Flameback	*Dinopium javanense*
33			Greater Flameback	*Chrysocolaptes lucidus*
34			Pale-headed Woodpecker	*Gecinulus grantia*
35			Bay Woodpecker	*Blythipicus pyrrhotis*
36		**MEGALAIMIDAE**	Great Barbet	*Megalaima virens*

37			Lineated Barbet	*Megalaima lineata*
38			Golden- throated Barbet	*Megalaima franklimii*
39			Blue-throated Barbet	*Megalaima asiatica*
40			Coppersmith Barbet	*Megalaima haemacephala*
41			Blue-eared Barbet	*Megalaima australis*
42	**CORACIIFORMES**	**BUCEROTIDAE**	Wreathed Hornbill	*Aceros undulatus*
43			Oriental Pied Hornbill	*Anthracoceros albirostris*
44			Great Hornbill	*Buceros bicornis*
45			Rufous-necked Hornbill	*Aceros nipalensis*
46		**UPUPIDAE**	Common Hoopoe	*Upupa epops*
47		**CORACIIDAE**	Indian Roller	*Coracias benghalensis*
48			Dollarbird	*Eurystomus orientalis*
49		**ALCEDINIDAE**	Blyth's Kingfisher	*Alcedo hercules*
50			Common Kingfisher	*Alcedo atthis*
51			Blue-eared Kingfisher	*Alcedo meninting*
52			Black-backed Kingfisher	*Ceyx erithacus*
53		**HALCYONIDAE**	Ruddy Kingfisher	*Halcyon coromanda*
54			White-throated Kingfisher	*Halcyon smyrnensis*
55			Black- capped Kingfisher	*Halcyon pileata*
56		**CERYLIDAE**	Crested Kingfisher	*Megaceryle lugubris*
57			Pied Kingfisher	*Ceryle rudis*
58	**CUCULIFORMES**	**CUCULIDAE**	Green- billed Malkoha	*Phaenicophaeus tristis*
59			Asian Koel	*Eudynamys scolopacea*
60			Chestnut-winged Cuckoo	*Clamator coromandus*
61			Large Hawk Cuckoo	*Hierococcyx sparverioides*
62			Hodgson's Hawk Cuckoo	*Hiercoccyx fugax*
63			Eurasian Cuckoo	*Cuculus canorus*
64			Oriental Cuckoo	*Cuculus saturatus*
65			Plaintive Cuckoo	*Cacomantis merulinus*
66			Banded Bay Cuckoo	*Cacomantis sonneratii*
67			Indian Cuckoo	*Cuculus micropterus*
68			Drongo Cuckoo	*Surniculus lugubris*
69		**CENTROPADIDAE**	Greater Coucal	*Centropus sinensis*
70			Lesser Coucal	*Centropus bengalensis*
71	**CORACIIFORMES**	**MEROPIDAE**	Blue- beared Bee-eater	*Nyctyornis athertoni*
72			Green Bee-eater	*Merops orientalis*
73			Chestnut-headed Bee-Eater	*Merops leschenaulti*
74			Blue- tailed Bee- eater	*Merops philipinus*
75	**TROGONIFORMES**	**TROGONIDAE**	Red- headed Trogon	*Harpactes erythrocephalus*
76	**PSITTACIFORMES**	**PSITTACIDAE**	Grey-headed Parakeet	*Psittacula finschii*
77			Red-breasted Parakeet	*Psittacula alexandri*
78			Blossom- headed Parakeet	*Psittacula roseata*
79	**APODIFORMES**	**APODIDAE**	Himalayan Swiftlet	*Collocalia brevirostris*

80			Brown-backed Needletail	*Hirundapus giganteus*
81			Asian Palm Swift	*Cypsiurus balasiensis*
82			Brown-backed Needletail	*Hirundapus giganteus*
83			House Swift	*Apus affinis*
84		**HEMIPROCNIDAE**	Crested Treeswift	*Hemiprocne coronata*
85	**STRIGIFORMES**	**TYTONIDAE**	Barn Owl	*Tyto alba*
86		**STRIGIDAE**	Mountain Scops Owl	*Otus spilocephalus*
87			Collared Scops Owl	*Otus bakkamoena*
88			Oriental Scops Owl	*Otus sunia*
89			Collared Owlet	*Glaucidium brodiei*
90			Tawny fish Owl	*Ketupa flavipes*
91			Asian Barred Owlet	*Glaucidium cuculoides*
92	**CAPRIMULGIFORMES**	**CAPRIMULGIDAE: CAPRIMULGINAE**	Grey Nightjar	*Caprimulgus indicus*
93			Large-tailed Nightjar	*Caprimulgus macrurus*
94			Great-eared Nightjar	*Eurostopodus macrotis*
95	**COLUMBIFORMES**	**COLUMBIDAE**	Oriental Turtle Dove	*Streptopelia orientalis*
96			Ashy Wood Pigeon	*Columba pulchricollis*
97			Spotted Dove	*Streptopelia chinensis*
98			Eurasian Collared Dove	*Streptopelia decaocto*
99			Barred Cuckoo Dove	*Macropygia unchall*
100			Emerald Dove	*Chalcophaps indica*
101			Pompadour Green Pigeon	*Treron pompadora*
102			Thick-billed Green Pigeon	*Treron curvirostra*
103			Pin-tailed Green Pigeon	*Treron apicauda*
104			Wedge-tailed Green Pigeon	*Treron sphenura*
105			Green Imperial Pigeon	*Ducula aenea*
106			Mountain Imperial Pigeon	*Ducula badia*
107	**GRUIFORMES**	**GRUIDAE**	Common Crane	*Grus grus*
108		**RALLIDAE**	White-breasted Waterhen	*Amaurornis phoenicurus*
109	**CHARADRIIFORMES**	**SCOLOPACIDAE: TRINGINAE**	Wood Snipe	*Gallinago nemoricola*
110			Common Greenshank	*Tringa nebularia*
111			Common Sandpiper	*Actitis hypoleucos*
112		**BURHINIDAE**	Great Thick-Knee	*Esacus recurvirostris*
113		**CHARADRIINAE**	Little- ring Plover	*Charadrius dubius*
114			River Lapwing	*Vanellus duvaucelii*
115			Grey-headed Lapwing	*Vanellus cinereus*
116			Red-wattled Lapwing	*Vanellus indicus*
117		**GLAREOLINAE**	Small Pratincole	*Glareola lactea*
118		**Laridae: Larini**	Pallas's Gull	*Larus ichthyaetus*
119			Brown-headed Gull	*Larus brunnicephalus*
120	**FALCONOFORMES**	**ACCIPITRIDAE: ACCIPITRINAE**	Jerdon's Baza	*Aviceda jerdoni*
121			Oriental Honey-Buzzard	*Pernis ptilorhyncus*
122			Pallas's Fish Eagle	*Haliaeetus leucoryphus*

123			Lesser-Fish Eagle	*Ichthyophaga bumills*
124			Grey-headed Fish Eagle	*Ichthyophaga ichthyaetus*
125			Black-shouldered Kite	*Elanus caeruleus*
126			Crested Serpent Eagle	*Spilornis cheela*
127			Hen Harrier	*Circus cyaneus*
128			Crested Goshawk	*Accipiter trivirgatus*
129			Besra	*Accipiter virgatus*
130			Shikra	*Accipiter badius*
131			Chinese Sparrow Hawk	*Accipites sloensis*
132			Japanese Sparrow Hawk	*Accipiter gularis*
133			Eurasian Sparrowhawk	*Accipiter nisus*
134			Grey-faced Buzzard	*Butastur indicus*
135			Common Buzzard	*Buteo buteo*
136			Bonelli's Eagle	*Hieraaetus fasciatus*
137			Black Eagle	*Ictinaetus malayensis*
138			Mountain Hawk Eagle	*Spizaetus nipalensis*
139		**FALCONIDAE**	Common Kestrel	*Falco tinnunculus*
140			Collared Falconet	*Microhierax caerulescens*
141			Oriental Hobby	*Falco severus*
142			Peregrine Falcon	*Falco peregrinus*
143	**PODICIPEDIFORMES**	**PODICIPEDIDAE**	Great Crested Grebe	*Podiceps cristatus*
144	**PELECANIFORMES**	**ANHINGIDAE**	Oriental Darter	*Anhinga melanogaster*
145		**PHALACROCORACIDAE**	Great Cormorant	*Phalacrocorax carbo*
146			Little Cormorant	*Phalacrocorax niger*
147	**CICONIFORMES**	**ARDEIDAE**	Little Egret	*Egretta garzetta*
148			Great Egret	*Casmerodius albus*
149			Cattle Egret	*Bubulcus ibis*
150			White-bellied Heron	*Ardea insignis*
151			Intermediate Egret	*Mesophoyx intermedia*
152			Chinese Pond Heron	*Ardeola bacchus*
153			Pond Heron	*Ardeola* spp.
154			Little Heron	*Butorides striatus*
155		**CICONIIDAE: CICONIINAE**	Black Stork	*Ciconia nigra*
156		**PITTIDAE**	Hooded Pitta	*Pitta sordida*
157			Blue-naped Pitta	*Pitta nipalensis*
158			Blue-winged Pitta	*Pitta moluccensis*
159		**EURYLAIMINAE**	Long-tailed Broadbill	*Psarisomus dalhousiae*
160			Silver- breasted Broadbill	*Serilophus lunatus*
161	**PASSERIFORMES**	**IRENIDAE**	Asian Fairy Bluebird	*Irena puella*
162			Blue-winged Leafbird	*Chloropsis cochinchinensis*
163			Golden-fronted Leafbird	*Chloropsis aurifrons*
164			Orange-bellied Leafbird	*Chloropsis hardwickii*
165		**LANIIDAE**	Brown Shrike	*Lanius cristatus*

166		Long-tailed Shrike	*Lanius schach*
167		Grey-backed Shrike	*Lanius tephronotus*
168	**CORVINAE: Corvini**	Red-billed Blue Magpie	*Urocissa erythrorhyncha*
169		Common Green Magpie	*Cissa chinensis*
170		Rufous Treepie	*Dendrocitta vagabunda*
171		Grey Treepie	*Dendrocitta formosae*
172		Collared Treepie	*Dendrocitta frontalis*
173		House Crow	*Corvus splendens*
174		Large-billed Crow	*Corvus macrorhynchos*
175	**Artamini**	Ashy Woodswallow	*Artamus fuscus*
176	**Oriolini**	Maroon Oriole	*Oriolus traillii*
177		Black-hooded Oriole	*Oriolus xanthornus*
178		Black-naped Oriole	*Oriolus chinensis*
179		Slender- billed Oriole	*Oriolus tenuirostris*
180		Large Cuckooshrike	*Coracina macei*
181		Indochinese Cuckooshrike	*Coracina polioptera*
182		Black-winged Cuckooshrike	*Coracina melaschistos*
183		Grey- chinned Minivet	*Pericrocotus solaris*
184		Ashy Minivet	*Pericrocotus divaricatus*
185		Long-tailed Minivet	*Pericrocotus ethologus*
186		Short-billed Minivet	*Pericrocotus brevirostris*
187		Scarlet Minivet	*Pericrocotus flammeus*
188		Bar-winged Flycatcher-Shrike	*Hemipus picatus*
189	**DICRURINAE: Rhipidurini**	Yellow-bellied Fantail	*Rhipidura hypoxantha*
190		White-throated Fantail	*Rhipidura albicollis*
191	**Dicrurini**	Black Drongo	*Dicrurus macrocercus*
192		Ashy Drongo	*Dicrurus leucophaeus*
193		Bronzed Drongo	*Dicrurus aeneus*
194		Lesser Racket-tailed Drongo	*Dicrurus remifer*
195		Spangled Drongo	*Dicrurus hottentottus*
196		Greater Racket-tailed Drongo	*Dicrurus paradiseus*
197	**Monarchini**	Asian Paradise-flycatcher	*Terpsiphone paradisi*
198		Black-naped Monarch	*Hypothymis azurea*
199	**AEGITHININAE**	Common Iora	*Aegithina tiphia*
200	**MALACONOTINAE: Vangini**	Large Woodshrike	*Tephrodornis gularis*
201		Common Woodshrike	*Tephrodornis pondicerianus*
202	**CINCLIDAE**	White- throated Dipper	*Cinclus cinclus*
203		Brown Dipper	*Cinclus pallasii*
204	**MUSCICAPIDAE: TURDINAE**	Blue Rock Thrush	*Monticola solitarius*
205		Chestnut-bellied Rock Thrush	*Monticola rufiventris*
206		Scaly Thrush	*Zoothera dauma*
207		Eyebrowed Thrush	*Turdus obscurus*
208		Chestnut Thrush	*Turdus rubrocanus*

209		Blue Whistling Thrush	*Myophonus caeruleus*
210		Orange-headed Thrush	*Zoothera citrina*
211		Plain-backed Thrush	*Zoothera mollissima*
212		Grey-winged Blackbird	*Turdus boulboul*
213		Green Cochoa	*Cochoa viridis*
214		Lesser Shortwing	*Brachypteryx leucophrys*
215		Rusty-bellied Shortwing	*Brachypteryx hyperythra*
216		White-browed Shortwing	*Brachypteryx montana*
217		Eurasian Blackbird	*Turdus merula*
218	**MUSCICAPINAE: Muscicapini**	Ferruginous Flycatcher	*Muscicapa ferruginea*
219		Rufous-gorgeted Flycatcher	*Ficedula strophiata*
220		White- gorgeted Flycatcher	*Ficedula monileger*
221		Snowy-browed Flycatcher	*Ficedula hyperythra*
222		Little Pied Flycatcher	*Ficedula westermanni*
223		Slaty-blue Flycatcher	*Ficedula tricolor*
224		Verditer Flycatcher	*Eumyias thalassina*
225		Brown-breasted Flycatcher	*Muscicapa muttui*
226		Red-throated Flycatcher	*Ficedula parva*
227		Large Niltava	*Niltava grandis*
228		Small Niltava	*Niltava macgrigoriae*
229		Rufous-bellied Niltava	*Niltava sundara*
230		Blue-throated Flycatcher	*Cyornis rubeculoides*
231		Pale Blue Flycatcher	*Cyornis unicolor*
232		Pygmy Blue Flycatcher	*Muscicapella hodgsoni*
233		Hill Blue Flycatcher	*Cyornis banyumas*
234		Tickell's Blue Flycatcher	*Cyornis tickelliae*
235		Grey-headed Canary Flycatcher	*Culicicapa ceylonensis*
236	**Saxicolini**	Siberian Rubythroat	*Luscinia calliope*
237		Orange-flanked Bush Robin	*Tarsiger cyanurus*
238		Golden Bush Robin	*Tarsiger chrysaeus*
239		Oriental Magpie Robin	*Copsychus saularis*
240		White-rumped Shama	*Copsychus malabaricus*
241		Hodgson's Redstart	*Phoenicurus hodgsoni*
242		Daurian Redstart	*Phoenicurus auroreus*
243		Blue-fronted Redstart	*Phoenicurus frontalis*
244		White-capped Water Redstart	*Chaimarrornis leucocephalus*
245		Plumbeous Water Redstart	*Rhyacornis leucocephalus*
246		White-bellied Redstart	*Hodgsonius phaenicuroides*
247		White-tailed Robin	*Myiomela leucura*
248		Little Forktail	*Enicurus scouleri*
249		Black-backed Forktail	*Enicurus immaculatus*
250		Slaty- backed Forktail	*Enicurus schistaceus*
251		White- crowned Forktail	*Enicurus leschenaulti*

252		Spotted Forktail	*Enicurus maculatus*
253		Siberian Stonechat	*Saxicola maura*
254		Pied Bushchat	*Saxicola caprata*
255		Grey Bushchat	*Saxicola ferrea*
256	**STURNIDAE: Sturnini**	Spot-winged Starling	*Saroglossa spiloptera*
257		Asian Pied Starling	*Sturnus contra*
258		Chestnut-tailed Starling	*Sturnus malabaricus*
259		Black-collared Starling	*Sturnus nigricollis*
260		Vinous-breasted Starling	*Sturnus burmannicus*
261		Common Myna	*Acridotheres tristis*
262		White-vented Myna	*Acridotheres grandis*
263		Collared Myna	*Acridotheres albocinctus*
264		Hill Myna	*Gracula religiosa*
265	**SITTIDAE: SITTINAE**	Chestnut-vented Nuthatch	*Sitta nagaensis*
266		Chestnut-bellied Nuthatch	*Sitta castanea*
267		Beautiful Nuthatch	*Sitta formosa*
268		Velvet-fronted Nuthatch	*Sitta frontalis*
269	**TROGLODYTINAE**	Winter Wren	*Troglodytes troglodytes*
270	**PARINAE**	Green- backed Tit	*Parus monticolus*
271		Yellow-browed Tit	*Sylviparus modestus*
272		Yellow- cheeked Tit	*parus spilonotus*
273		Sultan Tit	*Melanochlora sultanea*
274	**AEGITHALIDAE**	Black-throated Tit	*Aegithalos concinnus*
275		Black-browed Tit	*Aegithalos bonvaloti*
276	**HIRUNDININAE**	Plain Martin	*Riparia paludicola*
277		Barn Swallow	*Hirundo rustica*
278		Asian House Martin	*Delichon dasypus*
279		Red-rumped Swallow	*Hirundo daurica*
280		Striated Swallow	*Hirundo striolata*
281		Wire-tailed Swallow	*Hirundo smithii*
282		Asian House Martin	*Delichon dasypus*
283	**PYCNONOTIDAE**	Crested Finchbill	*Spizixos canifrons*
284		Black-crested Bulbul	*Pycnonotus melanicterus*
285		Red-whiskered Bulbul	*Pycnonotus jocosus*
286		Striated Bulbul	*Pycnonotus striatus*
287		Brown-breasted Bulbul	*Pycnonotus xanthorrhous*
288		Red-vented Bulbul	*Pycnonotus cafer*
289		Flavescent Bulbul	*Pycnonotus flavescens*
290		White-throated Bulbul	*Alophoixus flaveolus*
291		Olive Bulbul	*Iole virescens*
292		Ashy Bulbul	*Hemixos flavala*
293		Mountain Bulbul	*Hypsipetes mcclellandii*
294		Black Bulbul	*Hypsipetes leucocephalus*

295	**CISTICOLIDAE**	Rufescent Prinia	*Prinia rufescens*
296		Striated Prinia	*Prinia criniger*
297		Hill Prinia	*Prinia superciliaris*
298		Grey-breasted Prinia	*Prinia hodgsonii*
299		Yellow-bellied Prinia	*Prinia flaviventris*
300	**ZOSTEROPIDAE**	Chestnut-flanked White-Eye	*Zosterops erythropleurus*
301		Oriental White-eye	*Zosterops palpebrosus*
302		Japanese White-eye	*Zosterops japonicus*
303	**SYLVIIDAE: ACROCEPHALINAE**	Slaty- bellied Tesia	*Tesia olivea*
304		Grey- bellied Tesia	*Tesia cyaniventer*
305		Chestnut-headed Tesia	*Tesia castaneocoronata*
306		Pale foodted Bush Warbler	*Cettia pallidipes*
307		Brownish- flanked Bush Warbler	*Cettia fortipes*
308		Aberrant Bush Warbler	*Cettia flavolivacea*
309		Brown Bush Warbler	*Bradypterus luteoventris*
310		Thick-billed Warbler	*Acrocephalus aedon*
311		Mountain Tailorbird	*Orthotomus cuculatus*
312		Common Tailorbird	*Orthotomus sutorius*
313		Dark-necked Tailorbird	*Orthotomus atrogularis*
314		Dusky Warbler	*Phylloscopus fuscatus*
315		Buff-barred Warbler	*Phylloscopus pulcher*
316		Buff-throated Warbler	*Phylloscopus subaffinis*
317		Ashy-throated Warbler	*Phylloscopus maculipennis*
318		Lemon-rumped Warbler	*Phylloscopus chloronotus*
319		Yellow-browed Warbler	*Phylloscopus inornatus*
320		Two-barred Warbler	*Phylloscopus plumbeitarsus*
321		Greenish Warbler	*Phylloscopus trochiloides*
322		Tickell's Leaf Warbler	*Phylloscopus affinis*
323		Blyth's Leaf Warbler	*Phylloscopus reguloides*
324		White- tailed Leaf Warbler	*Phylloscopus davisoni*
325		Yellow-vented Warbler	*Phylloscopus cantator*
326		Mountain Leaf Warbler	*Phylloscopus trivirgatus*
327		Grey-hooded Warbler	*Seicercus xanthoschistus*
328		White- spectacled Warbler	*Seicercus affinis*
329		Grey- cheeked Warbler	*Seicercus poliogenys*
330		Chestnut- crowned Warbler	*seicercus castaniceps*
331		Broad-billed Warbler	*Tickellia hodgsoni*
332		Rufous-faced Warbler	*Abroscopus albogularis*
333		Black-faced Warbler	*Abroscopus schisticeps*
334		Yellow-bellied Warbler	*Abroscopus superciliaris*
335	**MEGALURINAE**	Striated Grassbird	*Megalurus palustris*
336	**GARRULACINAE**	White-crested Laughingthrush	*Garrulax leucolophus*
337		Lesser Necklaced Laughingthrush	*Garrulax monileger*

338		Greater Necklaced Laughingthrush	*Garrulax pectoralis*
339		Striated Laughingthrush	*Garrulax striatus*
340		Scaly Lasughingthrush	*Garrulax subunicolor*
341		White-browed Laughingthrush	*Garrulax sannio*
342		Blue-winged Laughingthrush	*Garrulax squamatus*
343		Chestnut- crowned Laughingthrush	*Garrulax erythrocephalus*
344		Red- tailed Laughingthrush	*Garrulax milnei*
345		Chestnut-backed Laughingthrush	*Garrulax nuchalis*
346		Rufous-necked Laughingthrush	*Garrulax ruficollis*
347		Spotted Laughingthrush	*Gusulax Ocellatus*
348		Grey-sided Laughingthrush	*Gurrulax caerulatus*
349		Red-faced Liocichla	*Liocichla phoenicea*
350	**SYLVINAE: Timaliini**	Buff-breasted Babbler	*Pellorneum tickelli*
351		Spot-throated Babbler	*Pellorneum albiventre*
352		Puff-throated Babbler	*Pellorneum ruficeps*
353		Spot-breasted Scimitar Babbler	*Pomatorhinus erythrocnemis*
354		Streak-breasted Scimitar Babbler	*Pomatorhinus ruficollis*
355		White-browed Scimitar Babbler	*Pomatorhinus schisticeps*
356		Red-billed Scimitar Babbler	*Pomatorhinus ochraceiceps*
357		Coral-billed Scimitar Babbler	*Pomatorhinus ferruginosus*
358		Slender-billed Scimitar Babbler	*Xiphirhynchus superciliaris*
359		Long- billed Wren Babbler	*Rimator malacoptilus*
360		Cachar Wedge-billed Babbler	*Sphenocichla roberti*
361		Eyebrowed Wren Babbler	*Napothera epilepidota*
362		Scaly-breasted Wren Babbler	*Pnoepyga albiventer*
363		Pygmy Wren Babbler	*Pnoepyga pusilla*
364		Spotted Wren Babbler	*Spelaeornis formosus*
365		Long-tailed Wren Babbler	*Spelaeornis chocolatinus*
366		Rufous-capped Babbler	*Stachyris ruficeps*
367		Rufous-fronted Babbler	*Stachyris rufifrons*
368		Golden Babbler	*Stachyris chrysaea*
369		Grey- throated Babbler	*Stachyris nigriceps*
370		Snowy-throated Babbler	*Stachyris oglei*
371		Chestnut-capped Babbler	*Timalia pileata*
372		Spot-necked Babbler	*Stachyris striolata*
373		Chevron-breasted Babbler	*Sphenocichla roberti*
374		Striped Tit Babbler	*Macronous gularis*
375		Yellow-eyed Babbler	*Chrysomma sinense*
376		Silver-eared Mesia	*Leiothrix argentauris*
377		Red-billed Leiothrix	*Leiothrix lutea*
378		Cutia	*Cutia nipalensis*
379		White-browed Shrike Babbler	*Pteruthius flaviscapis*
380		Black-eared Shrike Babbler	*Pteruthius melanotis*

381		Black-headed Shrike Babbler	*Pteruthius rufiventer*
382		Chestnut-fronted Shirke Babbler	*Pteruthius aenobarbus*
383		Rusty-fronted Barwing	*Actinodura egertoni*
384		Streak-throated Barwing	*Actinodura waldeni*
385		Blue-winged Minla	*Minla cyanouroptera*
386		Chestnut-tailed Minla	*Minla strigula*
387		Red-tailed Minla	*Minla ignotincta*
388		White-hooded Babbler	*Gampsorhynchus rufulus*
389		Yellow-throated Fulvetta	*Alcippe cinerea*
390		Rufous-winged Fulvetta	*Alcippe castaneceps*
391		White-browed Fulvetta	*Alcippe vinipectus*
392		Rufous-throated Fulvetta	*Alcippe rufogularis*
393		Grey-cheeked Fulvetta	*Alcippe morrisonia*
394		Brown-cheeked Fulvetta	*Alcippe poioicephala*
395		Nepal Fulvetta	*Alcippe nipalensis*
396		Rufous-backed Sibia	*Heterophasia annectens*
397		Grey Sibia	*Heterophasia gracilis*
398		Black-headed Sibia	*Heterophasia desgodinsi*
399		Beautiful Sibia	*Heterophasia pulchella*
400		Long-tailed Sibia	*Heterophasia picaoides*
401		Striated Yuhina	*Yuhina castaniceps*
402		White-naped Yuhina	*Yuhina bakeri*
403		Whiskered Yuhina	*Yuhina flavicollis*
404		Rufous-vented Yuhina	*Yuhina occipitalis*
405		Black-chinned Yuhina	*Yuhina nigrimenta*
406		White-bellied Yuhina	*Yuhina zantholeuca*
407		Spot-breasted Parrotbill	*Paradoxornis guttaticollis*
408		Black-throated Parrotbill	*Paradoxornis nipalensis*
409		Brown-winged Parrotbill	*Paradoxornis brunneus*
410		Grey-headed Parrotbill	*Paradoxornis gularis*
411		Lesser Rufous-headed Parrotbill	*Paradoxornis atrosuperciliaris*
412		Greater Rufous-headed Parrotbill	*Paradoxornis ruficeps*
413	**ALAUDIDAE**	Oriental Skylark	*Alauda gulgula*
414	**NECTARINIIDAE: NECTARINIINAE**	Yellow-vented Flowerpecker	*Dicaeum chrysorrheum*
415		Fire-breasted Flowerpecker	*Dicaeum ignipectus*
416		Plain Flowerpecker	*Dicaeum concolor*
417		Scarlet-backed Flowerpecker	*Dicaeum cruentatum*
418	**Nectariniini**	Ruby-cheeked Sunbird	*Anthreptes singalensis*
419		Green-tailed Sunbird	*Aethopyga nipalensis*
420		Mrs Gould's Sunbird	*Aethopyga gouldiae*
421		Black-throated Sunbird	*Aethopyga saturata*
422		Crimson Sunbird	*Aethopyga siparaja*
423		Little Spiderhunter	*Arachnothera longirostra*

424		Streaked Spiderhunter	*Arachnothera magna*
425	**PASSERIDAE: PASSERINAE**	Russet Sparrow	*Passer rutilans*
426		House Sparrow	*Passer domensticus*
427		Eurasian Tree Sparrow	*Passer montanus*
428	**MOTACILLINAE**	White Wagtail	*Motacilla alba*
429		Citrine Wagtail	*Motacilla citreola*
430		Yellow Wagtail	*Motacilla flava*
431		Grey Wagtail	*Motacilla cinerea*
432		Paddyfield Pipit	*Anthus rufulus*
433		Richard's Pipit	*Anthus richardi*
434		Olive-backed Pipit	*Anthus hodgsoni*
435		Rosy Pipit	*Anthus roseatus*
436	**PRUNELLINAE: Accentors**	Maroon -backed Accentor	*Prunella immaculata*
437	**ESTRILDINAE: Estrildini**	White-rumped Munia	*Lonchura striata*
438		Scaly-breasted Munia	*Lonchura punctulata*
439	**Carduelini**	Tibetan Siskin	*Carduelis thibetana*
440		Gold- naped Finch	*pyrrhoplectes epauletta*
441		Scarlet Finch	*Haematospiza sipahi*
442		Common Rosefinch	*Carpodacus erythrinus*
443		Spot-winged Grosbeak	*Mycerobas melanozanthos*
444	**EMBERIZINAE: Emberizini**	Tristram's Bunting	*Emberiza tristrami*
445		Yellow-throated Bunting	*Emberiza elegans*
446		Little Bunting	*Emberiza pusilla*
447		Chestnut Bunting	*Emberiza rutila*
448		Black-faced Bunting	*Emberiza spodocephala*

Appendix 3. Bird data recorded in Myitsone area

No.	Common name	Sciencetific name	Study site		Dist. (m)	Quan.	Microhabitat	IUCN 2009
	PHASIANIDAE: Partridges, quails, pheasants & Junglefow							
1	Chinese Francolin	*Francolinus pintadeanus*	I	e	20	2	On the ground	
2	Rufous-throated Partridge	*Arborophila rufogularis*	I	d	5 - 10	3	Bush	
3	Red Junglefowl	*Gallus gallus*	I	d,f	4-25	12	Paddyfield, Bamboo, Ground, Flying	
4	Kalij Pheasant	*Lophura leucomelanos*	I	d	5-12	2	Bush	
5	Grey Peacock Pheasant	*Polyplectron bicalcaratum*	I	d		1	Dead body	
	ANATIDAE: Geese, atypical ducks & pygmy-geese							
6	Bar-headed Goose	*Anser indicus*	I	c	100-120	1	Flying	
7	Ruddy Shelduck	*Tadorna ferruginea*	I	a,b,c,e	2-33	248	Water, Flying	
	Anatini: Typical ducks							
8	Gadwall	*Anas strepera*	I	a	23-27	22	Water	
9	Mallard	*Anas platyrhynchos*	I	a	23-27	1	Water	
10	Spot-billed Duck	*Anas poecilorhyncha*	I	a	23-27	38	Water	
11	Northern Pintail	*Anas acuta*	I	a	23-27	3	Water	
12	Tufted Duck	*Aythya fuligula*	I	a	23-27	4	Water	

13	Common Merganser	*Mergus merganser*	I	a,c,d	23-31	65	Water	
	PICIDAE: Wrynecks, piculets & typical woodpeckers							
14	Speckled Piculet	*Picumnus innominatus*	I	a,b,c,f	3-8	18	Lower Canopy, Bamboo	
15	White-browed Piculet	*Sasia ochracea*	I	a,b,d,f	5-11	13	Bamboo	
16	Grey-capped Pygmy Woodpecker	*Dendrocopos canicapillus*	I	b	7	2	Dead wood	
17	Fulvous-breasted Woodpecker	*Dendrocopos macei*	I	a,c,d	14-19	8	Middle & lower canopy, Bamboo	
18	Rufous Woodpecker	*Celeus brachyurus*	I	f	5-16	7	Lower Canopy, Tree Trunk, Bamboo	
19	Lesser Yellownape	*Picus chlorolophus*	I	d,e,f	5-30	6	Lower Canopy, Bamboo	
20	Greater Yellownape	*Picus flavinucha*	I	d,f	4-45	7	Middle & Lower Canopy, Tree Trunk, Bamboo	
21	Grey-headed Woodpecker	*Picus canus*	I	c,d,f	4-19	7	Lower Canopy, Bamboo	
22	Himalayan Flameback	*Dinopium shorii*	I	a,c	7-35	4	Bamboo, Tree Trunk	
23	Common Flameback	*Dinopium javanense*	I	a	10	1	Bamboo, Tree Trunk	
24	Greater Flameback	*Chrysocolaptes lucidus*	I	a,c,d,e	15-26	25	Bamboo, Tree Trunk	
25	Pale-headed Woodpecker	*Gecinulus grantia*	I	a,c,d	10-29	6	Bamboo, Tree Trunk	
26	Bay Woodpecker	*Blythipicus pyrrhotis*	I	a,b,c,d,f	3-28	18	Bamboo, Tree Trunk	
	MEGALAIMIDAE: Asian barbets							
27	Lineated Barbet	*Megalaima lineata*	I	a,b,c,d,e,f	7-32	77	Top, Middle & Lower Canopy	
28	Blue-throated Barbet	*Megalaima asiatica*	I	a,b,c,d,e,f	4-65	400	Top, Middle & Lower Canopy	
29	Blue-eared Barbet	*Megalaima australis*	I	a,b,c,d,f	20-33	24	Top, Middle & Lower Canopy	
30	Coppersmith Barbet	*Megalaima haemacephala*	I	a,b,d,e,f	7-50	60	Top, Middle & Lower Canopy, Bamboo	
	BUCEROTIDAE: Asian hornbills							
31	Oriental Pied Hornbill	*Anthracoceros albirostris*	I	a,b,c,d,e	31-82	81	Top, Middle & Lower Canopy	
32	Great Hornbill	*Buceros bicornis*	I	a,b,c,d	120-160	19	Top Canopy	NT
33	Rufous-necked Hornbill	*Aceros nipalensis*	I	a,c	52-210	3	Top Canopy	VU
34	Wreathed Hornbill	*Aceros undulatus*	I	b,c,d,f	50-190	26	Flying	
	UPUPIDAE: Hoopoes							
35	Common Hoopoe	*Upupa epops*	I	a, f	7-26	2	Ground	
	TROGONIDAE: Harpactini: Asian trogons							
36	Red-headed Trogon	*Harpactes erythrocephalus*	I	a,b,c,d,e	6-32	11	Middle & Lower Canopy, Bamboo	
	CORACIIDAE: Rollers							
37	Indian Roller	*Coracias benghalensis*	I	a,b,c,d,e,f	7-50	71	Top, Middle & Lower Canopy, Bamboo, Flying	
38	Dollarbird	*Eurystomus orientalis*	I	e,f	21-50	4	Flying	
	ALCEDINIDAE: Smaller kingfishers							
39	Common Kingfisher	*Alcedo atthis*	I	a,b,d,f	10-27	19	Stone, Water	
40	Blue-eared Kingfisher	*Alcedo meninting*		f	1	1	Stone	
	HALCYONIDAE: Larger kingfishers							
41	Ruddy Kingfisher	*Halcyon coromanda*	I	a	30	1	Lower Canopy	
42	White-throated Kingfisher	*Halcyon smyrnensis*		a,b,c,e,f	8-43	85	Top & Middle Canopy, Near Water, Bamboo	
	CERYLIDAE: Pied kingfishers							
43	Crested Kingfisher	*Megaceryle lugubris*	I	a,b,c,d,e	2-75	18	Stone, Flying	
44	Pied Kingfisher	*Ceryle rudis*	I	a,b,c,d	30-69	27	Stone	
	MEROPIDAE: Bee-eaters							
45	Blue-bearded Bee-eater	*Nyctyornis athertoni*		a,b,c,d,f	9-70	21	Top Canopy, Bamboo	
46	Green Bee-eater	*Merops orientalis*	I	a,b,c	22-49	151	Top & Middle Canopy, Bush	
47	Blue-tailed Bee-eater	*Merops philippinus*	I	a	58-60	1	Flying	
48	Chestnut-headed Bee-eater	*Merops leschenaulti*		f	7-16	13	Middle & Lower Canopy, Flying	

	CUCULIDAE: Old World cuckoos						
49	Indian Cuckoo	*Cuculus micropterus*	I	a,f	7-200	20	Top, Middle & Lower Canopy
50	Oriental Cuckoo	*Cuculus saturatus*	I	f	120	1	Lower Canopy
51	Plaintive Cuckoo	*Cacomantis merulinus*	I	f	10-60	4	Top & Lower Canopy
52	Drongo Cuckoo	*Surniculus lugubris*	I	a,f	9-80	13	Top, Middle & Lower Canopy
53	Asian Koel	*Eudynamys scolopacea*	I	a,f	10-80	11	Top & Middle Canopy, Flying
54	Green-billed Malkoha	*Phaenicophaeus tristis*	I	a,b,c,e	10-59	18	Top, Middle & Lower Canopy, Bamboo
	CENTROPADIDAE: Coucals						
55	Greater Coucal	*Centropus sinensis*	I	a,b,d,e,f	3-50	27	Middle & Lower Canopy, Bush
56	Lesser Coucal	*Centropus bengalensis*	I	a,f	6-30	4	Bush, Flying
	PSITTACIDAE: Parrots & parakeets						
57	Blossom-headed Parakeet	*Psittacula roseata*	I	c,e	25-50	20	Top Canopy
58	Grey-headed Parakeet	*Psittacula finschii*	I	a,f	5-150	135	Top & Middle Canopy, Bush, Flying
59	Red-breasted Parakeet	*Psittacula alexandri*	I	a,b	25-53	218	Top Canopy
	APODIDAE: Swifts						
60	Himalayan Swiftlet	*Collocalia brevirostris*	I	c	20-24	19	Flying
61	Asian Palm Swift	*Cypsiurus balasiensis*	I	a,b,c,d,e,f	7-39	693	Flying
62	Brown-backed Needletail	*Hirundapus giganteus*	I	f	10	2	Flying
	HEMIPROCNIDAE: Treeswifts						
63	Crested Treeswift	*Hemiprocne coronata*	I	d	100-117	3	Flying
	TYTONIDAE: Barn, grass and bay owls						
64	Barn Owl	*Tyto alba*	I	a	60-63	1	Flying
	STRIGIDAE: Typical owls						
65	Mountain Scops Owl	*Otus spilocephalus*	I	c,d	145-160	4	Lower Canopy
66	Collared Scops Owl	*Otus bakkamoena*	I	c,d,f	40-63	3	Lower Canopy
67	Collared Owlet	*Glaucidium brodiei*	I	c,d	20-30	7	Lower Canopy, Bamboo
68	Tawny Fish Owl	*Ketupa flavipes*	I	a	4	1	Flying
69	Asian Barred Owlet	*Glaucidium cuculoides*	I	c,d,f	3-40	10	Top, Middle & Lower Canopy, Bamboo
	CAPRIMULGIDAE: CAPRIMULGINAE: Typical nightjars						
70	Great-eared Nightjar	*Eurostopodus macrotis*	I	c,d	15-35	6	Flying
	COLUMBIDAE: Pigeons & doves						
71	Oriental Turtle Dove	*Streptopelia orientalis*	I	a,b,c	27-46	82	Top Canopy
72	Spotted Dove	*Streptopelia chinensis*	I	a,b,c,d,e,f		141	Top & Middle Canopy, Bamboo
73	Barred Cuckoo Dove	*Macropygia unchall*	I	c	20-29	2	Top Canopy
74	Emerald Dove	*Chalcophaps indica*	I	a,b,c,d,f	4-30	21	Middle & Lower Canopy, Ground, Flying
75	Pompadour Green Pigeon	*Treron pompadora*	I	a,b,c,e,f	15-40	75	Top & Middle Canopy
76	Thick-billed Green Pigeon	*Treron curvirostra*	I	f	15 - 60	8	Top & Lower Canopy
77	Pin-tailed Green Pigeon	*Treron apicauda*	I	e	10	1	Top Canopy
	GRUIDAE: GRUINAE: Typical cranes						
78	Common Crane	*Grus grus*	I	a,b,c	150-200	154	Flying
	RALLIDAE: Rails, gallinules & coots						
79	White-breasted Waterhen	*Amaurornis phoenicurus*	I	c,f	6-14	4	Bush, Ground
	TRINGINAE: Godwits, curlews, sandpipers & allies						
80	Common Sandpiper	*Actitis hypoleucos*	I	a,b,c,d	27-85	26	Sand, Stone
	CHARADRIINAE: Plovers & lapwings						
81	Little Ringed Plover	*Charadrius dubius*	I	a	22-30	4	Sand, Stone

82	River Lapwing	*Vanellus duvaucelii*	I	a,b,c	20-29	11	River Bank, Sand	
83	Red-wattled Lapwing	*Vanellus indicus*	I	a,f	7-60	17	Paddyfield, Ground, Flying	
	GLAREOLINAE: Pratincoles							
84	Small Pratincole	*Glareola lactea*	I	a,b,c,d,e	8-43	188	Stone, River Bank, Flying	
	Larini: Gulls							
85	Pallas's Gull	*Larus ichthyaetus*	I	a,b,d	20-32	9	River Bank, Flying	
86	Brown-headed Gull	*Larus brunnicephalus*	I	a	15-30	1	Flying	
	ACCIPITRIDAE: ACCIPITRINAE: Hawks & eagles							
87	Jerdon's Baza	*Aviceda jerdoni*	I	a	60-75	1	Flying	
88	Oriental Honey-Buzzard	*Pernis ptilorhyncus*	I	a,b,c,e	20-95	11	Flying	
89	Lesser-Fish Eagle	*Ichthyophaga bumills*	I	e	15	1	Flying	NT
90	Crested Serpent Eagle	*Spilornis cheela*	I	a,b,c,d,e,f	28-220	24	Top Canopy, Flying	
91	Crested Goshawk	*Accipiter trivirgatus*	I	a,b,c	40-52	10	Flying	
92	Shikra	*Accipiter badius*	I	a,b	170-181	4	Flying	
93	Chinese Sparrow Hawk	*Accipites sloensis*	I	a	75-80	1	Top Canopy	
94	Japanese Sparrow Hawk	*Accipiter gularis*	I	a,c	140-150	2	Top Canopy, Flying	
95	Grey-faced Buzzard	*Butastur indicus*	I	a	60-65	1	Flying	
96	Common Buzzard	*Buteo buteo*	I	a,b,c	47-60	8	Flying	
97	Bonelli's Eagle	*Hieraaetus fasciatus*	I	a	40-45	1	Flying	
98	Black Eagle	*Ictinaetus malayensis*	I	a,b,f	130-140	11	Top Canopy, Flying	
	FALCONIDAE: Falcons							
99	Collared Falconet	*Microhierax caerulescens*	I	a,b,c,e	5-46	33	Top Canopy, Bamboo	
100	Common Kestrel	*Falco tinnunculus*	I	a,b,c	7-80	4	Flying	
101	Oriental Hobby	*Falco severus*	I	a,b,c	160-180	9	Flying	
102	Peregrine Falcon	*Falco peregrinus*	I	a,b,c	130-135	7	Top Canopy, Flying	
	PODICIPEDIDAE: Grebes							
103	Great Crested Grebe	*Podiceps cristatus*	I	a	45-50	1	Water	
	ANHINGIDAE: Darters							
104	Oriental Darter	*Anhinga melanogaster*	I	a,c	80-93	4	Stone	NT
	PHALACROCORACIDAE: Cormorants							
105	Great Cormorant	*Phalacrocorax carbo*	I	a,b,c,e	4-62	94	Stone, Water, Flying	
	ARDEIDAE: Egrets, herons & bitterns							
106	Little Egret	*Egretta garzetta*	I	a	90-95	5	Stone	
107	Great Egret	*Casmerodius albus*	I	a	90-95	4	Stone	
108	Cattle Egret	*Bubulcus ibis*	I	a,c,f	14-95	144	Stone, Flying	
109	Pond Heron	*Ardeola spp.*	I	a,c,e	5-95	8	Stone, Flying	
110	Little Heron	*Butorides striatus*	I	a,d,e	11-95	5	Stone	
	PITTIDAE: Pittas							
111	Blue-naped Pitta	*Pitta nipalensis*	I	a		1	Dead body	
112	Blue-winged Pitta	*Pitta moluccensis*	I	f	3-5	8	Middle & Lower Canopy, Ground, Bush, Bamboo	
	EURYLAIMINAE: Typical broadbills							
113	Long-tailed Broadbill	*Psarisomus dalhousiae*	I	a,c,d,f	5-45	21	Lower Canopy	
	IRENIDAE: Fairy bulebirds & leafbirds							
114	Asian Fairy Bluebird	*Irena puella*	I	a,b,d,e,f	13-68	68	Top, Middle & Lower Canopy	
115	Blue-winged Leafbird	*Chloropsis cochinchinensis*	I	a,b,c,d	20-40	56	Top, Middle & Lower Canopy	
116	Golden-fronted Leafbird	*Chloropsis aurifrons*	I	a,b,c,d,e,f	6-110	101	Top, Middle & Lower Canopy	

117	Orange-bellied Leafbird	*Chloropsis hardwickii*	I	a,b,c,d,e,f	6-40	38	Top, Middle & Lower Canopy
	LANIIDAE: Shrikes						
118	Long-tailed Shrike	*Lanius schach*	I	c	10-15	5	Bush
119	Brown Shrike	*Lanius cristatus*	I	a,f	7-51	25	Lower Canopy, Bush
120	Grey-backed Shrike	*Lanius tephronotus*	I	a,b,c,d,e	1-100	43	Lower Canopy, Bush
	CORVINAE: Corvini: Jays, magpies, treepies, crows & allies						
121	Common Green Magpie	*Cissa chinensis*	I	a,b,c,d	40-60	12	Lower Canopy
122	Rufous Treepie	*Dendrocitta vagabunda*	I	a,b	50-120	17	Top & Middle Canopy
123	Grey Treepie	*Dendrocitta formosae*	I	a,b,c,d,e,f	4-100	74	Top Middle Canopy, Bush, Bamboo, Flying
124	Collared Treepie	*Dendrocitta frontalis*	I	a,b,c,d,f	7-57	17	Top & Middle Canopy
125	House Crow	*Corvus splendens*	I	a	3-10	12	Flying
126	Large-billed Crow	*Corvus macrorhynchos*	I	a,b,c,d,e,f	5-70	139	Top & Middle Canopy, Bamboo, Flying
	Artamini: Woodswallows & allies						
127	Ashy Woodswallow	*Artamus fuscus*	I	f	30-100	61	Top & Middle Canopy, Flying
	Oriolini: Orioles, cuckooshrikes, minivets & flycatcher-shrikes						
128	Black-hooded Oriole	*Oriolus xanthornus*	I	a,b,c,d,e,f	4-70	46	Top, Middle & Lower Canopy, Flying
129	Black-naped Oriole	*Oriolus chinensis*	I	a,f	80-87	9	Top & Middle Canopy
130	Maroon Oriole	*Oriolus traillii*	I	a,f	4-75	12	Top, Middle & Lower Canopy
131	Large Cuckooshrike	*Coracina macei*	I	a,c,f	11-50	12	Top & Middle Canopy
132	Black-winged Cuckooshrike	*Coracina melaschistos*	I	a,b,c,d,e	10-20	9	Top & Lower Canopy
133	Indochinese Cuckooshrike	*Coracina polioptera*		f	12	1	Lower Canopy
134	Grey-chinned Minivet	*Pericrocotus solaris*	I	d	11	15	Top Canopy
135	Long-tailed Minivet	*Pericrocotus ethologus*	I	a,d,f	18-35	30	Top Canopy
136	Short-billed Minivet	*Pericrocotus brevirostris*	I	a	4	33	Top Canopy
137	Scarlet Minivet	*Pericrocotus flammeus*	I	a,b,c,d,f	3-37	144	Top, Middle & Lower Canopy
138	Bar-winged Flycatcher-Shrike	*Hemipus picatus*	I	a,b,c,d,e,f	3-16	74	Top, Middle & Lower Canopy
	DICRURINAE: Rhipidurini: Fantails						
139	Yellow-bellied Fantail	*Rhipidura hypoxantha*	I	a,b,c,d,e	1-23	54	Lower Canopy
140	White-throated Fantail	*Rhipidura albicollis*	I	a,b,c,e	2-5	23	Lower Canopy, Bamboo
	Dicrurini: Drongos						
141	Black Drongo	*Dicrurus macrocercus*	I	a,f	4-50	21	Top & Lower Canopy, Bamboo, Bush, Flying
142	Ashy Drongo	*Dicrurus leucophaeus*	I	a,b,c,d,f	10-60	46	Top & Lower Canopy, Flying
143	Bronzed Drongo	*Dicrurus aeneus*	I	a,b,c,d,e,f	6-150	126	Top, Middle & Lower Canopy, Bamboo, Flying
144	Lesser Racket-tailed Drongo	*Dicrurus remifer*	I	a,b,c,d,f	10-50	15	Middle & Lower Canopy
145	Spangled Drongo	*Dicrurus hottentottus*	I	a,b,c,d,e,f	5-150	125	Top & Middle, Canopy
146	Greater Racket-tailed Drongo	*Dicrurus paradiseus*	I	a,b,d	15-60	19	Middle Canopy
	Monarchini: Monarchs, paradise-flycatchers & allies						
147	Black-naped Monarch	*Hypothymis azurea*	I	f	3-7	6	Lower Canopy, Bamboo, Bush
	AEGITHININAE: Ioras						
148	Common Iora	*Aegithina tiphia*	I	a	3-5	6	Lower Canopy
	MALACONOTINAE: Vangini: Philentomas, woodshrikes & allies						
149	Large Woodshrike	*Tephrodornis gularis*	I	c,d,e,f	5-50	35	Top Canopy
150	Common Woodshrike	*Tephrodornis pondicerianus*	I	f	6	7	Middle Canopy
	MUSCICAPIDAE: TURDINAE: Thrushes & shortwings						
151	Blue Rock Thrush	*Monticola solitarius*	I	a,b,c	20-150	15	Stone
152	Blue Whistling Thrush	*Myophonus caeruleus*	I	a,b,c,d	4-15	14	Stone, Ground

153	Orange-headed Thrush	*Zoothera citrina*	I	d	4	1	Bamboo
154	Eyebrowed Thrush	*Turdus obscurus*	I	d	6	3	Lower Canopy
155	Scaly Thrush	*Zoothera dauma*	I	c	4	1	Middle Canopy
156	Chestnut Thrush	*Turdus rubrocanus*	I	a,c	4-6	2	Ground
	MUSCICAPINAE: Muscicapini: Old World flycatchers						
157	Red-throated Flycatcher	*Ficedula parva*	I	a,b,c	2-8	13	Lower Canopy, Bush
158	Snowy-browed Flycatcher	*Ficedula hyperythra*	I	a	3-4	3	Bush
159	Little Pied Flycatcher	*Ficedula westermanni*	I	c,d	3-4	5	Lower Canopy
160	Slaty-blue Flycatcher	*Ficedula tricolor*	I	c	2	2	Lower Canopy
161	Large Niltava	*Niltava grandis*	I	a	56	1	Bush
162	Small Niltava	*Niltava macgrigoriae*	I	a,c,d	2-5	18	Lower Canopy, Bush
163	Rufous-bellied Niltava	*Niltava sundara*	I	c	2	1	Bush
164	Pale Blue Flycatcher	*Cyornis unicolor*	I	c,d	3	3	Lower Canopy
165	Blue-throated Flycatcher	*Cyornis rubeculoides*	I	a,b,c,d,f	2-7	88	Lower Canopy, Bush, Bamboo
166	Tickell's Blue Flycatcher	*Cyornis tickelliae*	I	f	4	2	Bamboo
167	Pygmy Blue Flycatcher	*Muscicapella hodgsoni*	I	c,d	3	4	Middle Canopy
168	Grey-headed Canary Flycatcher	*Culicicapa ceylonensis*	I	a,b,c,d,e,f	2-11	137	Lower Canopy, Bush
	Saxicolini: Chats & allies						
169	Siberian Rubythroat	*Luscinia calliope*	I	a,b,c	2-3	19	Bush
170	Orange-flanked Bush Robin	*Tarsiger cyanurus*	I	c	2	1	Bush
171	Oriental Magpie Robin	*Copsychus saularis*	I	a,b,c,d,f	3-23	32	Lower Canopy, Bush, Bamboo, Top Post
172	White-rumped Shama	*Copsychus malabaricus*	I	a,b,c,d,e,f	2 -21	31	Lower Canopy, Bamboo, Bush
173	Hodgson's Redstart	*Phoenicurus hodgsoni*	I	b,c	2-4	4	Stone
174	Daurian Redstart	*Phoenicurus auroreus*	I	c	3-5	6	River Bank
175	White-capped Water Redstart	*Chaimarrornis leucocephalus*	I	b,c,d,e	4-10	14	Stone
176	Plumbeous Water Redstart	*Rhyacornis fuliginosus*	I	b,c,d,e	5-8	14	Stone
177	White-tailed Robin	*Myiomela leucura*	I	a,c	2-21	3	Bush
178	Black-backed Forktail	*Enicurus immaculatus*	I	a,b,c,d	4-10	32	Stone, Stream
179	Slaty-backed Forktail	*Enicurus schistaceus*	I	b,c,d,f	3-6	14	Stone
180	White-crowned Forktail	*Enicurus leschenaulti*	I	d	3-4	2	Stream
181	Siberian Stonechat	*Saxicola maura*	I	a	2-4	8	Bush
182	Pied Bushchat	*Saxicola caprata*	I	d,f	5-20	3	Bush, Bamboo
183	Grey Bushchat	*Saxicola ferrea*	I	a,b,c,d	1-5	16	Bush
	STURNIDAE: Sturnini: Starlings & mynas						
184	Asian Pied Starling	*Sturnus contra*	I	f	10	28	Middle Canopy
185	Chestnut-tailed Starling	*Sturnus malabaricus*	I	a,b,c,d,f	5-70	281	Top, Middle & Lower Canopy
186	Black-collared Starling	*Sturnus nigricollis*	I	a,f	5-60	58	Top Canopy
187	Vinous-breasted Starling	*Sturnus burmannicus*	I	a,b,c,e,f	5-100	146	Top, Middle & Lower Canopy, Flying
188	Collared Myna	*Acridotheres albocinctus*	I	a,b,c,d,e,f	9-150	505	Top, Middle & Lower Canopy, Bamboo, Flying
189	Hill Myna	*Gracula religiosa*	I	a,b,d	40-150	53	Top, Middle & Lower Canopy
	SITTIDAE: SITTINAE: Nuthatches						
190	Chestnut-bellied Nuthatch	*Sitta castanea*	I	b,f	3-10	16	Lower Canopy, Tree Trunk
191	Velvet-fronted Nuthatch	*Sitta frontalis*	I	a,b,c,d,e,f	3-30	30	Top & Lower Canopy, Tree Trunk
	PARINAE: Typical tits						
192	Sultan Tit	*Melanochlora sultanea*	I	a,b,c,d	3-7	49	Top, Middle & Lower Canopy
	HIRUNDININAE: Martins and swallows						
193	Plain Martin	*Riparia paludicola*	I	c	100	13	Flying

194	Barn Swallow	*Hirundo rustica*	I	a,c,d,e,f	4-10	44	Flying
195	Wire-tailed Swallow	*Hirundo smithii*	I	a,b	5-100	51	Stone, Flying
196	Red-rumped Swallow	*Hirundo daurica*	I	a,c,d,f	10-40	149	Flying
197	Striated Swallow	*Hirundo striolata*	I	a,c	5-8	15	Flying
198	Asian House Martin	*Delichon dasypus*	I	c,e	10-70	89	Flying
	PYCNONOTIDAE: Bulbuls						
199	Black-crested Bulbul	*Pycnonotus melanicterus*	I	a,b,c,d,e	3-30	62	Top & Middle Canopy
200	Red-whiskered Bulbul	*Pycnonotus jocosus*	I	a,b,c,d,e,f	3-120	416	Top, Middle & Lower Canopy, Bamboo
201	Red-vented Bulbul	*Pycnonotus cafer*	I	a,b,c,d,e,f	1-150	357	Top, Middle & Lower Canopy, Bamboo, Flying
202	White-throated bulbul	*Alophoixus flaveolus*	I	a,b,c,d,e,f	5-50	104	Top, Middle & Lower Canopy, Bamboo
203	Olive Bulbul	*Iole virescens*	I	a,b,c,d,f	3-10	59	Top & Middle Canopy, Bamboo
204	Ashy Bulbul	*Hemixos flavala*	I	b,c,d,e,f	3-45	56	Top & Middle Canopy
205	Black Bulbul	*Hypsipetes leucocephalus*	I	a,b,c,d,e,f	3-35	305	Top, Middle & Lower Canopy, Bamboo, Flying
	CISTICOLIDAE: African warblers (cisticolas, prinias & allies)						
206	Rufescent Prinia	*Prinia rufescens*	I	a,b,c	1-4	34	Bush
207	Grey-breasted Prinia	*Prinia hodgsonii*	I	c,f	1-2	8	Bush
208	Yellow-bellied Prinia	*Prinia flaviventris*	I	c	2	2	Bush
	ZOSTEROPIDAE: White-eyes						
209	Oriental White-eye	*Zosterops palpebrosus*	I	b,d	2-4	25	Lower Canopy
210	Japanese White-eye	*Zosterops japonicus*	I	a,b,c,d,f	1-5	100	Lower Canopy
	SYLVIIDAE: ACROCEPHALINAE: Tesias, warblers, tailorbirds & allies						
211	Slaty-bellied Tesia	*Tesia olivea*	I	c,d	2-3	5	Bush, Ground
212	Grey-bellied Tesia	*Tesia cyaniventer*	I	a,d	2-3	7	Bush, Ground
213	Thick-billed Warbler	*Acrocephalus aedon*	I	f	3	2	Lower Canopy, Bamboo
214	Mountain Tailorbird	*Orthotomus cuculatus*	I	d	2-3	4	Bush
215	Common Tailorbird	*Orthotomus sutorius*	I	a,b,c,d,e,f	2-4	73	Bush
216	Dark-necked Tailorbird	*Orthotomus atrogularis*	I	a,b,c,d,f	2-5	17	Bush
217	Dusky Warbler	*Phylloscopus fuscatus*	I	a,b,c,d,f	2 -5	19	Bush
218	Buff-barred Warbler	*Phylloscopus pulcher*	I	d	2	3	Bush
219	Yellow-browed Warbler	*Phylloscopus inornatus*	I	a,b,c,d	2-5	24	Middle & Lower Canopy
220	Greenish Warbler	*Phylloscopus trochiloides*	I	a,b,c	2-6	19	Middle & Lower Canopy
221	Two-barred Warbler	*Phylloscopus plumbeitarsus*	I	b,c,d	3-5	13	Lower Canopy
222	Blyth's Leaf Warbler	*Phylloscopus reguloides*	I	d	2-4	6	Lower Canopy
223	White-tailed Leaf Warbler	*Phylloscopus davisoni*	I	d	2-4	4	Middle Canopy
224	White-spectacled Warbler	*Seicercus affinis*	I	a,b,c,d	1-4	41	Lower Canopy
225	Grey-cheeked Warbler	*Seicercus poliogenys*	I	c,d	2	6	Lower Canopy
226	Chestnut-crowned Warbler	*Seicercus castaniceps*	I	d	2	1	Lower Canopy
227	Rufous-faced Warbler	*Abroscopus albogularis*	I	a,b,c,d	2-5	35	Lower Canopy
228	Yellow-bellied Warbler	*Abroscopus superciliaris*	I	a,b,c,d,e,f	2-8	224	Middle & Lower Canopy, Bamboo, Bush
	MEGALURINAE: Grassbirds						
229	Striated Grassbird	*Megalurus palustris*	I	a	2-3	2	Bush
	GARRULACINAE: Laughingthrushes						
230	White-crested Laughingthrush	*Garrulax leucolophus*	I	a,b,c,d,e,f	2-80	152	Lower Canopy, Bamboo, Bush
231	Lesser Necklaced Laughingthrush	*Garrulax monileger*	I	a,e,f	2-25	59	Bush, Bamboo
232	Greater Necklaced Laughingthrush	*Garrulax pectoralis*	I	a,b,c,d,f	2-5	85	Bush
233	Rufous-necked Laughingthrush	*Garrulax ruficollis*	I	a,c	2-3	15	Bush

234	Chestnut-backed Laughingthrush	*Garrulax nuchalis*	I	a,c,f	2-3	16	Bush	NT
	SYLVINAE: Timaliini: Babblers							
235	Puff-throated Babbler	*Pellorneum ruficeps*	I	a,b,c,d,f	2-22	70	Lower Canopy, Bush, Bamboo	
236	White-browed Scimitar Babbler	*Pomatorhinus schisticeps*	I	a,b,d	2-3	18	Bush	
237	Red-billed Scimitar Babbler	*Pomatorhinus ochraceiceps*	I	a,c	2-3	60	Lower Canopy, Bush	
238	Coral-billed Scimitar Babbler	*Pomatorhinus ferruginosus*	I	f	4	8	Bush	
239	Pygmy Wren Babbler	*Pnoepyga pusilla*	I	a,d	1-2	6	Bush	
240	Rufous-capped Babbler	*Stachyris ruficeps*	I	a,d	2-3	36	Bush	
241	Rufous-fronted Babbler	*Stachyris rufifrons*	I	a,c,d	1-3	41	Bush	
242	Golden Babbler	*Stachyris chrysaea*	I	a,d,f	1-5	33	Bush	
243	Grey-throated Babbler	*Stachyris nigriceps*	I	a,c,d	1-3	31	Bush	
244	Striped Tit Babbler	*Macronous gularis*	I	a,c,d,f	1-13	104	Lower Canopy, Bush, Bamboo	
245	Chestnut-capped Babbler	*Timalia pileata*	I	d	2	4	Bush	
246	Yellow-eyed Babbler	*Chrysomma sinense*	I	a	2-4	7	Bush	
247	Silver-eared Mesia	*Leiothrix argentauris*	I	c,d	2-5	111	Middle & Lower Canopy	
248	White-hooded Babbler	*Gampsorhynchus rufulus*	I	a,b,c,d	2-6	82	Middle & Lower Canopy	
249	Rufous-throated Fulvetta	*Alcippe rufogularis*	I	b,c,d	2-3	16	Bush	
250	Brown-cheeked Fulvetta	*Alcippe poioicephala*	I	a,b,c,d,f	1-17	463	Middle & Lower Canopy, Bush, Bamboo	
251	White-bellied Yuhina	*Yuhina zantholeuca*	I	a,b,c,e	1-6	21	Lower Canopy	
252	Lesser Rufous-headed Parrotbill	*Paradoxornis atrosuperciliaris*	I	a,c,d	1-5	27	Bush	
	ALAUDIDAE: Larks							
253	Oriental Skylark	*Alauda gulgula*	I	a	4-6	3	Flying	
	NECTARINIIDAE: NECTARINIINAE: Dicaeini: Flowerpeckers							
254	Yellow-vented Flowerpecker	*Dicaeum chrysorrheum*	I	c,d	3	4	Lower Canopy	
255	Plain Flowerpecker	*Dicaeum concolor*	I	a,b,d,f	3-14	55	Top, Middle & Lower Canopy	
256	Scarlet-backed Flowerpecker	*Dicaeum cruentatum*	I	a	3	2	Lower Canopy	
	Nectariniini: Sunbirds & spiderhunters							
257	Ruby-cheeked Sunbird	*Anthreptes singalensis*	I	a,b,d,f	3-5	16	Top, Middle & Lower Canopy, Bamboo	
258	Black-throated Sunbird	*Aethopyga saturata*	I	a,b,c,d	2-7	55	Top, Middle & Lower Canopy	
259	Crimson Sunbird	*Aethopyga siparaja*	I	a,b,c,d,f	2-10	46	Top, Middle & Lower Canopy, Bamboo	
260	Little Spiderhunter	*Arachnothera longirostra*	I	a,b,c,d,e	3 15	45	Top, Middle & Lower Canopy, Bamboo	
261	Streaked Spiderhunter	*Arachnothera magna*	I	c,d,e,f	3-17	34	Middle & Lower Canopy, Bamboo, Flying	
	PASSERIDAE: PASSERINAE: Sparrows							
262	House Sparrow	*Passer domensticus*	I	b	1-3	8	Near the Building	
263	Eurasian Tree Sparrow	*Passer montanus*	I	a,c,e,f	1-12	115	Top Canopy, Ground, Near the Building, House	
	MOTACILLINAE: Wagtails & pipits							
264	White Wagtail	*Motacilla alba*	I	a,b,c,d,e	3-15	61	Sand, Stone, Rock	
265	Citrine Wagtail	*Motacilla citreola*	I	a	3-4	4	Ground	
266	Richard's Pipit	*Anthus richardi*	I	f	4-8	6	Ground	
267	Olive-backed Pipit	*Anthus hodgsoni*	I	a,b,c,d,f	3 15	39	Lower Canopy, Bush, Ground	
	ESTRILDINAE: Estrildini: Munias & Java Sparrows							
268	White-rumped Munia	*Lonchura striata*	I	a,b,c,d,f	2-12	156	Bush	
269	Scaly-breasted Munia	*Lonchura punctulata*	I	a,b,f	2-23	93	Bush	
	Carduelini: Finches, siskins, crossbills, grosbeaks & allies							
270	Common Rosefinch	*Carpodacus erythrinus*	I	c,f	5-20	27	Top & Lower Canopy	

	EMBERIZINAE: Emberizini: Buntings & allies						
271	Little Bunting	*Emberiza pusilla*	I	a	4-6	25	Bush
272	Chestnut Bunting	*Emberiza rutila*	I	a	5-12	17	Bush
273	Black-faced Bunting	*Emberiza spodocephala*	I	a	6-13	31	Bush

I = Myitsone area, CR= Critical Endainger, VU= Vulnerable , NT= Near-Threatened

Appendix. 4. Bird data recorded in Lasa area

No	Common name	Scientific name	Study site		Dist. (m)	Quat.	Microhabitat	IUCN Red 2009
	PHASIANIDAE: Partridges,quails,pheasants&Junglefowl							
1	Red Junglefowl	*Gallus gallus*	II	a,c,d	5-33	12	Ground	
2	Grey Peacock Pheasant	*Polyplectron bicalcaratum*	II	b,c,d	10-34	5	Ground	
	DENDROCYGNIDAE: Whistling-ducks							
3	Lesser Whistling-Duck	*Dendrocygna javanica*	II	d	15	1	Flying	
	PICIDAE: Wrynecks, piculets & typical woodpeckers							
4	Speckled Piculet	*Picumnus innominatus*	II	b,c	2-9	5	Lower Canopy, Bamboo	
5	White-browed Piculet	*Sasia ochracea*	II	a,b,c,d	4-18	10	Bamboo	
6	Fulvous-breasted Woodpecker	*Dendrocopos macei*	II	a,c	14-35	3	Middle Canopy	
7	Rufous Woodpecker	*Celeus brachyurus*	II	b,c	8-14	6	Bamboo, Tree Trunk	
8	Greater Yellownape	*Picus flavinucha*	II	d	13	1	Tree Trunk	
9	Grey-headed Woodpecker	*Picus canus*	II	d	51	1	Middle Canopy	
10	Greater Flameback	*Chrysocolaptes lucidus*	II	c	7-12	4	Flying, Tree Trunk	
11	Pale-headed Woodpecker	*Gecinulus grantia*	II	d	8	1	Bamboo	
12	Bay Woodpecker	*Blythipicus pyrrhotis*	II	d	7-62	5	Bamboo	
	MEGALAIMIDAE: Asian barbets							
13	Blue-throated Barbet	*Megalaima asiatica*	II	a,b,c,d	7-47	73	Top Canopy	
14	Blue-eared Barbet	*Megalaima australis*	II	d	16-39	5	Top & Lower Canopy	
	BUCEROTIDAE: Asian hornbills							
15	Oriental Pied Hornbill	*Anthracoceros albirostris*	II	a,d	11-97	10	Top & Middle Canopy	
16	Great Hornbill	*Buceros bicornis*	II	d	167	6	Flying	NT
17	Rufous-necked Hornbill	*Aceros nipalensis*	II	b	100	4	Flying	VU
	UPUPIDAE: Hoopoes							
18	Common Hoopoe	*Upupa epops*	II	a,d	4-34	5	Flying	
	CORACIIDAE: Rollers							
19	Dollarbird	*Eurystomus orientalis*	II	a,c,d	8-95	8	Flying	
	ALCEDINIDAE: Smaller kingfishers							
20	Blyth's Kingfisher	*Alcedo hercules*	II	d	8	1	On the Stone	NT
21	Common Kingfisher	*Alcedo atthis*	II	a,b,c,d	3-30	8	On the Stone, Near Water	
22	Black-backed Kingfisher	*Ceyx erithacus*	II	d	19	1	Bamboo	
	HALCYONIDAE: Larger kingfishers							
23	White-throated Kingfisher	*Halcyon smyrnensis*	II	a,b,c,d	4-100	17	Middle & Lower Canopy	
	CERYLIDAE: Pied kingfishers							
24	Crested Kingfisher	*Megaceryle lugubris*	II	a,c,d	9-45	9	On the Stone	
25	Pied Kingfisher	*Ceryle rudis*	II	b,d	5-31	5	On the Stone, Flying	
	CUCULIDAE: Old World cuckoos							

26	Chestnut-winged Cuckoo	*Clamator coromandus*	II	b,d	10-15	3	Lower Canopy, Flying
27	Large Hawk Cuckoo	*Hierococcyx sparverioides*	II	a,b,c,d	9-76	16	Top & Middle Canopy
28	Plaintive Cuckoo	*Cacomantis merulinus*	II	a,c,d	4-72	10	Middle Canopy
29	Indian Cuckoo	*Cuculus micropterus*	II	a,b,c,d	9-97	29	Middle Canopy
30	Drongo Cuckoo	*Surniculus lugubris*	II	c,d	16-100	22	Top, Middle & Lower Canopy, Bamboo
	CENTROPADIDAE: Coucals						
31	Greater Coucal	*Centropus sinensis*	II	a,c,d	3-32	12	Bush, Ground
32	Lesser Coucal	*Centropus bengalensis*	II	a,c,d	8	1	Ground
	PSITTACIDAE: Parrots & parakeets						
33	Grey-headed Parakeet	*Psittacula finschii*	II	d	18-24	3	Top Canopy, Flying
34	Red-breasted Parakeet	*Psittacula alexandri*	II	a,d	4-18	10	Flying
	APODIDAE: Swifts						
35	Asian Palm Swift	*Cypsiurus balasiensis*	II	a,b,c,d	3-62	644	Flying
	STRIGIDAE: Typical owls						
36	Mountain Scops Owl	*Otus spilocephalus*	II	b	4-6	2	Lower Canopy
37	Oriental Scops Owl	*Otus sunia*	II	d	6	1	Lower Canopy
38	Collared Owlet	*Glaucidium brodiei*	II	b,d	3-18	5	Middle & Lower Canopy, Bamboo
39	Asian Barred Owlet	*Glaucidium cuculoides*	II	b,c,d	5-21	4	Lower Canopy, Bamboo
	CAPRIMULGIDAE: CAPRIMULGINAE: Typical nightjars						
40	Great-eared Nightjar	*Eurostopodus macrotis*	II	a	9	1	Flying
	COLUMBIDAE: Pigeons & doves						
41	Oriental Turtle Dove	*Streptopelia orientalis*	II	a,b,c	11-25	13	Bamboo
42	Spotted Dove	*Streptopelia chinensis*	II	a,b,c,d	7-51	46	Top Canopy, Bamboo
43	Emerald Dove	*Chalcophaps indica*	II	d	7-21	3	Ground, Lower Canopy, Flying
44	Pompadour Green Pigeon	*Treron pompadora*	II	b,d	12-34	9	Bamboo, Lower Canopy
45	Thick-billed Green Pigeon	*Treron curvirostra*	II	c,d	21-100	101	Middle & Lower Canopy, Bamboo
46	Pin-tailed Green Pigeon	*Treron apicauda*	II	c,d	5-150	45	Top & Lower Canopy, Bamboo, Flying
47	Wedge-tailed Green Pigeon	*Treron sphenura*	II	b	15	4	Flying
48	Green Imperial Pigeon	*Ducula aenea*	II	d	21	1	Flying
49	Mountain Imperial Pigeon	*Ducula badia*	II	b,c	30-50	5	Top Canopy, Flying
	RALLIDAE: Rails, gallinules & coots						
50	White-breasted Waterhen	*Amaurornis phoenicurus*	II	b,d	10-18	2	Bush, On the Ground
	SCOLOPACIDAE: TRINGINAE: Godwits, curlews, sandpipers & allies						
51	Common Greenshank	*Tringa nebularia*	II	d	13	1	Flying
52	Common Sandpiper	*Actitis hypoleucos*	II	d	11-25	7	On the Stone, Sand Band,Flying
	BURHINIDAE: Thick-knees						
53	Great Thick-Knee	*Esacus recurvirostris*	II	d	26	3	On the Stone
	CHARADRIINAE: Plovers & lapwings						
54	River Lapwing	*Vanellus duvaucelii*	II	d	21-27	7	On the Stone
55	Grey-headed Lapwing	*Vanellus cinereus*	II	a,d	12-33	9	On the Stone
56	Red-wattled Lapwing	*Vanellus indicus*	II	d	18	2	On the Stone
	GLAREOLINAE: Pratincoles						
57	Small Pratincole	*Glareola lactea*	II	d	43	117	Flying
	ACCIPITRIDAE: ACCIPITRINAE: Hawks & eagles						

58	Oriental Honey-Buzzard	*Pernis ptilorhyncus*	II	b	101	1	Flying	
59	Pallas's Fish Eagle	*Haliaeetus leucoryphus*	II	d	100	1	Flying	VU
60	Grey-headed Fish Eagle	*Ichthyophaga ichthyaetus*	II	d	104-212	5	Flying	NT
61	Crested Serpent Eagle	*Spilornis cheela*	II	a,b,d	20-207	9	Flying	
62	Crested Goshawk	*Accipiter trivirgatus*	II	b	109	1	Flying	
63	Besra	*Accipiter virgatus*	II	d	96	1	Flying	
64	Eurasian Sparrowhawk	*Accipiter nisus*	II	d	120	1	Flying	
65	Common Buzzard	*Buteo buteo*	II	c,d	50-120	3	Flying	
66	Black Eagle	*Ictinaetus malayensis*	II	b,c,d,	102-167	3	Flying	
	FALCONIDAE: Falcons							
67	Common Kestrel	*Falco tinnunculus*	II	a,	112	1	Flying	
68	Peregrine Falcon	*Falco peregrinus*	II	a	5	1	Flying	
	PHALACROCORACIDAE: Cormorants							
69	Great Cormorant	*Phalacrocorax carbo*	II	c,d	20-98	22	Flying	
	ARDEIDAE: Egrets, herons & bitterns							
70	Little Egret	*Egretta garzetta*	II	d	13-50	2	Near Water, On the Stone	
71	White-bellied Heron	*Ardea insignis*	II	d	50-53	2	Near Water, Flying	CR
72	Intermediate Egret	*Mesophoyx intermedia*	II	d	110	1	On the Stone	
73	Chinese Pond Heron	*Ardeola bacchus*	II	d	35	3	On the Stone	
74	Pond Heron	*Ardeola spp.*	II	d	34	2	Top Canopy	
75	Little Heron	*Butorides striatus*	II	d	4 -24	6	Flying, On the Stone	
	CICONIIDAE: CICONIINAE: Storks							
76	Black Stork	*Ciconia nigra*	II	d	112	4	Flying	
	PITTIDAE: Pittas							
77	Hooded Pitta	*Pitta sordida*	II	d	15	1	Bush	
78	Blue-winged Pitta	*Pitta moluccensis*	II	d	4-5	4	Middle Canopy, Bush	
	EURYLAIMINAE: Typical broadbills							
79	Long-tailed Broadbill	*Psarisomus dalhousiae*	II	a,b,d	8-31	69	Middle Canopy	
	IRENIDAE: Fairy bulebirds & leafbirds							
80	Golden-fronted Leafbird	*Chloropsis aurifrons*	II	b,d	20-23	5	Middle Canopy, Bamboo	
81	Orange-bellied Leafbird	*Chloropsis hardwickii*	II	a,c,d	7-26	19	Middle Canopy	
	LANIIDAE: Shrikes							
82	Long-tailed Shrike	*Lanius schach*	II	a,b	5-9	2	Top Canopy	
83	Grey-backed Shrike	*Lanius tephronotus*	II	a,b,d	4-11	7	Middle Canopy, Bush	
	CORVINAE: Corvini: Jays, magpies, treepies, crows & allies							
84	Red-billed Blue Magpie	*Urocissa erythrorhyncha*	II	c	140	1	Middle Canopy	
85	Common Green Magpie	*Cissa chinensis*	II	b,d	21-24	5	Middle Canopy, Bamboo	
86	Grey Treepie	*Dendrocitta formosae*	II	a,b,c,d	7-100	64	Top Canopy, Bamboo	
87	Collared Treepie	*Dendrocitta frontalis*	II	a,b,c,d	5-150	48	Bamboo	
88	Large-billed Crow	*Corvus macrorhynchos*	II	a,b,c,d	8-48	87	Flying, Top Canopy	
	Artamini: Woodswallows & allies							
89	Ashy Woodswallow	*Artamus fuscus*	II	a,b	11-30	5	Flying, Top Canopy	
	Oriolini: Orioles, cuckooshrikes, minivets & flycatcher-shrikes							
90	Maroon Oriole	*Oriolus traillii*	II	c,d	12-29	13	Top, Middle & Lower Canopy	
91	Indochinese Cuckooshrike	*Coracina polioptera*	II	d	20-21	3	Top & Lower Canopy	

92	Ashy Minivet	*Pericrocotus divaricatus*	II	a	6	4	Lower Canopy
93	Long-tailed Minivet	*Pericrocotus ethologus*	II	a,b,c,d	9-24	36	Lower Canopy
94	Scarlet Minivet	*Pericrocotus flammeus*	II	b,c,d	5-50	55	Top, Middle & Lower Canopy, Bamboo, Flying
95	Bar-winged Flycatcher-Shrike	*Hemipus picatus*	II	b,d	9-20	17	Middle & Lower Canopy, Bamboo
	DICRURINAE: Rhipidurini: Fantails						
96	Yellow-bellied Fantail	*Rhipidura hypoxantha*	II	b	4-6	5	Bamboo, Lower Canopy
97	White-throated Fantail	*Rhipidura albicollis*	II	a	9	1	Bush
	Dicrurini: Drongos						
98	Black Drongo	*Dicrurus macrocercus*	II	d	10	2	Lower Canopy
99	Ashy Drongo	*Dicrurus leucophaeus*	II	a,b,c,d	7-81	20	Bamboo
100	Bronzed Drongo	*Dicrurus aeneus*	II	a,b,c,d	4-35	38	Top Canopy
101	Lesser Racket-tailed Drongo	*Dicrurus remifer*	II	b,d	12-21	4	Bamboo, Flying, Middle Canopy
102	Spangled Drongo	*Dicrurus hottentottus*	II	b,c,d	10-27	27	Top, Middle & Lower Canopy, Bamboo, Flying
	Monarchini: Monarchs, paradise-flycatchers & allies						
103	Asian Paradise-flycatcher	*Terpsiphone paradisi*	II	a,b,c,d	3-62	33	Middle Canopy
104	Black-naped Monarch	*Hypothymis azurea*	II	a,b,c,d	3-25	24	Middle & Lower Canopy
	MALACONOTINAE: Vangini: Philentomas, woodshrikes & allies						
105	Common Woodshrike	*Tephrodornis pondicerianus*	II	a	13	2	Lower Canopy
	MUSCICAPIDAE: TURDINAE: Thrushes & shortwings						
106	Blue Rock Thrush	*Monticola solitarius*	II	d	4	2	On the Stone
107	Blue Whistling Thrush	*Myophonus caeruleus*	II	d	9-24	2	Ground, On the Stone
	MUSCICAPINAE: Muscicapini: Old World flycatchers						
108	Red-throated Flycatcher	*Ficedula parva*	II	b,c,d	4-14	34	Bush, Bamboo, Lower Canopy
109	Small Niltava	*Niltava macgrigoriae*	II	b	4	2	Middle Canopy
110	Blue-throated Flycatcher	*Cyornis rubeculoides*	II	a,b,c,d	4--32	44	Bush
111	Tickell's Blue Flycatcher	*Cyornis tickelliae*	II	b	3	2	Lower Canopy
112	Grey-headed Canary Flycatcher	*Culicicapa ceylonensis*	II	b,d	4-28	21	Bush, Bamboo, Lower Canopy
	Saxicolini: Chats & allies						
113	Oriental Magpie Robin	*Copsychus saularis*	II	a,b,c,d	4-54	31	Middle & Lower Canopy
114	White-rumped Shama	*Copsychus malabaricus*	II	a,b,d	7-29	10	Lower Canopy
115	Hodgson's Redstart	*Phoenicurus hodgsoni*	II	a	3	1	Bush
116	White-capped Water Redstart	*Chaimarrornis leucocephalus*	II	a,b,c,d	4-24	8	On the Stone
117	White-tailed Robin	*Myiomela leucura*	II	a	4	1	Bush
118	Black-backed Forktail	*Enicurus immaculatus*	II	b,d	2-31	3	Flying, On the Stone, Near Water
119	Siberian Stonechat	*Saxicola maura*	II	b,d	6-24	9	Bush
120	Grey Bushchat	*Saxicola ferrea*	II	b,d	6-18	6	Lower Canopy, Bush
	STURNIDAE: Sturnini: Starlings & mynas						
121	Asian Pied Starling	*Sturnus contra*	II	d	13-53	20	Banana Tree, Top Canopy
122	Chestnut-tailed Starling	*Sturnus malabaricus*	II	a,b,c,d	7-46	118	Middle Canopy
123	Vinous-breasted Starling	*Sturnus burmannicus*	II	a	27	3	Top Canopy
124	Common Myna	*Acridotheres tristis*	II	a,b	4-11	7	Middle Canopy, Bamboo
125	White-vented Myna	*Acridotheres grandis*	II	d	10-13	7	Middle Canopy
126	Collared Myna	*Acridotheres albocinctus*	II	a,b,c,d	9-42	35	Middle Canopy
127	Hill Myna	*Gracula religiosa*	II	b	14	2	Flying
	SITTIDAE: SITTINAE: Nuthatches						

128	Chestnut-bellied Nuthatch	*Sitta castanea*	II	a,b,c,d	4-75	23	Ground, Middle Canopy	
129	Velvet-fronted Nuthatch	*Sitta frontalis*	II	a,b,c,d	5-26	19	Middle Canopy, Tree Trunk	
	HIRUNDININAE: Martins and swallows							
130	Plain Martin	*Riparia paludicola*	II	a,c,d	3-96	55	Flying	
131	Barn Swallow	*Hirundo rustica*	II	a,d	7-21	45	Flying	
132	Wire-tailed Swallow	*Hirundo smithii*	II	d	8	5	Flying	
	PYCNONOTIDAE: Bulbuls							
133	Red-whiskered Bulbul	*Pycnonotus jocosus*	II	a,b,c,d	6-46	170	Top Canopy, Bamboo	
134	Brown-breasted Bulbul	*Pycnonotus xanthorrhous*	II	b	13	3	Middle Canopy	
135	Red-vented Bulbul	*Pycnonotus cafer*	II	a,b,c,d	5-47	136	Top Canopy,Bamboo	
136	White-throated bulbul	*Alophoixus flaveolus*	II	b,c,d	4-38	101	Top, Middle & Lower Canopy, Bush, Bamboo, Bananan Tree	
137	Olive Bulbul	*Iole virescens*	II	b	14	3	Top Canopy	
138	Ashy Bulbul	*Hemixos flavala*	II	a,b,c,d	5-50	61	Bamboo	
139	Black Bulbul	*Hypsipetes leucocephalus*	II	a,b,c,d	7-100	176	Top Canopy, Bamboo'	
	CISTICOLIDAE: African warblers (cisticolas, prinias & allies)							
140	Hill Prinia	*Prinia superciliaris*	II	d	4	1	Bush	
141	Grey-breasted Prinia	*Prinia hodgsonii*	II	b,d	3-12	16	Bush	
142	Yellow-bellied Prinia	*Prinia flaviventris*	II	d	7-14	3	Bush	
	ZOSTEROPIDAE: White-eyes							
143	Oriental White-eye	*Zosterops palpebrosus*	II	a	4	8	Bush	
144	Japanese White-eye	*Zosterops japonicus*	II	a,b,c,d	3-18	52	Middle Canopy	
	SYLVIIDAE: ACROCEPHALINAE: Tesias, warblers, tailorbirds & allies							
145	Mountain Tailorbird	*Orthotomus cuculatus*	II	b,d	4-7	4	Bush	
146	Common Tailorbird	*Orthotomus sutorius*	II	a,b,c,d	2-11	40	Bush, Ground	
147	Dark-necked Tailorbird	*Orthotomus atrogularis*	II	a,b,d	3-5	14	Middle Canopy	
148	Dusky Warbler	*Phylloscopus fuscatus*	II	a,b,d	2-20	15	Bush	
149	Buff-throated Warbler	*Phylloscopus subaffinis*	II	b	6	3	Bamboo	
150	Greenish Warbler	*Phylloscopus trochiloides*	II	b	9	4	Bamboo	
151	Yellow-vented Warbler	*Phylloscopus cantator*	II	a,b,c,d	3-10	20	Bamboo, Bush	
152	Rufous-faced Warbler	*Abroscopus albogularis*	II	a,b,c,d	3-24	43	Bush	
153	Yellow-bellied Warbler	*Abroscopus superciliaris*	II	b,c,d	2-26	45	Bush, Middle & Lower Canopy, Bamboo	
	MEGALURINAE: Grassbirds							
154	Striated Grassbird	*Megalurus palustris*	II	a,b	3-8	6	Bush	
	GARRULACINAE: Laughingthrushes							
155	White-crested Laughingthrush	*Garrulax leucolophus*	II	a,b,c,d	4-65	143	Bush	
156	Lesser Necklaced Laughingthrush	*Garrulax monileger*	II	a	8	1	Bush	
157	Greater Necklaced Laughingthrush	*Garrulax pectoralis*	II	b,c,d	4-12	14	Lower Canopy, Bush	
158	Chestnut-backed Laughingthrush	*Garrulax nuchalis*	II	b,c,d	4-57	41	Bush	NT
159	Rufous-necked Laughingthrush	*Garrulax ruficollis*	II	b	4-10	6	Bush, Lower Canopy	
	SYLVINAE: Timaliini: Babblers							
160	Buff-breasted Babbler	*Pellorneum tickelli*	II	b	3	3	Bush	
161	Spot-throated Babbler	*Pellorneum albiventre*	II	a,b	3-7	12	Bush	
162	Puff-throated Babbler	*Pellorneum ruficeps*	II	b,c,d	3-21	41	Bush	
163	White-browed Scimitar Babbler	*Pomatorhinus schisticeps*	II	a,b,d	4-10	17	Bush, Bamboo,	

164	Red-billed Scimitar Babbler	*Pomatorhinus ochraceiceps*	II	b	23	7	Middle Canopy
165	Coral-billed Scimitar Babbler	*Pomatorhinus ferruginosus*	II	b	4	6	Bush
166	Pygmy Wren Babbler	*Pnoepyga pusilla*	II	b,d	3-7	4	Bush
167	Rufous-fronted Babbler	*Stachyris rufifrons*	II	c,d	3-4	8	Bush
168	Golden Babbler	*Stachyris chrysaea*	II	a,b,c,d	3-19	50	Bush, Bamboo
169	Spot-necked Babbler	*Stachyris striolata*	II	b	6	5	Bush
170	Striped Tit Babbler	*Macronous gularis*	II	d	3-13	25	Lower Canopy, Bush
171	White-hooded Babbler	*Gampsorhynchus rufulus*	II	b,d	6-11	22	Middle & Lower Canopy, Bamboo
172	Rufous-throated Fulvetta	*Alcippe rufogularis*	II	b	3	7	Bush
173	Brown-cheeked Fulvetta	*Alcippe poioicephala*	II	d	3-14	19	Bush, Lower Canopy
174	Nepal Fulvetta	*Alcippe nipalensis*	II	a,b	4	18	Bush
175	Beautiful Sibia	*Heterophasia pulchella*	II	b	25	1	Lower Canopy
176	Striated Yuhina	*Yuhina castaniceps*	II	a,b,d	7-12	38	Lower Canopy
177	Black-chinned Yuhina	*Yuhina nigrimenta*	II	d	3	4	Middle Canopy
178	White-bellied Yuhina	*Yuhina zantholeuca*	II	b,c,d	5-7	25	Middle & Lower Canopy, Bush, Bamboo
179	Lesser Rufous-headed Parrotbill	*Paradoxornis atrosuperciliaris*	II	b	23	4	Middle Canopy
180	Greater Rufous-headed Parrotbill	*Paradoxornis ruficeps*	II	a,b	3-24	10	Middle Canopy, Bamboo
	NECTARINIIDAE: NECTARINIINAE: Dicaeini: Flowerpeckers						
181	Yellow-vented Flowerpecker	*Dicaeum chrysorrheum*	II	d	18	3	Lower Canopy
182	Plain Flowerpecker	*Dicaeum concolor*	II	b,c,d	2-29	26	Middle & Lower Canopy, Bamboo, Flying
	Nectariniini: Sunbirds & spiderhunters						
183	Ruby-cheeked Sunbird	*Anthreptes singalensis*	II	a,d	5-6	4	Middle & Lower Canopy
184	Black-throated Sunbird	*Aethopyga saturata*	II	b,c,d	3-15	17	Middle & Lower Canopy, Bamboo, Bush
185	Crimson Sunbird	*Aethopyga siparaja*	II	a,b,c,d	2-21	55	Middle & Lower Canopy, Banana Tree, Bamboo, Bush
186	Little Spiderhunter	*Arachnothera longirostra*	II	a,b,c,d	4-18	20	Middle & Lower Canopy, Bamboo, Banana Tree, Bush, Flying
187	Streaked Spiderhunter	*Arachnothera magna*	II	a,b,c,d	4-41	37	Top, Middle & Lower Canopy, Bamboo, Bush, Banana Tree, Flying
	PASSERIDAE: PASSERINAE: Sparrows						
188	Russet Sparrow	*Passer rutilans*	II	b	13	29	Lower Canopy
189	Eurasian Tree Sparrow	*Passer montanus*	II	a,b,c,d	3-16	160	Bush, Ground, Flying
	MOTACILLINAE: Wagtails & pipits						
190	White Wagtail	*Motacilla alba*	II	a,b,c,d	4-22	38	On the Stone, Ground
191	Citrine Wagtail	*Motacilla citreola*	II	b,d	7-23	5	Ground, On the Stone
192	Yellow Wagtail	*Motacilla flava*	II	d	12	1	Ground
193	Richard's Pipit	*Anthus richardi*	II	a	5	1	Ground
194	Olive-backed Pipit	*Anthus hodgsoni*	II	a,b,d	3-14	29	Middle & Lower Canopy, Bamboo, Ground, Flying
	ESTRILDINAE: Munias & Java Sparrows						
195	White-rumped Munia	*Lonchura striata*	II	b,d	5-6	23	Bush
	Carduelini: Finches, siskins, crossbills, grosbeaks & allies						
196	Common Rosefinch	*Carpodacus erythrinus*	II	d	24	4	Lower Canopy
	EMBERIZINAE: Emberizini: Buntings & allies						
197	Little Bunting	*Emberiza pusilla*	II	d	10	13	Ground

II= Lasa area

Appendix. 5. Bird data recorded in Chibwe area

No	Common name	Scientific name	Study site		Dist. (m)	Quan.	Microhabitat	IUCN 2009
	PHASIANIDAE: Partridges,quails,pheasants&Junglefowl							
1	Hill Partridge	*Arborophila torqueola*	III	a	45	2	Ground	
2	Rufous-throated Partridge	*Arborophila rufogularis*	III	b	60	4	Ground	
3	Mountain Bamboo Partridge	*Bambusicola fytchii*	III	b	7-70	14	Bush, Ground	
4	Red Junglefowl	*Gallus gallus*	III	a,b	10-150	9	Bush, Ground	
5	Silver Pheasant	*Lophura nycthemera*	III	a	14	2	Ground	
6	Grey Peacock Pheasant	*Polyplectron bicalcaratum*	III	a,b	12-70	11	Ground, Bush	
	PICIDAE: Wrynecks, piculets & typical woodpeckers							
7	Eurasian Wryneck	*Jynx torquilla*	III	a,b	12-45	4	Bush, Lower Canopy	
8	White-browed Piculet	*Sasia ochracea*	III	a	5-6	3	Bush, Lower Canopy	
9	Grey-capped Pygmy Woodpecker	*Dendrocopos canicapillus*	III	a	15	2	Top Canopy	
10	Rufous Woodpecker	*Celeus brachyurus*	III	a,b	15-20	8	Top & Middle Canopy, Bamboo	
11	Lesser Yellownape	*Picus chlorolophus*	III	b	22	1	Top Canopy	
12	Greater Yellownape	*Picus flavinucha*	III	b	15	2	Middle Canopy	
13	Grey-headed Woodpecker	*Picus canus*	III	a,b	10-80	7	Top & Middle Canopy	
14	Greater Flameback	*Chrysocolaptes lucidus*	III	b	15	1	Middle Canopy	
15	Bay Woodpecker	*Blythipicus pyrrhotis*	III	a,b	10-70	13	Top, Middle & Lower Canopy	
	MEGALAIMIDAE: Asian barbets							
16	Great Barbet	*Megalaima virens*	III	a,b	30-150	11	Top & Middle Canopy	
17	Golden-throated Barbet	*Megalaima franklinii*	III	a,b	15-80	11	Top & Middle Canopy	
18	Blue-throated Barbet	*Megalaima asiatica*	III	a,b	10-100	41	Top & Middle Canopy	
	BUCEROTIDAE: Asian hornbills		III					
19	Great Hornbill	*Buceros bicornis*	III	a,b	80-150	4	Middle Canopy, Flying	NT
20	Rufous-necked Hornbill	*Aceros nipalensis*	III	a,b	25-200	10	Top & Middle Canopy, Flying	VU
	UPUPIDAE: Hoopoes							
21	Common Hoopoe	*Upupa epops*	III	a,b	8-13	8	Middle & Lower Canopy, Ground	
	TROGONIDAE: Harpactini: Asian trogons							
22	Red-headed Trogon	*Harpactes erythrocephalus*	III	a,b	9-45	8	Middle & Lower Canopy, Bamboo	
	ALCEDINIDAE: Smaller kingfishers							
23	Blyth's Kingfisher	*Alcedo hercules*	III	a	20	1	Flying	NT
24	Common Kingfisher	*Alcedo atthis*	III	a,b	14-20	3	Lower Canopy, River Bank	
25	Black-backed Kingfisher	*Ceyx erithacus*	III	a,b	5-35	10	Lower Canopy	
	HALCYONIDAE: Larger kingfishers							
26	White-throated Kingfisher	*Halcyon smyrnensis*	III	a,b	14-60	4	Top & Lower Canopy	
27	Black-capped Kingfisher	*Halcyon pileata*	III	a,b	20-50	4	Top, Middle & Lower Canopy	
	CERYLIDAE: Pied kingfishers							
28	Crested Kingfisher	*Megaceryle lugubris*	III	a	20	1	Flying	
	MEROPIDAE: Bee-eaters							
29	Blue-bearded Bee-eater	*Nyctyornis athertoni*	III	a,b	20-80	7	Top Canopy, Bamboo	
30	Chestnut-headed Bee-Eater	*Merops leschenaulti*	III	a	40-50	13	Flying	
	CUCULIDAE: Old World cuckoos							
31	Chestnut-winged Cuckoo	*Clamator coromandus*	III	a	7-45	22	Middle Canopy, Bamboo	
32	Large Hawk Cuckoo	*Hierococcyx*	III	a,b	25-150	9	Middle & Lower Canopy	

		sparverioides					
33	Hodgson's Hawk Cuckoo	*Hiercoccyx fugax*	III	a,b	10-80	3	Middle & Lower Canopy, Flying
34	Eurasian Cuckoo	*Cuculus canorus*	III	a,b	80	3	Top & Middle Canopy
35	Oriental Cuckoo	*Cuculus saturatus*	III	a	15-40	3	Middle Canopy
36	Banded Bay Cuckoo	*Cacomantis sonneratii*	III	b	23-170	5	Top Canopy
37	Indian Cuckoo	*Cuculus micropterus*	III	a,b	15-150	18	Top, Middle & Lower Canopy
38	Drongo Cuckoo	*Surniculus lugubris*	III	a,b	13-100	14	Top, Middle & Lower Canopy
39	Green-billed Malkoha	*Phaenicophaeus tristis*	III	a	19-70	4	Top & Middle Canopy
	CENTROPADIDAE: Coucals						
40	Greater Coucal	*Centropus sinensis*	III	a	30	2	Bush
41	Lesser Coucal	*Centropus bengalensis*	III	a	20	2	Bush
	PSITTACIDAE: Parrots & parakeets						
42	Grey-headed Parakeet	*Psittacula finschii*	III	a	35-80	9	Flying
	APODIDAE: Swifts						
43	Brown-backed Needletail	*Hirundapus giganteus*	III	a	70	3	Flying
44	Asian Palm Swift	*Cypsiurus balasiensis*	III	a,b	4-70	92	Flying
	STRIGIDAE: Typical owls						
45	Mountain Scops Owl	*Otus spilocephalus*	III	a,b	13-50	11	Middle & Lower Canopy
46	Collared Owlet	*Glaucidium brodiei*	III	a	20	1	Bamboo
47	Asian Barred Owlet	*Glaucidium cuculoides*	III	a	70	1	Middle Canopy
	CAPRIMULGIDAE: CAPRIMULGINAE: Typical nightjars						
48	Grey Nightjar	*Caprimulgus indicus*	III	a,b	10-80	4	Lower Canopy, Ground, Flying
	COLUMBIDAE: Pigeons & doves						
49	Oriental Turtle Dove	*Streptopelia orientalis*	III	a,b	15-50	9	Top Canopy, Groud
50	Spotted Dove	*Streptopelia chinensis*	III	a,b	10-120	19	Top & Middle Canopy, Ground
51	Eurasian Collared Dove	*Streptopelia decaocto*	III	a	80	2	Top Canopy
52	Emerald Dove	*Chalcophaps indica*	III	a	14-80	7	Ground
53	Pompadour Green Pigeon	*Treron pompadora*	III	a	50	3	Top Canopy
54	Pin-tailed Green Pigeon	*Treron apicauda*	III	a,b	22-180	73	Top & Middle Canopy, Flying
55	Wedge-tailed Green Pigeon	*Treron sphenura*	III	a	30-100	4	Top & Lower Canopy
56	Green Imperial Pigeon	*Ducula aenea*	III	a	19	4	Top Canopy
57	Mountain Imperial Pigeon	*Ducula badia*	III	a,b	27-100	36	Top Canopy, Flying
	RALLIDAE: Rails, gallinules & coots						
58	White-breasted Waterhen	*Amaurornis phoenicurus*	III	a,b			
	SCOLOPACIDAE: CHARADRIINAE: Plovers & lapwings						
59	River Lapwing	*Vanellus duvaucelii*	III	a	90-170	4	On the Bank
60	Grey-headed Lapwing	*Vanellus cinereus*	III	a	17-54	4	Ground
	GLAREOLINAE: Pratincoles						
61	Small Pratincole	*Glareola lactea*	III	b	23	5	Band
	ACCIPITRIDAE: ACCIPITRINAE: Hawks & eagles						
62	Black-shouldered Kite	*Elanus caeruleus*	III	a	30	1	Flying
63	Crested Serpent Eagle	*Spilornis cheela*	III	a,b	38-250	7	Flying
64	Hen Harrier	*Circus cyaneus*	III	a	28	1	Flying
65	Crested Goshawk	*Accipiter trivirgatus*	III	a,b	28-55	4	Flying
66	Shikra	*Accipiter badius*	III	b	150	1	Flying
67	Besra	*Accipiter virgatus*	III	a	100	1	Lower Canopy
68	Common Buzzard	*Buteo buteo*	III	a	21-50	2	Flying

69	Black Eagle	*Ictinaetus malayensis*	III	a,b	100-150	2	Flying
70	Mountain Hawk Eagle	*Spizaetus nipalensis*	III	b	100	1	Flying
	FALCONIDAE: Falcons						
71	Common Kestrel	*Falco tinnunculus*	III	a	150	2	Flying
72	Oriental Hobby	*Falco severus*	III	a	100	1	Top Canopy
73	Peregrine Falcon	*Falco peregrinus*	III	a	150	1	Flying
	ARDEIDAE: Egrets, herons & bitterns						
74	Little Egret	*Egretta garzetta*	III	a	24-50	8	Flying, Ground
75	Great Egret	*Casmerodius albus*	III	a	72	2	Ground
76	Cattle Egret	*Bubulcus ibis*	III	b	200	1	Ground
77	Chinese Pond Heron	*Ardeola bacchus*	III	a	100	1	Flying
78	Little Heron	*Butorides striatus*	III	a	23-35	2	Band
	CICONIIDAE: CICONIINAE: Storks						
79	Black Stork	*Ciconia nigra*	III	a	150	1	Flying
	PITTIDAE: Pittas						
80	Hooded Pitta	*Pitta sordida*	III	a	10-40	7	Middle Canopy, Ground
81	Blue-winged Pitta	*Pitta moluccensis*	III	a	40	1	Lower Canopy
	EURYLAIMINAE: Typical broadbills						
82	Long-tailed Broadbill	*Psarisomus dalhousiae*	III	a,b	30-90	18	Middle Canopy, Bush
83	Silver-breasted Broadbill	*Serilophus lunatus*	III	a	15	2	Lower Canopy
	IRENIDAE: Fairy bulebirds & leafbirds						
84	Orange-bellied Leafbird	*Chloropsis hardwickii*	III	a,b	15-40	25	Top & Middle Canopy
	LANIIDAE: Shrikes						
85	Brown Shrike	*Lanius cristatus*	III	a	3-8	3	Bush
86	Long-tailed Shrike	*Lanius schach*	III	a,b	10-35	10	Top & Lower Canopy, Bush
87	Grey-backed Shrike	*Lanius tephronotus*	III	a,b	13-35	4	Top Canopy, Bush
	CORVINAE: Corvini: Jays, magpies, treepies, crows & allies						
88	Red-billed Blue Magpie	*Urocissa erythrorhyncha*	III	a	22	4	Ground
89	Common Green Magpie	*Cissa chinensis*	III	a,b	10-50	10	Middle Canopy, Bamboo, Bush
90	Grey Treepie	*Dendrocitta formosae*	III	a,b	10-80	44	Top, Middle & Lower Canopy, Bush
91	Collared Treepie	*Dendrocitta frontalis*	III	a,b	15-40	11	Top & Middle Canopy
92	House Crow	*Corvus splendens*	III	a	17	4	Flying
93	Large-billed Crow	*Corvus macrorhynchos*	III	a	20-190	9	Top Canopy, Flying
	Artamini: Woodswallows & allies						
94	Ashy Woodswallow	*Artamus fuscus*	III	a,b	21-100	18	Top Canopy, Flying
	Oriolini: Orioles, cuckooshrikes, minivets & flycatcher-shrikes						
95	Black-hooded Oriole	*Oriolus xanthornus*	III	a	20	2	Top Canopy
96	Maroon Oriole	*Oriolus traillii*	III	a,b	18-70	23	Top & Middle Canopy, Bush, Bamboo
97	Large Cuckooshrike	*Coracina macei*	III	a	100	3	Top Canopy
98	Indochinese Cuckooshrike	*Coracina polioptera*	III	a,b	15-100	16	Top & Middle Canopy, Bush
99	Grey-chinned Minivet	*Pericrocotus solaris*	III	a	17-26	7	Top Canopy
100	Long-tailed Minivet	*Pericrocotus ethologus*	III	a,b	13-40	16	Top & Middle Canopy
101	Short-billed Minivet	*Pericrocotus brevirostris*	III	a	15-25	8	Top Canopy
102	Scarlet Minivet	*Pericrocotus flammeus*	III	a,b	13-30	21	Top & Lower Canopy
103	Bar-winged Flycatcher-Shrike	*Hemipus picatus*	III	a,b	15-20	12	Top & Middle Canopy
	DICRURINAE: Rhipidurini: Fantails						
104	Yellow-bellied Fantail	*Rhipidura hypoxantha*	III	a,b	6-10	7	Top & Middle Canopy

105	White-throated Fantail	*Rhipidura albicollis*	III	a	6	1	Bush	
	Dicrurini: Drongos							
106	Ashy Drongo	*Dicrurus leucophaeus*	III	a,b	15-100	26	Top & Middle Canopy, Bamboo	
107	Bronzed Drongo	*Dicrurus aeneus*	III	a,b	13-70	15	Top & Middle Canopy, Bamboo	
108	Lesser Racket-tailed Drongo	*Dicrurus remifer*	III	a,b	7-100	10	Middle & Lower Canopy	
109	Spangled Drongo	*Dicrurus hottentottus*	III	a,b	19-150	25	Top, Middle & Lower Canopy, Bush, Bamboo	
110	Greater Racket-tailed Drongo	*Dicrurus paradiseus*	III	a,b	12-14	6	Top & Middle Canopy	
	Monarchini: Monarchs, paradise-flycatchers & allies							
111	Asian Paradise-flycatcher	*Terpsiphone paradisi*	III	a,b	6-30	15	Middle & Lower Canopy, Bamboo, Bush	
	MALACONOTINAE: Vangini: Philentomas, woodshrikes & allies							
112	Large Woodshrike	*Tephrodornis gularis*	III	a,b	23-60	17	Top & Middle Canopy	
	CINCLIDAE: Dippers							
113	Brown Dipper	*Cinclus pallasii*	III	a,b	21-26	4	Stone, Rock	
	MUSCICAPIDAE: TURDINAE: Thrushes & shortwings							
114	Blue Rock Thrush	*Monticola solitarius*	III	a	15	2	Ground	
115	Blue Whistling Thrush	*Myophonus caeruleus*	III	a,b	10-80	11	Middle Canopy, Ground, Rock	
116	Orange-headed Thrush	*Zoothera citrina*	III	a,b	11-20	5	Middle & Lower Canopy, Bamboo	
117	Plain-backed Thrush	*Zoothera mollissima*	III	a	15	1	Ground	
118	Grey-winged Blackbird	*Turdus boulboul*	III	a	17	3	Ground	
119	Lesser Shortwing	*Brachypteryx leucophrys*	III	a	6	1	Bush	
120	Rusty-bellied Shortwing	*Brachypteryx hyperythra*	III	b	5	1	Bush	NT
	MUSCICAPINAE: Muscicapini: Old World flycatchers							
121	Ferruginous Flycatcher	*Muscicapa ferruginea*	III	a	6-8	2	Lower Canopy, Bamboo	
122	Red-throated Flycatcher	*Ficedula parva*	III	a,b	6-20	14	Middle Canopy, Bush	
123	Little Pied Flycatcher	*Ficedula westermanni*	III	a	10	2	Lower Canopy	
124	Verditer Flycatcher	*Eumyias thalassina*	III	a,b	7-23	7	Top Canopy	
125	Large Niltava	*Niltava grandis*	III	b	10-30	3	Middle Canopy, Bush	
126	Small Niltava	*Niltava macgrigoriae*	III	a,b	6-20	8	Middle Canopy, Bush	
127	Pale Blue Flycatcher	*Cyornis unicolor*	III	a,b	10-35	7	Top Canopy, Bamboo	
128	Blue-throated Flycatcher	*Cyornis rubeculoides*	III	a,b	9-40	16	Middle Canopy, Bush	
129	Hill Blue Flycatcher	*Cyornis banyumas*	III	a	30	7	Lower Canopy, Bamboo	
130	Tickell's Blue Flycatcher	*Cyornis tickelliae*	III	b	5	2	Bush	
131	Grey-headed Canary Flycatcher	*Culicicapa ceylonensis*	III	a,b	10-30	13	Middle & Lower Canopy	
	Saxicolini: Chats & allies							
132	Siberian Rubythroat	*Luscinia calliope*	III	a,b	6-15	5	Lower Canopy, Bush	
133	Oriental Magpie Robin	*Copsychus saularis*	III	a,b	9-100	25	Top, Middle & Lower Canopy, Bush	
134	Hodgson's Redstart	*Phoenicurus hodgsoni*	III	b		2		
135	White-capped Water Redstart	*Chaimarrornis leucocephalus*	III	a,b	18-60	16	Stone, Bank, Rock	
136	Plumbeous Water Redstart	*Rhyacornis fuliginosus*	III	a,b	14-100	10	Rock	
137	White-bellied Redstart	*Hodgsonius phaenicuroides*	III	a	7	1	Bush	
138	Little Forktail	*Enicurus scouleri*	III	a,b	8-40	3	Stream, Stone	
139	Black-backed Forktail	*Enicurus immaculatus*	III	a,b	9-16	3	Stream, Bush	
140	Slaty-backed Forktail	*Enicurus schistaceus*	III	a	10-35	3	Stream, Bush	
141	Spotted Forktail	*Enicurus maculatus*	III	b	8-11	4	Stream	
142	Siberian Stonechat	*Saxicola maura*	III	a,b	10-15	10	Bush, Ground	
143	Grey Bushchat	*Saxicola ferrea*	III	a,b	12-25	6	Bush	

	STURNIDAE: Sturnini: Starlings & mynas							
144	Chestnut-tailed Starling	*Sturnus malabaricus*	III	a,b	13-120	61	Top Canopy	
145	Hill Myna	*Gracula religiosa*	III	b	150	1	Flying	
	SITTIDAE: SITTINAE: Nuthatches							
146	Chestnut-vented Nuthatch	*Sitta nagaensis*	III	a	19-48	4	Top Canopy, Tree Trunk	
147	Chestnut-bellied Nuthatch	*Sitta castanea*	III	a,b	3-51	7	Tree Trunk	
148	Velvet-fronted Nuthatch	*Sitta frontalis*	III	a,b	13-50	5	Middle Canopy, Tree Trunk	
149	Beautiful Nuthatch	*Sitta formosa*	III	b	15-35	7	Middle Canopy	VU
	PARINAE: Typical tits							
150	Green-backed Tit	*Parus monticolus*	III	a	15-17	3	Top & Middle Canopy	
151	Yellow-cheeked Tit	*Parus spilonotus*	III	a,b	17-70	10	Top & Middle Canopy	
152	Sultan Tit	*Melanochlora sultanea*	III	b	20-50	7	Middle Canopy	
	AEGITHALIDAE: Long-tailed tits							
153	Black-throated Tit	*Aegithalos concinnus*	III	a	20	2	Bush	
	HIRUNDININAE: Martins and swallows							
154	Striated Swallow	*Hirundo striolata*	III	a,b	21-50	24	Flying	
	PYCNONOTIDAE: Bulbuls							
155	Crested Finchbill	*Spizixos canifrons*	III	a,b	25-38	16	Top Canopy	
156	Striated Bulbul	*Pycnonotus striatus*	III	b	10	2	Middle Canopy	
157	Red-whiskered Bulbul	*Pycnonotus jocosus*	III	a,b	16-70	96	Top, Middle & Lower Canopy, Bush	
158	Flavescent Bulbul	*Pycnonotus flavescens*	III	b	10-30	10	Top Canopy	
159	White-throated bulbul	*Alophoixus flaveolus*	III	a,b	7-60	53	Middle & Lower Canopy, Bamboo, Bush	
160	Ashy Bulbul	*Hemixos flavala*	III	a,b	8-80	41	Top & Middle Canopy, Bamboo	
161	Mountain Bulbul	*Hypsipetes mcclellandii*	III	a,b	6-50	23	Top & Middle Canopy	
162	Black Bulbul	*Hypsipetes leucocephalus*	III	a,b	17-100	92	Top, Middle & Lower Canopy, Bamboo	
	CISTICOLIDAE: African warblers (cisticolas, prinias & allies)							
163	Hill Prinia	*Prinia superciliaris*	III	a,b	5-10	8	Bush	
164	Grey-breasted Prinia	*Prinia hodgsonii*	III	a,b	3-18	12	Bush	
	ZOSTEROPIDAE: White-eyes							
165	Japanese White-eye	*Zosterops japonicus*	III	a,b	9-65	35	Top & Lower Canopy	
	SYLVIIDAE: ACROCEPHALINAE: Tesias, warblers, tailorbirds & allies							
166	Slaty-bellied Tesia	*Tesia olivea*	III	a	15	1	Bush	
167	Brownish-flanked Bush Warbler	*Cettia fortipes*	III	a,b	4-30	5	Bush	
168	Aberrant Bush Warbler	*Cettia flavolivacea*	III	a,b	3-30	4	Bush	
169	Thick-billed Warbler	*Acrocephalus aedon*	III	a,b	10-45	3	Bush	
170	Common Tailorbird	*Orthotomus sutorius*	III	a,b	5-15	6	Bush	
171	Dusky Warbler	*Phylloscopus fuscatus*	III	a	4-8	5	Bush	
172	Tickell's Leaf Warbler	*Phylloscopus affinis*	III	b	8	2	Top Canopy	
173	Blyth's Leaf Warbler	*Phylloscopus reguloides*	III	a	12	1	Middle Canopy	
174	Yellow-vented Warbler	*Phylloscopus cantator*	III	b	25	2	Middle Canpoy	
175	Grey-cheeked Warbler	*Seicercus poliogenys*	III	a	10	2	Bush	
176	Chestnut-crowned Warbler	*Seicercus castaniceps*	III	a,b	5-15	7	Middle & Lower Canopy, Bush	
177	Rufous-faced Warbler	*Abroscopus albogularis*	III	a,b	10-30	16	Lower Canopy, Bamboo	
178	Yellow-bellied Warbler	*Abroscopus superciliaris*	III	a,b	5-35	61	Middle Canopy, Bamboo	
	MEGALURINAE: Grassbirds							
179	Striated Grassbird	*Megalurus palustris*	III	a	12	2	Bush	
	GARRULACINAE: Laughingthrushes							

180	White-crested Laughingthrush	*Garrulax leucolophus*	III	a,b	8-40	32	Bamboo, Bush	
181	Lesser Necklaced Laughingthrush	*Garrulax monileger*	III	a,b	10-35	26	Middle Canopy, Bush, Bamboo	
182	Greater Necklaced Laughingthrush	*Garrulax pectoralis*	III	a,b	4-45	27	Middle Canopy, Bush	
183	Rufous-necked Laughingthrush	*Garrulax ruficollis*	III	b	10	5	Bush	
184	Chestnut-backed Laughingthrush	*Garrulax nuchalis*	III	a	15-26	7	Bush, Bamboo	NT
185	White-browed Laughingthrush	*Garrulax sannio*	III	a,b	22-50	12	Top Canopy, Bush	
186	Blue-winged Laughingthrush	*Garrulax squamatus*	III	a	20-50	8	Bush	
187	Red-tailed Laughingthrush	*Garrulux milnei*	III	a	25	1	Bush	
188	Spotted Laughingthrush	*Gusulax Ocellatus*	III	a	30	2	Bush	
189	Grey-sided Laughingthrush	*Gurrulax caerulatus*	III	a	35	2	Bush	
190	Red-faced Liocichla	*Liocichla phoenicea*	III	b	12-80	9	Bush	
	SYLVINAE: Timaliini: Babblers							
191	Buff-breasted Babbler	*Pellorneum tickelli*	III	b	10-15	4	Bush	
192	Puff-throated Babbler	*Pellorneum ruficeps*	III	a,b	6-20	10	Bush, Ground	
193	Spot-breasted Scimitar Babbler	*Pomatorhinus erythrocnemis*	III	a	18	5	Bush	
194	White-browed Scimitar Babbler	*Pomatorhinus schisticeps*	III	a	6	2	Bush	
195	Streak-breasted Scimitar Babbler	*Pomatorhinus ruficollis*	III	a	6-8	5	Bush	
196	Red-billed Scimitar Babbler	*Pomatorhinus ochraceiceps*	III	a,b	20-50	23	Top & Middle Canopy, Bamboo, Bush	
197	Coral-billed Scimitar Babbler	*Pomatorhinus ferruginosus*	III	a,b	8-19	12	Bush	
198	Slender-billed Scimitar Babbler	*Xiphirhynchus superciliaris*	III	b	7	1	Bush	
199	Pygmy Wren Babbler	*Pnoepyga pusilla*	III	b	7-20	2	Bush	
200	Spotted Wren Babbler	*Spelaeornis formosus*	III	a,b	3-10	6	Bush	
201	Long-tailed Wren Babbler	*Spelaeornis chocolatinus*	III	a,b	3-6	2	Bush	
202	Rufous-capped Babbler	*Stachyris ruficeps*	III	a,b	6-12	4	Middle Canopy, Bush	
203	Golden Babbler	*Stachyris chrysaea*	III	b	8	4	Bush	
204	Grey-throated Babbler	*Stachyris nigriceps*	III	a,b	4-50	16	Bamboo, Bush	
205	Silver-eared Mesia	*Leiothrix argentauris*	III	b	9-30	18	Bush	
206	Red-billed Leiothrix	*Leiothrix lutea*	III	a,b	6-12	16	Lower Canopy, Bush	
207	Cutia	*Cutia nipalensis*	III	a,b	28-80	6	Middle Canopy	
208	White-browed Shrike Babbler	*Pteruthius flaviscapis*	III	a,b	25-100	9	Top & Middle Canopy	
209	Black-eared Shrike Babbler	*Pteruthius melanotis*	III	a	15	3	Middle Canopy	
210	White-hooded Babbler	*Gampsorhynchus rufulus*	III	a,b	10-35	33	Middle Canopy	
211	Blue-winged Minla	*Minla cyanouroptera*	III	a	8-17	7	Top & Middle Canopy	
212	Rufous-winged Fulvetta	*Alcippe castaneceps*	III	a	4	3	Bush	
213	Brown-cheeked Fulvetta	*Alcippe poioicephala*	III	a	8	12	Lower Canopy	
214	Grey-cheeked Fulvetta	*Alcippe morrisonia*	III	a,b	7 -10	12	Middle Canopy	
215	Nepal Fulvetta	*Alcippe nipalensis*	III	a,b	8-22	48	Middle & Lower Canopy, Bush	
216	Rufous-backed Sibia	*Heterophasia annectens*	III	b	40	2	Middle Canopy	
217	Grey Sibia	*Heterophasia gracilis*	III	a,b	15-80	13	Middle Canopy	
218	Black-headed Sibia	*Heterophasia desgodinsi*	III	a	45	5	Middle Canopy	
219	Beautiful Sibia	*Heterophasia pulchella*	III	a	20	8	Top & Middle Canopy	
220	Long-tailed Sibia	*Heterophasia picaoides*	III	a,b	16-38	28	Top & Middle Canopy	
221	Striated Yuhina	*Yuhina castaniceps*	III	a,b	8-35	84	Middle & Lower Canopy, Bamboo, Bush	
222	White-naped Yuhina	*Yuhina bakeri*	III	b	9-30	11	Middle Canopy	
223	Whiskered Yuhina	*Yuhina flavicollis*	III	a	25	3	Lower Canopy	

224	Rufous-vented Yuhina	*Yuhina occipitalis*	III	a,b	11-15	8	Top Canopy
225	Black-chinned Yuhina	*Yuhina nigrimenta*	III	b	15-20	6	Bush
226	White-bellied Yuhina	*Yuhina zantholeuca*	III	a,b	15-40	8	Middle Canopy, Bamboo
227	Grey-headed Parrotbill	*Paradoxornis gularis*	III	b	40	11	Middle Canopy
228	Brown-winged Parrotbill	*Paradoxornis brunneus*	III	a	8	7	Bush
229	Lesser Rufous-headed Parrotbill	*Paradoxornis atrosuperciliaris*	III	a,b	10-70	20	Middle Canopy, Bamboo
230	Greater Rufous-headed Parrotbill	*Paradoxornis ruficeps*	III	a,b	5-20	18	Middle & Lower Canopy, Bush, Bamboo
	NECTARINIIDAE: NECTARINIINAE: Dicaeini: Flowerpeckers						
231	Fire-breasted Flowerpecker	*Dicaeum ignipectus*	III	a,b	10	4	Top & Middle Canopy
	Nectariniini: Sunbirds & spiderhunters						
232	Mrs Gould's Sunbird	*Aethopyga gouldiae*	III	a,b	10-12	4	Top Canopy, Bush
233	Black-throated Sunbird	*Aethopyga saturata*	III	a,b	5-20	18	Middle & Lower Canopy, Bush
234	Crimson Sunbird	*Aethopyga siparaja*	III	a	15	6	Middle & Lower Canopy, Bush
235	Little Spiderhunter	*Arachnothera longirostra*	III	a	30	2	Lower Canopy
236	Streaked Spiderhunter	*Arachnothera magna*	III	a,b	10-80	19	Top, Middle & Lower Canopy, Bamboo
	PASSERIDAE: PASSERINAE: Sparrows						
237	Russet Sparrow	*Passer rutilans*	III	a,b	20-60	7	Top Canopy
238	Eurasian Tree Sparrow	*Passer montanus*	III	a,b	10-15	10	Lower Canopy, House
	MOTACILLINAE: Wagtails & pipits						
239	White Wagtail	*Motacilla alba*	III	a,b	15-17	17	Ground, Band
240	Citrine Wagtail	*Motacilla citreola*	III	a	14	3	Ground
241	Yellow Wagtail	*Motacilla flava*	III	b	15	3	Ground
242	Grey Wagtail	*Motacilla cinerea*	III	a,b	17	6	Ground
243	Paddyfield Pipit	*Anthus rufulus*	III	b	10	2	Ground
244	Olive-backed Pipit	*Anthus hodgsoni*	III	a,b	6-18	12	Lower Canopy, Ground
245	Rosy Pipit	*Anthus roseatus*	III	b	12	2	Ground
	ESTRILDINAE: Estrildini: Munias & Java Sparrows						
246	White-rumped Munia	*Lonchura striata*	III	a,b	6-50	44	Top Canopy, Bamboo, Bush
247	Scaly-breasted Munia	*Lonchura punctulata*	III	b	9	6	Bush
	Carduelini: Finches, siskins, crossbills, grosbeaks & allies						
248	Common Rosefinch	*Carpodacus erythrinus*	III	b	15-40	5	Top Canopy, Bush
249	Spot-winged Grosbeak	*Mycerobas melanozanthos*	III	a	30-60	9	Top Canopy, Flying
	EMBERIZINAE: Emberizini: Buntings & allies						
250	Little Bunting	*Emberiza pusilla*	III	a,b	10-16	15	Top & Lower Canopy, Ground
251	Black-faced Bunting	*Emberiza spodocephala*	III	a	13-20	5	Bush

III= Chebwe area

Appendix 6. Bird data recorded in Wusot area

No.	Common name	Scientific name	Study site	Dist. (m)	Quant.	Microhabit	IUCLN 2009
	PHASIANIDAE: Partridges,quails,pheasants&Junglefowl						
1	Rufous-throated Partridge	*Arborophila rufogularis*	IV	8-150	6	Bush	
2	Kalij Pheasant	*Lophura leucomelanos*	IV	80	1	Ground	
3	Grey Peacock Pheasant	*Polyplectron bicalcaratum*	IV	50-150	2	Bush	

	PICIDAE: Wrynecks, piculets & typical woodpeckers						
4	Speckled Piculet	*Picumnus innominatus*	IV	6	1	Top Canopy	
5	White-browed Piculet	*Sasia ochracea*	IV	3	1	Middle Canopy	
6	Fulvous-breasted Woodpecker	*Dendrocopos macei*	IV	13-20	4	Top Canopy	
7	Lesser Yellownape	*Picus chlorolophus*	IV	80	1	Lower Canopy	
8	Greater Flameback	*Chrysocolaptes lucidus*	IV	17-19	2	Top Canopy	
9	Bay Woodpecker	*Blythipicus pyrrhotis*	IV	11-40	3	Top & Lower Canopy	
	MEGALAIMIDAE: Asian barbets						
10	Great Barbet	*Megalaima virens*	IV	8-25	4	Top Canopy	
11	Golden-throated Barbet	*Megalaima franklinii*	IV	9-14	6	Top & Middle Canopy	
12	Blue-throated Barbet	*Megalaima asiatica*	IV	12-20	7	Midddle Canopy	
	BUCEROTIDAE: Asian hornbills						
13	Great Hornbill	*Buceros bicornis*	IV	32-38	2	Flying	NT
14	Rufous-necked Hornbill	*Aceros nipalensis*	IV	15-19	2	Top Canopy, Flying	VU
	TROGONIDAE: Harpactini: Asian trogons						
15	Red-headed Trogon	*Harpactes erythrocephalus*	IV	15-25	3	Top & Middle Canopy	
	ALCEDINIDAE: Smaller kingfishers						
16	Common Kingfisher	*Alcedo atthis*	IV	9	1	River Bank	
	CERYLIDAE: Pied kingfishers						
17	Crested Kingfisher	*Megaceryle lugubris*	IV	140	1	Rock	
	MEROPIDAE: Bee-eaters						
18	Blue-bearded Bee-eater	*Nyctyornis athertoni*	IV	70	1	Top Canopy	
	CUCULIDAE: Old World cuckoos						
19	Large Hawk Cuckoo	*Hierococcyx sparverioides*	IV	17-150	6	Top, Middle & Lower Canopy	
20	Hodgson's Hawk Cuckoo	*Hiercoccyx fugax*	IV	16	1	Lower Canopy	
21	Banded Bay Cuckoo	*Cacomantis sonneratii*	IV	25-200	3	Top & Middle Canopy	
22	Indian Cuckoo	*Cuculus micropterus*	IV	12-100	5	Middle & Lower Canopy	
23	Drongo Cuckoo	*Surniculus lugubris*	IV	10-40	13	Top & Middle Canopy	
	COLUMBIDAE: Pigeons & doves						
24	Ashy Wood Pigeon	*Columba pulchricollis*	IV	52	1	Top Canopy	
25	Spotted Dove	*Streptopelia chinensis*	IV	150	1	Top Canopy	
26	Emerald Dove	*Chalcophaps indica*	IV	15-25	2	Flying, Ground	
27	Pin-tailed Green Pigeon	*Treron apicauda*	IV	16	6	Flying	
	SCOLOPACIDAE: SCOLOPACINAE: Woodcocks & snipes						
28	Wood Snipe	*Gallinago nemoricola*	IV	6	1	Ground	VU
	ACCIPITRIDAE: ACCIPITRINAE: Hawks & eagles						
29	Crested Serpent Eagle	*Spilornis cheela*	IV	150	1	Flying	
30	Crested Goshawk	*Accipiter trivirgatus*	IV	25	1	Flying	
31	Common Buzzard	*Buteo buteo*	IV	60	1	Flying	
32	Black Eagle	*Ictinaetus malayensis*	IV	100-150	3	Flying	
33	Mountain Hawk Eagle	*Spizaetus nipalensis*	IV	90	2	Flying	
	PHALACROCORACIDAE: Cormorants						
34	Great Cormorant	*Phalacrocorax carbo*	IV	26-53	4	Flying	
	ARDEIDAE: Egrets, herons & bitterns						
35	Little Egret	*Egretta garzetta*	IV	200	1	Flying	
36	Chinese Pond Heron	*Ardeola bacchus*	IV	150	1	Flying	

	CICONIIDAE: CICONIINAE: Storks					
37	Black Stork	*Ciconia nigra*	IV	38	5	Flying
	EURYLAIMINAE: Typical broadbills					
38	Long-tailed Broadbill	*Psarisomus dalhousiae*	IV	15-150	13	Top & Middle Canopy
39	Silver-breasted Broadbill	*Serilophus lunatus*	IV	15	2	Bush
	IRENIDAE: Fairy bulebirds & leafbirds					
40	Orange-bellied Leafbird	*Chloropsis hardwickii*	IV	10-25	9	Top & Middle Canopy, Bush
	LANIIDAE: CORVINAE: Corvini: Jays, magpies, treepies, crows & allies					
41	Common Green Magpie	*Cissa chinensis*	IV	13-35	3	Middle & Lower Canopy, Bush
42	Grey Treepie	*Dendrocitta formosae*	IV	12	2	Top Canopy
43	Collared Treepie	*Dendrocitta frontalis*	IV	13-25	6	Top & Middle Canopy
	Artamini: Woodswallows & allies					
44	Ashy Woodswallow	*Artamus fuscus*	IV	40	5	Flying
	Oriolini: Orioles, cuckooshrikes, minivets & flycatcher-shrikes					
45	Maroon Oriole	*Oriolus traillii*	IV	9-75	12	Top & Middle Canopy, Flying
46	Indochinese Cuckooshrike	*Coracina polioptera*	IV	16-80	10	Top & Middle Canopy
47	Long-tailed Minivet	*Pericrocotus ethologus*	IV	70	2	Top Canopy
48	Scarlet Minivet	*Pericrocotus flammeus*	IV	8-14	15	Top & Middle Canopy
49	Bar-winged Flycatcher-Shrike	*Hemipus picatus*	IV	15	3	Top Canopy
	Dicrurini: Drongos					
50	Ashy Drongo	*Dicrurus leucophaeus*	IV	11-120	4	Top & Middle Canopy
51	Bronzed Drongo	*Dicrurus aeneus*	IV	10	2	Middle Canopy
52	Lesser Racket-tailed Drongo	*Dicrurus remifer*	IV	5-250	4	Top & Middle Canopy, Flying
	MALACONOTINAE: Vangini: Philentomas, woodshrikes & allies					
53	Large Woodshrike	*Tephrodornis gularis*	IV	12-60	3	Top & Middle Canopy
	MUSCICAPIDAE: TURDINAE: Thrushes & shortwings					
54	Blue Whistling Thrush	*Myophonus caeruleus*	IV	10-150	2	Bush, Stone
55	Orange-headed Thrush	*Zoothera citrina*	IV	8	1	Bush
56	Green Cochoa	*Cochoa viridis*	IV	9-80	7	Top, Middle & Lower Canopy
57	White-browed Shortwing	*Brachypteryx montana*	IV	5	1	Bush
	MUSCICAPINAE: Muscicapini: Old World flycatchers					
58	Brown-breasted Flycatcher	*Muscicapa muttui*	IV	8	1	Middle Canopy
59	Red-throated Flycatcher	*Ficedula parva*	IV	10-15	5	Middle Canopy, Bamboo
60	Snowy-browed Flycatcher	*Ficedula hyperythra*	IV	3	1	Bush
61	Verditer Flycatcher	*Eumyias thalassina*	IV	25	1	Top Canopy
62	Small Niltava	*Niltava macgrigoriae*	IV	14-15	5	Bush
63	Pale Blue Flycatcher	*Cyornis unicolor*	IV	7-27	11	Middle & Lower Canopy, Bush
64	Hill Blue Flycatcher	*Cyornis banyumas*	IV	6-15	7	Lower Canopy, Bush
65	Grey-headed Canary Flycatcher	*Culicicapa ceylonensis*	IV	6-11	3	Middle Canopy, Bush
	Saxicolini: Chats & allies					
66	Hodgson's Redstart	*Phoenicurus hodgsoni*	IV	10	2	Bush
67	White-capped Water Redstart	*Chaimarrornis leucocephalus*	IV	17-180	11	Rock, Stone
68	Plumbeous Water Redstart	*Rhyacornis fuliginosus*	IV	25-200	5	Rock
69	Black-backed Forktail	*Enicurus immaculatus*	IV	10	2	Stream
70	Slaty-backed Forktail	*Enicurus schistaceus*	IV	11-25	6	Rock, Stream

71	Siberian Stonechat	*Saxicola maura*	IV	10-18	5	Middle Canopy, Bush	
	SITTIDAE: SITTINAE: Nuthatches						
72	Chestnut-vented Nuthatch	*Sitta nagaensis*	IV	12	2	Top Canopy	
73	Velvet-fronted Nuthatch	*Sitta frontalis*	IV	10	3	Tree Trunk	
74	Beautiful Nuthatch	*Sitta formosa*	IV	15-19	5	Top Canopy, Tree Trunk	VU
	HIRUNDININAE: Martins and swallows						
75	Red-rumped Swallow	*Hirundo daurica*	IV	80	6	Top Canopy	
	PYCNONOTIDAE: Bulbuls						
76	Red-whiskered Bulbul	*Pycnonotus jocosus*	IV	10-100	20	Top & Middle Canopy, Bush	
77	White-throated bulbul	*Alophoixus flaveolus*	IV	8-25	30	Top, Middle & Lower Canopy	
78	Ashy Bulbul	*Hemixos flavala*	IV	8-70	47	Top, Middle & Lower Canopy	
79	Black Bulbul	*Hypsipetes leucocephalus*	IV	12-150	50	Top & Middle Canopy	
	CISTICOLIDAE: African warblers (cisticolas, prinias & allies)						
80	Hill Prinia	*Prinia superciliaris*	IV	10-14	6	Bamboo, Bush	
	SYLVIIDAE: ACROCEPHALINAE: Tesias, warblers, tailorbirds & allies						
81	Common Tailorbird	*Orthotomus sutorius*	IV	6	6	Bush	
82	Dusky Warbler	*Phylloscopus fuscatus*	IV	5	1	Bush	
83	Blyth's Leaf Warbler	*Phylloscopus reguloides*	IV	5	3	Middle Canopy	
84	Yellow-vented Warbler	*Phylloscopus cantator*	IV	4-10	10	Middle Canopy, Bush, Bamboo	
85	Rufous-faced Warbler	*Abroscopus albogularis*	IV	4-12	13	Lower Canopy, Bamboo, Bush	
86	Yellow-bellied Warbler	*Abroscopus superciliaris*	IV	6	4	Bamboo	
	GARRULACINAE: Laughingthrushes						
87	White-crested Laughingthrush	*Garrulax leucolophus*	IV	12-70	14	Lower Canopy, Bush	
88	Lesser Necklaced Laughingthrush	*Garrulax monileger*	IV	40	4	Bush	
89	Greater Necklaced Laughingthrush	*Garrulax pectoralis*	IV	10-80	17	Lower Canopy, Bush	
90	Red-faced Liocichla	*Liocichla phoenicea*	IV	15	6	Bush	
	SYLVINAE: Timaliini: Babblers						
91	Buff-breasted Babbler	*Pellorneum tickelli*	IV	5	2	Bush	
92	Puff-throated Babbler	*Pellorneum ruficeps*	IV	5	2	Bush	
93	Coral-billed Scimitar Babbler	*Pomatorhinus ferruginosus*	IV	10	3	Topv Canopy	
94	Cachar Wedge- billed Babbler	*Sphenocichla roberti*	IV	16	2	Bush	
95	Spotted Wren Babbler	*Spelaeornis formosus*	IV	7-10	2	Bush	
96	Long-tailed Wren Babbler	*Spelaeornis chocolatinus*	IV	5	2	Bush	
97	Golden Babbler	*Stachyris chrysaea*	IV	3-8	9	Bush	
98	Grey-throated Babbler	*Stachyris nigriceps*	IV	5-8	9	Middle Canopy, Bush	
99	Silver-eared Mesia	*Leiothrix argentauris*	IV	7-20	16	Bush	
100	White-hooded Babbler	*Gampsorhynchus rufulus*	IV	7-13	8	Middle Canopy	
101	Blue-winged Minla	*Minla cyanouroptera*	IV	15	7	Top Canopy	
102	Nepal Fulvetta	*Alcippe nipalensis*	IV	6-10	32	Bush	
103	Rufous-backed Sibia	*Heterophasia annectens*	IV	10-15	5	Lower Canopy	
104	Striated Yuhina	*Yuhina castaniceps*	IV	5-8	21	Top & Middle Canopy	
105	White-naped Yuhina	*Yuhina bakeri*	IV	8	11	Middle Canopy	
106	Whiskered Yuhina	*Yuhina flavicollis*	IV	20	12	Middle Canopy	
107	Black-chinned Yuhina	*Yuhina nigrimenta*	IV	8	3	Bush	
108	White-bellied Yuhina	*Yuhina zantholeuca*	IV	6-8	7	Lower Canopy	
109	Black-throated Parrotbill	*Paradoxornis nipalensis*	IV	6-10	5	Bush	

110	Lesser Rufous-headed Parrotbill	*Paradoxornis atrosuperciliaris*	IV	5	2	Middle Canopy
111	Greater Rufous-headed Parrotbill	*Paradoxornis ruficeps*	IV	9-15	10	Middle Canopy, Bamboo, Bush
	NECTARINIIDAE Nectariniini: Sunbirds & spiderhunters					
112	Black-throated Sunbird	*Aethopyga saturata*	IV	4-15	12	Top & Middle Canopy, Bush
113	Streaked Spiderhunter	*Arachnothera magna*	IV	12	1	Middle Canopy
	PASSERIDAE: PASSERINAE: Sparrows					
114	Russet Sparrow	*Passer rutilans*	IV	15	4	Top Canopy
	MOTACILLINAE: Wagtails & pipits					
115	White Wagtail	*Motacilla alba*	IV	7	3	Bank
116	Olive-backed Pipit	*Anthus hodgsoni*	IV	17-20	29	Ground, Bush
	ESTRILDINAE: Estrildini: Munias & Java Sparrows					
117	Scaly-breasted Munia	*Lonchura punctulata*	IV	8	3	Ground

IV= Wusot area

Appendix 7. Bird data recorded in Pisa area

No.	Common name	Scientific name	Study site	Dist. (m)	Quant.	Microhabitat	IUCN 2009
	PHASIANIDAE: Partridges,quails,pheasants&Junglefowl						
1	Hill Partridge	*Arborophila torqueola*	V	13	2	Ground	
2	Rufous-throated Partridge	*Arborophila rufogularis*	V	8	20	Ground	
3	White-cheeked Partridge	*Arborophila atrogularis*	V	8	2	Ground	NT
4	Mountain Bamboo Partridge	*Bambusicola fytchii*	V	11	2	Ground	
5	Red Junglefowl	*Gallus gallus*	V	20	2	Ground	
6	Silver Pheasant	*Lophura nycthemera*	V	10	2	Ground	
	PICIDAE: Wrynecks, piculets & typical woodpeckers						
7	Great Spotted Woodpecker	*Dendrocopos major*	V	23	2	Top Canopy	
8	Grey-headed Woodpecker	*Picus canus*	V	18	2	Top Canopy	
9	Himalayan Flameback	*Dinopium shorii*	V	23	2	Top Canopy	
10	Common Flameback	*Dinopium javanense*	V	16	2	Top Canopy	
	MEGALAIMIDAE: Asian barbets						
11	Great Barbet	*Megalaima virens*	V	20	3	Top Canopy	
12	Coppersmith Barbet	*M. haemacephala*	V	25	2	Top Canopy	
	UPUPIDAE: Hoopoes						
13	Common Hoopoe	*Upupa epops*	V	10-13	3	Lower Canopy	
	HALCYONIDAE: Larger kingfishers						
14	White-throated Kingfisher	*Halcyon smyrnensis*	V	15-17	2	Top & Lower Canopy	
	CUCULIDAE: Old World cuckoos						
15	Large Hawk Cuckoo	*Hierococcyx sparverioides*	V	22	1	Lower Canopy	

16	Plaintive Cuckoo	*Cacomantis merulinus*	V	15	1	Top Canopy
17	Green-billed Malkoha	*Phaenicophaeus tristis*	V	18	2	Top Canopy
	STRIGIDAE: Typical owls					
18	Collared Scops Owl	*Otus bakkamoena*	V	18	1	Lower Canopy
	COLUMBIDAE: Pigeons & doves					
19	Oriental Turtle Dove	*Streptopelia orientalis*	V	20	2	Top Canopy
20	Green Imperial Pigeon	*Ducula aenea*	V	23	1	Top Canopy
21	Mountain Imperial Pigeon	*Ducula badia*	V	35	4	Top Canopy
	FALCONIDAE: Falcons					
22	Common Kestrel	*Falco tinnunculus*	V	24	1	Flying
	PHALACROCORACIDAE: Cormorants					
23	Little Cormorant	*Phalacrocorax niger*	V	32	1	Rock
	EURYLAIMINAE: Typical broadbills					
24	Long-tailed Broadbill	*Psarisomus dalhousiae*	V	19	2	Lower Canopy
	IRENIDAE: Fairy bulebirds & leafbirds					
25	Blue-winged Leafbird	*Chloropsis cochinchinensis*	V	15	4	Top Canopy
26	Orange-bellied Leafbird	*Chloropsis hardwickii*	V	22	4	Top Canopy
	LANIIDAE: Shrikes					
27	Long-tailed Shrike	*Lanius schach*	V	7	2	Top Canopy
	CORVINAE: Corvini: Jays, magpies, treepies, crows & allies					
28	Common Green Magpie	*Cissa chinensis*	V	10	3	Middle Canopy
29	Large-billed Crow	*Corvus macrorhynchos*	V	22	2	Flying
	Oriolini: Orioles, cuckooshrikes, minivets & flycatcher-shrikes					
30	Long-tailed Minivet	*Pericrocotus ethologus*	V	18	2	Top Canopy
31	Short-billed Minivet	*Pericrocotus brevirostris*	V	17	4	Top Canopy
	DICRURINAE: Rhipidurini: Fantails					
32	White-throated Fantail	*Rhipidura albicollis*	V	6	3	Bush
	Dicrurini: Drongos					
33	Ashy Drongo	*Dicrurus leucophaeus*	V	19	4	Top Canopy
	Monarchini: Monarchs, paradise-flycatchers & allies					
34	Black-naped Monarch	*Hypothymis azurea*	V	13	2	Top Canopy
	AEGITHININAE: Ioras					
35	Common Iora	*Aegithina tiphia*	V	15	1	Middle Canopy
	MUSCICAPIDAE: TURDINAE: Thrushes & shortwings					
36	Chestnut-bellied Rock Thrush	*Monticola rufiventris*	V	15-19	6	Top Canopy
37	White-browed Shortwing	*Brachypteryx montana*	V	4	2	Bush
	MUSCICAPINAE: Muscicapini: Old World flycatchers					
38	Red-throated Flycatcher	*Ficedula parva*	V	10	2	Bush
39	Large Niltava	*Niltava grandis*	V	5-6	4	Lower Canopy, Bush
40	Grey-headed Canary Flycatcher	*Culicicapa ceylonensis*	V	7-10	4	Middle & Lower Canopy
	Saxicolini: Chats & allies					
41	Oriental Magpie Robin	*Copsychus saularis*	V	20	2	Top Canopy
42	White-rumped Shama	*Copsychus malabaricus*	V	17	1	Lower Canopy
43	Daurian Redstart	*Phoenicurus auroreus*	V	10	1	Bush
44	Little Forktail	*Enicurus scouleri*	V	16	2	Stream
45	Slaty-backed Forktail	*Enicurus schistaceus*	V	15	2	Stream
46	Grey Bushchat	*Saxicola ferrea*	V	13	2	Bush
	SITTIDAE: SITTINAE: Nuthatches					

47	Chestnut-vented Nuthatch	*Sitta nagaensis*	V	16-18	2	Tree Trunk
48	Velvet-fronted Nuthatch	*Sitta frontalis*	V	18	2	Tree Trunk
	PARINAE: Typical tits					
49	Yellow-cheeked Tit	*Parus spilonotus*	V	10	5	Middle Canopy
50	Yellow-browed Tit	*Sylviparus modestus*	V	12	12	Middle Canopy
	AEGITHALIDAE: Long-tailed tits					
51	Black-throated Tit	*Aegithalos concinnus*	V	20	6	Middle Canopy
52	Black-browed Tit	*Aegithalos bonvaloti*	V	23	4	Middle Canopy
	PYCNONOTIDAE: Bulbuls					
53	Crested Finchbill	*Spizixos canifrons*	V	16	4	Top Canopy
54	Black-crested Bulbul	*Pycnonotus melanicterus*	V	13	5	Top Canopy
55	White-throated bulbul	*Alophoixus flaveolus*	V	8-12	13	Lower Canopy
56	Black Bulbul	*Hypsipetes leucocephalus*	V	12-20	50	Top Canopy
	CISTICOLIDAE: African warblers (cisticolas, prinias & allies)					
57	Striated Prinia	*Prinia criniger*	V	5	2	Bush
	ZOSTEROPIDAE: White-eyes					
58	Chestnut-flanked White-Eye	*Zosterops erythropleurus*	V	13	8	Top Canopy
	SYLVIIDAE: ACROCEPHALINAE: Tesias, warblers, tailorbirds & allies					
59	Chestnut-headed Tesia	*Tesia castaneocoronata*	V	3	2	Bush
60	Slaty-bellied Tesia	*Tesia olivea*	V	5	2	Bush
61	Grey-bellied Tesia	*Tesia cyaniventer*	V	4	8	Bush
62	Pale foodted Bush Warbler	*Cettia pallidipes*	V	5	3	Bush
63	Brown Bush Warbler	*Bradypterus luteoventris*	V	3-4	3	Bush
64	Mountain Tailorbird	*Orthotomus cuculatus*	V	5	1	Bush
65	Buff-barred Warbler	*Phylloscopus pulcher*	V	7	2	Bush
66	Ashy-throated Warbler	*Phylloscopus maculipennis*	V	5	4	Lower Canopy, Bush
67	Lemon-rumped Warbler	*Phylloscopus chloronotus*	V	4	2	Bush
68	Yellow-browed Warbler	*Phylloscopus inornatus*	V	6	2	Bush
69	White-tailed Leaf Warbler	*Phylloscopus davisoni*	V	8-9	4	Lower Canopy
70	Grey-hooded Warbler	*Seicercus xanthoschistus*	V	6	4	Bush
71	White-spectacled Warbler	*Seicercus affinis*	V	5	4	Bush
72	Grey-cheeked Warbler	*Seicercus poliogenys*	V	4-5	3	Lower Canopy, Bush
73	Black-faced Warbler	*Abroscopus schisticeps*	V	6	3	Bush
	MEGALURINAE: Grassbirds					
74	Striated Grassbird	*Megalurus palustris*	V	10- 6	4	Bush
	GARRULACINAE: Laughingthrushes					
75	White-crested Laughingthrush	*Garrulax leucolophus*	V	9-12	16	Bush
76	Chestnut-crowned Laughingthrush	*Garrulax erythrocephalus*	V	7-9	14	Bush
77	Red-tailed Laughingthrush	*Garrulux milnei*	V	12	10	Bush
	SYLVINAE: Timaliini: Babblers					
78	Puff-throated Babbler	*Pellorneum ruficeps*	V	6	2	Bush
79	Streak-breasted Scimitar Babbler	*Pomatorhinus ruficollis*	V	5	2	Bush
80	Scaly-breasted Wren Babbler	*Pnoepyga albiventer*	V	3	3	Bush
81	Pygmy Wren Babbler	*Pnoepyga pusilla*	V	3	2	Bush
82	Rufous-fronted Babbler	*Stachyris rufifrons*	V	5	5	Bush
83	Black-eared Shrike Babbler	*Pteruthius melanotis*	V	14	3	Middle Canopy
84	Rusty-fronted Barwing	*Actinodura egertoni*	V	6	6	Middle Canopy

85	Nepal Fulvetta	*Alcippe nipalensis*	V	5	14	Bush
86	Beautiful Sibia	*Heterophasia pulchella*	V	21	10	Top Canopy
87	Long-tailed Sibia	*Heterophasia picaoides*	V	19-20	13	Top Canopy
88	Stripe-throated Yuhina	*Yuhina gularis*	V	14	20	Middle Canopy
89	Lesser Rufous-headed Parrotbill	*Paradoxornis atrosuperciliaris*	V	7-8	8	Bush
90	Greater Rufous-headed Parrotbill	*Paradoxornis ruficeps*	V	8	6	Lower Canopy
	NECTARINIIDAE: Nectariniini: Sunbirds & spiderhunters					
91	Green-tailed Sunbird	*Aethopyga nipalensis*	V	9	1	Top Canopy
92	Black-throated Sunbird	*Aethopyga saturata*	V	5	2	Loer Canopy
93	Streaked Spiderhunter	*Arachnothera magna*	V	8	2	Top Canopy
	MOTACILLINAE: Wagtails & pipits					
94	White Wagtail	*Motacilla alba*	V	17-18	5	Bank
	ESTRILDINAE: Carduelini: Finches, siskins, grosbeaks & allies					
95	Tibetan Siskin	*Carduelis thibetana*	V	13	30	Top Canopy
96	Common Rosefinch	*Carpodacus erythrinus*	V	32	2	Top Canopy
	EMBERIZINAE: Emberizini: Buntings & allies					
97	Little Bunting	*Emberiza pusilla*	V	14	6	Top Canopy

V= Pisa area

Appendix 8. Bird data recorded in Khaunglanphu area

No.	Common Name	Species Name	Study site		Dist. (m)	Quan.	Microhabitat	IUCN 2009
	Phasianidae: Partridges							
1	Rufous-throated Partridge	*Arborophila rufogularis*	VI	b	21-24	4	Bamboo	
2	Mountain Bamboo Partridge	*Bambusicola fytchii*	VI	c	5	6	Bamboo	
3	Blyth's Tragopan	*Tragopan blythii*	VI	a	5-9	6	Bamboo	VU
4	Kalij Pheasant	*Lophura leucomelanos*	VI	b,d	20-24	14	Ground, Bamboo	
	ANATIDAE: Geese, atypical ducks & pygmy-geese							
5	Bar-headed Goose	*Anser indicus*	VI	a,b	18-46	3	River, Flying	
6	Ruddy Shelduck	*Tadorna ferruginea*	VI	a	22	2	Flying	
	PICIDAE: Wrynecks, piculets & typical woodpeckers							
7	Speckled Piculet	*Picumnus innominatus*	VI	b	5	2	Lower Canopy	
8	White-browed Piculet	*Sasia ochracea*	VI	a,d	3-6	3	Bamboo	
9	Crimson-breasted Woodpecker	*Dendrocopos cathpharius*	VI	a	8-14	2	Tree Trunk	
10	Lesser Yellownape	*Picus chlorolophus*	VI	a	13	1	Tree Trunk	
11	Greater Yellownape	*Picus flavinucha*	VI	a	18	1	Tree Trunk	
12	Bay Woodpecker	*Blythipicus pyrrhotis*	VI	a,b,d	8-18	12	Bamboo	
	MEGALAIMIDAE: Asian barbets							
13	Great Barbet	*Megalaima virens*	VI	a,b,c	13-23	39	Top & Middle Canopy	
14	Golden-throated Barbet	*Megalaima franklinii*	VI	a,b,c	8-18	17	Top & Middle Canopy	
15	Blue-throated Barbet	*Megalaima asiatica*	VI	a	19	2	Top Canopy	
	BUCEROTIDAE: Asian hornbills							

16	Great Hornbill	*Buceros bicornis*	VI	a	35	8	Flying	NT
17	Rufous-necked Hornbill	*Aceros nipalensis*	VI	a,d	15-36	3	Top Canopy	VU
	UPUPIDAE: Hoopoes							
18	Common Hoopoe	*Upupa epops*	VI	b,c	7-17	2	Lower Canopy, Ground	
	TROGONIDAE: Harpactini: Asian trogons							
19	Red-headed Trogon	*Harpactes erythrocephalus*	VI	a,b,d	7-13	3	Bamboo	
	ALCEDINIDAE: Smaller kingfishers							
20	Common Kingfisher	*Alcedo atthis*	VI	a	12	1	Band	
	CERYLIDAE: Pied kingfishers							
21	Crested Kingfisher	*Megaceryle lugubris*	VI	a	22	1	Band	
	CUCULIDAE: Old World cuckoos							
22	Large Hawk Cuckoo	*Hierococcyx sparverioides*	VI	a	15-26	2	Top Canopy	
23	Banded Bay Cuckoo	*Cacomantis sonneratii*	VI	a	16	5	Middle Canopy	
	APODIDAE: Swifts							
24	Himalayan Swiftlet	*Collocalia brevirostris*	VI	a,c	14-43	49	Flying	
25	Asian Palm Swift	*Cypsiurus balasiensis*	VI	c	18	22	Flying	
26	House Swift	*Apus affinis*	VI	d	18	6	Flying	
	STRIGIDAE: Typical owls							
27	Mountain Scops Owl	*Otus spilocephalus*	VI	a	19-32	2	Lower Canopy	
28	Oriental Scops Owl	*Otus sunia*	VI	b	17	1	Lower Canopy	
29	Collared Scops Owl	*Otus bakkamoena*	VI	a	24	1	Lower Canopy	
30	Collared Owlet	*Glaucidium brodiei*	VI	a,b,c	10-22	6	Lower Canopy	
31	Asian Barred Owlet	*Glaucidium cuculoides*	VI	c	12	1	Middle Canopy	
	CAPRIMULGIDAE: CAPRIMULGINAE: Typical nightjars							
32	Large-tailed Nightjar	*Caprimulgus macrurus*	VI	d	6	1	Flying	
33	Great-eared Nightjar	*Eurostopodus macrotis*	VI	a	5	1	Flying	
	COLUMBIDAE: Pigeons & doves							
34	Oriental Turtle Dove	*Streptopelia orientalis*	VI	a,b	12-20	10	Ground, Top Canopy	
35	Spotted Dove	*Streptopelia chinensis*	VI	a	13	4	Top Canopy	
36	Barred Cuckoo Dove	*Macropygia unchall*	VI	a	16	1	Lower Canopy	
37	Emerald Dove	*Chalcophaps indica*	VI	a	8	1	Lower Canopy	
38	Pompadour Green Pigeon	*Treron pompadora*	VI	b	13	6	Top Canopy	
39	Wedge-tailed Green Pigeon	*Treron sphenura*	VI	a	4	5	Middle Canopy	
40	Mountain Imperial Pigeon	*Ducula badia*	VI	a	22-25	27	Top Canopy	
	TRINGINAE: Sandpipers							
41	Common Sandpiper	*Actitis hypoleucos*	VI	a	17	2	Water	
	ACCIPITRIDAE: ACCIPITRINAE: Hawks & eagles							
42	Oriental Honey-Buzzard	*Pernis ptilorhyncus*	VI	a	29	1	Flying	
43	Lesser-Fish Eagle	*Ichthyophaga bumills*	VI	c	19	1	Flying	NT
44	Crested Serpent Eagle	*Spilornis cheela*	VI	b	22	1	Flying	
45	Crested Goshawk	*Accipiter trivirgatus*	VI	a,b	24-35	3	Flying	
46	Shikra	*Accipiter badius*	VI	a	20	1	Lower Canopy	
47	Common Buzzard	*Buteo buteo*	VI	a,b	18-24	4	Flying	
48	Bonelli's Eagle	*Hieraaetus fasciatus*	VI	c,d	20-22	2	Flying	
49	Black Eagle	*Ictinaetus malayensis*	VI	b,c	17-41	4	Flying	

50	Mountain Hawk Eagle	*Spizaetus nipalensis*	VI	a,d	25-41	2	Flying	VU
	FALCONIDAE: Falcons							
51	Common Kestrel	*Falco tinnunculus*	VI	b,c	14	2	Top Canopy	
	PHALACROCORACIDAE: Cormorants							
52	Great Cormorant	*Phalacrocorax carbo*	VI	a	19-34	9	Band	
	EURYLAIMINAE: Typical broadbills							
53	Long-tailed Broadbill	*Psarisomus dalhousiae*	VI	a,d	10-13	21	Top, Middle & Lower Canopy	
54	Silver-breasted Broadbill	*Serilophus lunatus*	VI	d	10	2	Middle Canopy	
	IRENIDAE: Fairy bulebirds & leafbirds							
55	Blue-winged Leafbird	*Chloropsis cochinchinensis*	VI	a	12	2	Top Canopy	
56	Orange-bellied Leafbird	*Chloropsis hardwickii*	VI	a,b,c,d	8-21	19	Middle & Lower Canopy	
	LANIIDAE: Shrikes							
57	Long-tailed Shrike	*Lanius schach*	VI	a	9	2	Lower Canopy	
58	Grey-backed Shrike	*Lanius tephronotus*	VI	b	9-15.	2	Lower Canopy	
	CORVINAE: Corvini: Jays, magpies, treepies, nutcrackers, crows & allies							
59	Common Green Magpie	*Cissa chinensis*	VI	a,c,d	9-12	3	Top & Lower Canopy, Ground	
60	Grey Treepie	*Dendrocitta formosae*	VI	a,d	10-14	8	Middle & Lower Canopy	
61	Collared Treepie	*Dendrocitta frontalis*	VI	b	8-10.	3	Middle Canopy	
62	Large-billed Crow	*Corvus macrorhynchos*	VI	a,b,c	14-24	56	Top Canopy, Flying	
	Oriolini: Orioles, cuckooshrikes, trillers, minivets & flycatcher-shrikes							
63	Maroon Oriole	*Oriolus traillii*	VI	a	16	16	Top Canopy	
64	Indochinese Cuckooshrike	*Coracina polioptera*	VI	a	16	2	Top Canopy	
65	Grey-chinned Minivet	*Pericrocotus solaris*	VI	a	11	11	Lower Canopy	
66	Scarlet Minivet	*Pericrocotus flammeus*	VI	a	10	8	Lower Canopy	
67	Bar-winged Flycatcher-Shrike	*Hemipus picatus*	VI	a	9	12	Lower Canopy	
	DICRURINAE: Rhipidurini: Fantails							
68	Yellow-bellied Fantail	*Rhipidura hypoxantha*	VI	a,c	7-8	3	Lower Canopy	
69	White-throated Fantail	*Rhipidura albicollis*	VI	a,c	3-5	7	Bamboo, Bush	
	Dicrurini: Drongos							
70	Ashy Drongo	*Dicrurus leucophaeus*	VI	a	15	1	Lower Canopy	
71	Bronzed Drongo	*Dicrurus aeneus*	VI	a,b	11-19	18	Middle & Lower Canopy	
72	Lesser Racket-tailed Drongo	*Dicrurus remifer*	VI	a	19	1	Lower Canopy	
	MALACONOTINAE: Vangini: Philentomas, woodshrikes & allies							
73	Large Woodshrike	*Tephrodornis gularis*	VI	a	20	8	Middle Canopy	
	CINCLIDAE: Dippers							
74	Brown Dipper	*Cinclus pallasii*	VI	a	33	1	Band	
	MUSCICAPIDAE: TURDINAE: Thrushes & shortwings							
75	Chestnut-bellied Rock Thrush	*Monticola rufiventris*	VI	a,b	13-27.	5	Middle & Lower Canopy	
76	Blue Rock Thrush	*Monticola solitarius*	VI	a	9	1	River	
77	Blue Whistling Thrush	*Myophonus caeruleus*	VI	a	8	1	River	
78	Plain-backed Thrush	*Zoothera mollissima*	VI	b,c	5-6	2	Ground	
79	Green Cochoa	*Cochoa viridis*	VI	a,d	10-15	6	Middle & Lower Canopy	
80	Lesser Shortwing	*Brachypteryx leucophrys*	VI	a,c	3-4	2	Bush	NT
81	White-browed Shortwing	*Brachypteryx montana*	VI	a	5	2	Bush	
	MUSCICAPINAE: Muscicapini: Old World flycatchers							

82	Rufous-gorgeted Flycatcher	*Ficedula strophiata*	VI	a,c	3-5	8	Bush	
83	White-gorgeted Flycatcher	*Ficedula monileger*	VI	a	4	2	Bush	
84	Snowy-browed Flycatcher	*Ficedula hyperythra*	VI	a	3	2	Bush	
85	Little Pied Flycatcher	*Ficedula westermanni*	VI	a	5	1	Lower Canopy	
86	Slaty-blue Flycatcher	*Ficedula tricolor*	VI	d	3	1	Bush	
87	Verditer Flycatcher	*Eumyias thalassina*	VI	c	10	1	Middle Canopy	
88	Large Niltava	*Niltava grandis*	VI	a,b,c,d	5-9	13	Middle & Lower Canopy, Bush	
89	Small Niltava	*Niltava macgrigoriae*	VI	a	5	2	Bush	
90	Rufous-bellied Niltava	*Niltava sundara*	VI	a	3	1	Bush	
91	Blue-throated Flycatcher	*Cyornis rubeculoides*	VI	a	5	1	Bush	
92	Grey-headed Canary Flycatcher	*Culicicapa ceylonensis*	VI	a	7	2	Lower Canopy	
	Saxicolini: Chats & allies							
93	Orange-flanked Bush Robin	*Tarsiger cyanurus*	VI	b	6	2	Bush	
94	Golden Bush Robin	*Tarsiger chrysaeus*	VI	c	6-7	3	Bush, Ground	
95	Hodgson's Redstart	*Phoenicurus hodgsoni*	VI	a	8	2	River	
96	Daurian Redstart	*Phoenicurus auroreus*	VI	a	9	1	Band	
97	Blue-fronted Redstart	*Phoenicurus frontalis*	VI	c	5	2	Lower Canopy	
98	White-capped Water Redstart	*Chaimarrornis leucocephalus*	VI	a	21	2	Band	
99	Plumbeous Water Redstart	*Rhyacornis fuliginosus*	VI	a	15	2	Band	
100	Little Forktail	*Enicurus scouleri*	VI	b	19	1	Stone,	
101	Black-backed Forktail	*Enicurus immaculatus*	VI	a	6	1	On the stone	
102	Slaty-backed Forktail	*Enicurus schistaceus*	VI	a	8	2	On the stone	
103	White-crowned Forktail	*Enicurus leschenaulti*	VI	b	7	1	Stone	
104	Spotted Forktail	*Enicurus maculatus*	VI	b	7	1	Stone	
105	Siberian Stonechat	*Saxicola maura*	VI	a	6	1	Bush	
106	Grey Bushchat	*Saxicola ferrea*	VI	b,c	6-8	4	Bush	
	STURNIDAE: Sturnini: Starlings & mynas							
107	Spot-winged Starling	*Saroglossa spiloptera*	VI	b	13	1	Top Canopy	
	SITTIDAE: SITTINAE: Nuthatches							
108	Chestnut-bellied Nuthatch	*Sitta castanea*	VI	a	10	3	Tree Trunk	
109	Velvet-fronted Nuthatch	*Sitta frontalis*	VI	a	9	2	Tree Trunk	
110	Beautiful Nuthatch	*Sitta formosa*	VI	a	8	3	Lower Canopy	VU
	TROGLODYTINAE: Wrens							
111	Winter Wren	*Troglodytes troglodytes*	VI	a	3	1	Bush	
	PARINAE: Typical tits							
112	Green-backed Tit	*Parus monticolus*	VI	a,b,c	7-13.	10	Middle & Lower Canopy	
113	Yellow-cheeked Tit	*Parus spilonotus*	VI	a,c	9-13	8	Middle & Lower Canopy	
114	Yellow-browed Tit	*Sylviparus modestus*	VI	a	9	4	Lower Canopy	
115	Sultan Tit	*Melanochlora sultanea*	VI	a	8	6	Middle Canopy	
	AEGITHALIDAE: Long-tailed tits							
116	Black-throated Tit	*Aegithalos concinnus*	VI	a,c	4-5	11	Lower Canopy	
	HIRUNDININAE: Martins and swallows							
117	Barn Swallow	*Hirundo rustica*	VI	b	14-21.	18	Flying	
118	Asian House Martin	*Delichon dasypus*	VI	a	17	29	Flying	
	PYCNONOTIDAE: Bulbuls							
119	Crested Finchbill	*Spizixos canifrons*	VI	b	21	15	Top Canopy	
120	Striated Bulbul	*Pycnonotus striatus*	VI	a	15	6	Top Canopy	

121	Brown-breasted Bulbul	*P. xanthorrhous*	VI	a,b,c	7-18	77	Top, Middle & Lower Canopy	
122	White-throated Bulbul	*Alophoixus flaveolus*	VI	a	8-18	19	Top & Middle Canopy	
123	Ashy Bulbul	*Hemixos flavala*	VI	a,c	12-15	17	Middle & Lower Canopy	
124	Mountain Bulbul	*Hypsipetes mcclellandii*	VI	b,d	12-19	24	Top & Middle Canopy	
125	Black Bulbul	*H.leucocephalus*	VI	a,b,c	13-17	99	Top & Middle Canopy	
	CISTICOLIDAE: African warblers (cisticolas, prinias & allies)							
126	Hill Prinia	*Prinia superciliaris*	VI	b,c	2-8.	14	Bush, Lower Canopy	
127	Grey-breasted Prinia	*Prinia hodgsonii*	VI	d	5	4	Bush	
	ZOSTEROPIDAE: White-eyes							
128	Oriental White-eye	*Zosterops palpebrosus*	VI	a,d	5	30	Lower Canopy	
129	Japanese White-eye	*Zosterops japonicus*	VI	b,c,d	8-10	45	Middle & Lower Canopy	
	SYLVIIDAE: ACROCEPHALINAE: Tesias, warblers, tailorbirds & allies							
130	Chestnut-headed Tesia	*Tesia castaneocoronata*	VI	a	3	1	Bush	
131	Slaty-bellied Tesia	*Tesia olivea*	VI	a,d	2-4	5	Bush	
132	Grey-bellied Tesia	*Tesia cyaniventer*	VI	a	2	1	Bush	
133	Brownish-flanked Bush Warbler	*Cettia fortipes*	VI	b,c	2-4.	7	Bush	
134	Aberrant Bush Warbler	*Cettia flavolivacea*	VI	a	2	2	Bush	
135	Mountain Tailorbird	*Orthotomus cuculatus*	VI	a	5	2	Bush	
136	Common Tailorbird	*Orthotomus sutorius*	VI	a	4	2	Lower Canopy	
137	Dusky Warbler	*Phylloscopus fuscatus*	VI	a	4	2	Bush	
138	Buff-barred Warbler	*Phylloscopus pulcher*	VI	a	6	1	Lower Canopy	
139	Ashy-throated Warbler	*P. maculipennis*	VI	a,b,c	2-4.	2	Bamboo, Lower Canopy	
140	Lemon-rumped Warbler	*P. chloronotus*	VI	a	3	2	Bamboo	
141	Yellow-browed Warbler	*P. inornatus*	VI	a	4	2	Bamboo	
142	Two-barred Warbler	*P. plumbeitarsus*	VI	a,b	4-5	4	Lower Canopy	
143	Blyth's Leaf Warbler	*P. reguloides*	VI	a	3	1	Bamboo	
144	Yellow-vented Warbler	*P. cantator*	VI	a	4	1	Bamboo	
145	Grey-cheeked Warbler	*Seicercus poliogenys*	VI	a,c	3-4	8	Bamboo, Lower Canopy	
146	Chestnut-crowned Warbler	*S. castaniceps*	VI	a,b	4-9	4	Bush, Bamboo	
147	Broad-billed Warbler	*Tickellia hodgsoni*	VI	b	3	2	Bamboo	
148	Rufous-faced Warbler	*Abroscopus albogularis*	VI	a,b,c,d	2-6.	43	Bamboo, Middle & Lower Canopy	
149	Yellow-bellied Warbler	*A. superciliaris*	VI	a	3	9	Bamboo	
	GARRULACINAE: Laughingthrushes							
150	White-crested Laughingthrush	*Garrulax leucolophus*	VI	a	6	8	Lower Canopy	
151	Lesser Necklaced Laughingthrush	*Garrulax monileger*	VI	a	6	4	Bush	
152	Greater Necklaced Laughingthrush	*Garrulax pectoralis*	VI	a	5	9	Middle Canopy	
153	Striated Laughingthrush	*Garrulax striatus*	VI	a	7	6	Middle Canopy	
154	Chestnut-backed Laughingthrush	*Garrulax nuchalis*	VI	a	3	8	Bush	NT
155	White-browed Laughingthrush	*Garrulax sannio*	VI	b	15	6	Bush	
156	Blue-winged Laughingthrush	*Garrulax squamatus*	VI	c	9	1	Lower Canopy	
157	Scaly Laughingthrush	*Garrulux subunicolor*	VI	b	9	2	Bush	
158	Red-tailed Laughingthrush	*Garrulux milnei*	VI	b,c	5-9	16	Bush	
159	Red-faced Liocichla	*Liocichla phoenicea*	VI	a,b,d	5-10	14	Bush	
	SYLVINAE: Timaliini: Babblers							
160	Spot-throated Babbler	*Pellorneum albiventre*	VI	a	2	1	Bush	

161	Puff-throated Babbler	*Pellorneum ruficeps*	VI	a	5	7	Bush	
162	Streak-breasted Scimitar Babbler	*Pomatorhinus ruficollis*	VI	b	4	9	Bush	
163	White-browed Scimitar Babbler	*P. schisticeps*	VI	b	5	3	Bush	
164	Coral-billed Scimitar Babbler	*P. ferruginosus*	VI	a	7-8	11	Bush	
165	Long- billed Wren Babbler	*Rimator malacoptilus*	VI	a	3	1	Bush	
166	Chevron-breasted Babbler	*Sphenocichla roberti*	VI	c	2	1	Bush	NT
167	Eyebrowed Wren Babbler	*Napothera epilepidota*	VI	a	4	2	Bush	
168	Scaly-breasted Wren Babbler	*Pnoepyga albiventer*	VI	b	3	1	Bush	
169	Pygmy Wren Babbler	*Pnoepyga pusilla*	VI	a	2-3	3	Bush	
170	Spotted Wren Babbler	*Spelaeornis formosus*	VI	a	4	1	Bush	
171	Long-tailed Wren Babbler	*S. chocolatinus*	VI	a	3	1	Bush	
172	Rufous-capped Babbler	*Stachyris ruficeps*	VI	b	3	2	Bamboo	
173	Rufous-fronted Babbler	*Stachyris rufifrons*	VI	a	2	5	Bush	
174	Golden Babbler	*Stachyris chrysaea*	VI	a,b,c	3-6	81	Bush, Lower Canopy	
175	Grey-throated Babbler	*Stachyris nigriceps*	VI	a,b,d	2-8	30	Bush, Lower Canopy	
176	Snowy-throated Babbler	*Stachyris oglei*	VI	a	7	6	Bush	VU
177	Chestnut-capped Babbler	*Timalia pileata*	VI	a	3	2	Bush	
178	Silver-eared Mesia	*Leiothrix argentauris*	VI	a,b,c,d	3-9	302	Middle & Lower Canopy, Bush	
179	Red-billed Leiothrix	*Leiothrix lutea*	VI	a	6	9	Lower Canopy	
180	Cutia	*Cutia nipalensis*	VI	a	12	3	Middle Canopy	
181	Black-headed Shrike Babbler	*Pteruthius rufiventer*	VI	a	14	2	Tree Trunk	
182	White-browed Shrike Babbler	*P. flaviscapis*	VI	a,c,d	6-18	16	Top, Middle & Lower Canopy	
183	Black-eared Shrike Babbler	*Pteruthius melanotis*	VI	a,b,c	8-19	21	Lower Canopy	
184	Rusty-fronted Barwing	*Actinodura egertoni*	VI	b,c	7-14	20	Top & Middle Canopy	
185	Streak-throated Barwing	*Actinodura waldeni*	VI	a	11	4	Middle Canopy	
186	Blue-winged Minla	*Minla cyanouroptera*	VI	a	7	6	Middle Canopy	
187	Chestnut-tailed Minla	*Minla strigula*	VI	b	12	8	Lower Canopy	
188	Red-tailed Minla	*Minla ignotincta*	VI	a	13	8	Middle Canopy	
189	Yellow-throated Fulvetta	*Alcippe cinerea*	VI	a,b,c	3-4	38	Lower Canopy, Bush	
190	Rufous-winged Fulvetta	*Alcippe castaneceps*	VI	a	2	8	Lower Canopy	
191	White-browed Fulvetta	*Alcippe vinipectus*	VI	a	3	5	Bamboo	
192	Eyebrowed Wren Babbler	*Alcippe rufogularis*	VI	a	2	8	Bush	
193	Grey-cheeked Fulvetta	*Alcippe morrisonia*	VI	a	3	6	Lower Canopy	
194	Nepal Fulvetta	*Alcippe nipalensis*	VI	a,b,c,d	2-7	336	Bush, Middle & Lower Canopy	
195	Rufous-backed Sibia	*Heterophasia annectens*	VI	a,c	10-17	4	Middle & Lower Canopy	
196	Beautiful Sibia	*H. pulchella*	VI	a	4	7	Middle Canopy	
197	Long-tailed Sibia	*H. picaoides*	VI	a	14	12	Middle Canopy	
198	Striated Yuhina	*Yuhina castaniceps*	VI	a,b,c	8-19	55	Middle & Lower Canopy	
199	White-naped Yuhina	*Yuhina bakeri*	VI	a	8-11	18	Lower Canopy	
200	Whiskered Yuhina	*Yuhina flavicollis*	VI	a,b,c	5-13	83	Middle & Lower Canopy	
201	Black-chinned Yuhina	*Yuhina nigrimenta*	VI	a	8	12	Lower Canopy	
202	White-bellied Yuhina	*Yuhina zantholeuca*	VI	a	6	3	Lower Canopy	
203	Spot-breasted Parrotbill	*Paradoxornis guttaticollis*	VI	b,c	4-8.	14	Bamboo	
204	Black-throated Parrotbill	*P. nipalensis*	VI	a,b,c	3-5	32	Bamboo, Bush, Lower Canopy	
205	Brown-winged Parrotbill	*P. brunneus*	VI	b	6-10.	25	Bush	

206	Lesser Rufous-headed Parrotbill	*P. atrosuperciliaris*	VI	a	8	14	Bush
207	Greater Rufous-headed Parrotbill	*P. ruficeps*	VI	a	5	7	Middle Canopy
	ALAUDIDAE: Larks						
208	Oriental Skylark	*Alauda gulgula*	VI	a	5	1	Ground
	NECTARINIIDAE: NECTARINIINAE: Dicaeini: Flowerpeckers						
209	Fire-breasted Flowerpecker	*Dicaeum ignipectus*	VI	b	13	2	Lower Canopy
	Nectariniini: Sunbirds & spiderhunters						
210	Green-tailed Sunbird	*Aethopyga nipalensis*	VI	a	7	2	Middle Canopy
211	Black-throated Sunbird	*Aethopyga saturata*	VI	a,c	2-7	25	Top,Middle & Lower Canopy
212	Crimson Sunbird	*Aethopyga siparaja*	VI	a	5	1	Top Canopy
213	Little Spiderhunter	*Arachnothera longirostra*	VI	a	10	2	Lower Canopy
214	Streaked Spiderhunter	*A. magna*	VI	a	7-11	7	Lower Canopy, Bamboo
	PASSERIDAE: PASSERINAE: Sparrows						
215	Russet Sparrow	*Passer rutilans*	VI	a,c	8-14	4	Top & Lower Canopy
216	Eurasian Tree Sparrow	*Passer montanus*	VI	b,c	7	11	Ground, Lower Canopy
	MOTACILLINAE: Wagtails & pipits						
217	White Wagtail	*Motacilla alba*	VI	a,b,c	7-12	10	Band, Ground
218	Olive-backed Pipit	*Anthus hodgsoni*	VI	b	7-12.	19	Ground
	PRUNELLINAE: Accentors						
219	Maroon -backed Accentor	*Prunella immaculata*	VI	d	8	1	Ground
	ESTRILDINAE: Estrildini: Munia						
220	White-rumped Munia	*Lonchura striata*	VI	a,b,c	5-9	28	Bamboo, Bush
	Carduelini: Finches, siskins, crossbills, grosbeaks & allies						
221	Tibetan Siskin	*Carduelis thibetana*	VI	a	23	142	Middle Canopy
222	Gold-naped Finch	*Pyrrhoplectes epauletta*	VI	b,c	3-13	4	Top Canopy & Bush
	EMBERIZINAE: Emberizini: Buntings & allies						
223	Tristram's Bunting	*Emberiza tristrami*	VI	b	5	2	Ground
224	Yellow-throated Bunting	*Emberiza elegans*	VI	b	5	4	Ground
225	Little Bunting	*Emberiza pusilla*	VI	a,b,c	5-13	62	Lower Canopy, Ground, Bush
226	Black-faced Bunting	*E. spodocephala*	VI	b,c	5-7	7	Ground, Bush

IV= Khaunglanphu area

Appendix 9. Bird data recorded in Yenam area

No	Common Name	Species Name	Study site		Dist. (m)	Quant.	Microhabitat	IUCN 2009
	PHASIANIDAE: Partridges, quails, pheasants & Junglefow							
1	Rufous-throated Partridge	*Arborophila rufogularis*	VII	a,b,c	3-5	7	Ground	
2	White-cheeked Partridge	*Arborophila atrogularis*	VII	c	4	1	Ground	NT
3	Grey Peacock Pheasant	*Polyplectron bicalcaratum*	VII	a,b,c,d	3-5	6	Ground	
4	Kalij Pheasant	*Lophura leucomelanos*	VII	b	3	2	Ground	
	ANATIDAE: Anatini: Typical ducks							
5	Common Merganser	*Mergus merganser*	VII	a	4	4	In the water	
	PICIDAE: Wrynecks, piculets & typical woodpeckers							

6	Speckled Piculet	*Picumnus innominatus*	VII	c	3	1	Bamboo	
7	White-browed Piculet	*Sasia ochracea*	VII	b,c,d	3	5	Bamboo, Bush, Lower Canopy	
8	Crimson-breasted Woodpecker	*Dendrocopos cathpharius*	VII	c	5	2	Lower Canopy	
9	Greater Yellownape	*Picus flavinucha*	VII	c	5	2	Lower Canopy	
10	Bay Woodpecker	*Blythipicus pyrrhotis*	VII	c	5	1	Middle Canopy	
	MEGALAIMIDAE: Asian barbets							
11	Great Barbet	*Megalaima virens*	VII	a,b,c,d	2-12	24	Tree trunk, Bamboo, Top, Middle & Lower Canopy	
12	Lineated Barbet	*Megalaima lineata*	VII	a,b,c	2-8	8	Top & Middle Canopy	
13	Golden-throated Barbet	*Megalaima franklinii*	VII	b	3	1	Top Canopy	
14	Blue-throated Barbet	*Megalaima asiatica*	VII	a,b,c,d	3-6	13	Bamboo, Top & Middle Canopy	
	BUCEROTIDAE: Asian hornbills							
15	Great Hornbill	*Buceros bicornis*	VII	a	3-6	5	Top Canopy	
16	Rufous-necked Hornbill	*Aceros nipalensis*	VII	b	75	3	Flying	NT
17	Wreathed Hornbill	*Aceros undulatus*	VII	d	70	4	Flying	VU
	UPUPIDAE: Hoopoes			d	24	1	Flying	
18	Common Hoopoe	*Upupa epops*	VII	a	6	1	Ground	
	TROGONIDAE: Harpactini: Asian trogons			a	6	2	Lower Canopy	
19	Red-headed Trogon	*Harpactes erythrocephalus*	VII					
	ALCEDINIDAE: Smaller kingfishers							
20	Blyth's Kingfisher	*Alcedo hercules*	VII	b	5	1	On the stone	NT
21	Common Kingfisher	*Alcedo atthis*	VII	a	3	1	On the stone	
	CERYLIDAE: Pied kingfishers							
22	Crested Kingfisher	*Megaceryle lugubris*	VII	a,b,d	2-60	4	Flying, On the stone	
	CUCULIDAE: Old World cuckoos							
23	Large Hawk Cuckoo	*Hierococcyx sparverioides*	VII	d,c	4-8	3	Bamboo, Top & Middle Canopy	
24	Indian Cuckoo	*Cuculus micropterus*	VII	a	4	1	Top Canopy	
	APODIDAE: Swifts							
25	Himalayan Swiftlet	*Collocalia brevirostris*	VII	a,b,c,d	3-50	166	Flying	
	STRIGIDAE: Typical owls							
26	Mountain Scops Owl	*Otus spilocephalus*	VII	b,c	4-5	2	Lower Canopy, Bamboo	
27	Collared Scops Owl	*Otus bakkamoena*	VII	b	3	1	Middle Canopy	
28	Collared Owlet	*Glaucidium brodiei*	VII	a,b,c,d	3-8	25	Bamboo, Middle Canopy	
29	Asian Barred Owlet	*Glaucidium cuculoides*	VII	b,c	2-3	2	Lower Canopy	
	COLUMBIDAE: Pigeons & doves							
30	Mountain Imperial Pigeon	*Ducula badia*	VII	a	5	2	Flying	
	ACCIPITRIDAE: ACCIPITRINAE: Hawks & eagles							
31	Grey-headed Fish Eagle	*Ichthyophaga ichthyaetus*	VII	a	8	1	Flying	NT
32	Crested Serpent Eagle	*Spilornis cheela*	VII	b,c	15-19	2	Flying	
33	Crested Goshawk	*Accipiter trivirgatus*	VII	c	45	1	Flying	
34	Eurasian Sparrowhawk	*Accipiter nisus*	VII	c	7	1	Flying	
35	Common Buzzard	*Buteo buteo*	VII	a,c	11-70	2	Flying	
36	Black Eagle	*Ictinaetus malayensis*	VII	a,b,c,d	15-50	5	Flying	
37	Mountain Hawk Eagle	*Spizaetus nipalensis*	VII	b	72	1	Flying	
	FALCONIDAE: Falcons							
38	Collared Falconet	*Microhierax caerulescens*	VII	c	7	1	Top Canopy	
	PHALACROCORACIDAE: Cormorants							

39	Great Cormorant	*Phalacrocorax carbo*	VII	a,b,d	3-13	18	Flying, on the stone
	ARDEIDAE: Egrets, herons & bitterns						
40	Little Heron	*Butorides striatus*	VII	a,b	3-5	5	On the Stone, Ground
	EURYLAIMINAE: Typical broadbills						
41	Long-tailed Broadbill	*Psarisomus dalhousiae*	VII	c	23	1	Middle Canopy
42	Silver-breasted Broadbill	*Serilophus lunatus*	VII	b	4	4	Lower Canopy
	IRENIDAE: Fairy bulebirds & leafbirds						
43	Asian Fairy Bluebird	*Irena puella*	VII	b	3	2	Middle Canopy
44	Golden-fronted Leafbird	*Chloropsis aurifrons*	VII	c,d	3-5	5	Lower Canopy
45	Orange-bellied Leafbird	*Chloropsis hardwickii*	VII	b,d	5-25	3	Middle Canopy
	LANIIDAE: Shrikes		VII				
46	Long-tailed Shrike	*Lanius schach*	VII	a,b	2-3	4	Bamboo, Bush
47	Grey-backed Shrike	*Lanius tephronotus*	VII	a,b	2-3	4	Bamboo, Bush
	CORVINAE: Corvini: Jays, magpies, treepies, nutcrackers, crows & allies						
48	Common Green Magpie	*Cissa chinensis*	VII	a,c,d	4-5	3	Middle Canopy, Bush, Bamboo
49	Grey Treepie	*Dendrocitta formosae*	VII	a,b,c,d	3-24	10	Top Canopy, Bamboo
50	Collared Treepie	*Dendrocitta frontalis*	VII	b,c	2-7	5	Top & Middle Canopy
51	Large-billed Crow	*Corvus macrorhynchos*	VII	a	5	5	Flying
	Oriolini: Orioles, cuckooshrikes, trillers, minivets & flycatcher-shrikes						
52	Slender- billed Oriole	*Oriolus tenuirostris*	VII	d	7	1	Middle Canopy
53	Maroon Oriole	*Oriolus traillii*	VII	b,c	2-15	6	Top & Middle Canopy
54	Large Cuckooshrike	*Coracina macei*	VII	b	6	2	Flying
55	Grey-chinned Minivet	*Pericrocotus solaris*	VII	b	7	4	Middle Canopy
56	Long-tailed Minivet	*Pericrocotus ethologus*	VII	a,b,c,d	4-20	33	Top & Middle Canopy
57	Bar-winged Flycatcher-Shrike	*Hemipus picatus*	VII	a,d	3-20	21	Bamboo, Top and Lower Canopy
	DICRURINAE: Rhipidurini: Fantails						
58	Yellow-bellied Fantail	*Rhipidura hypoxantha*	VII	a,b	2-3	8	Bush, Lower Canopy
59	White-throated Fantail	*Rhipidura albicollis*	VII	a,b.c,d	2-6	9	Middle & Lower Canopy, Bush
	Dicrurini: Drongos						
60	Ashy Drongo	*Dicrurus leucophaeus*	VII	c	5	2	Lower Canopy
61	Bronzed Drongo	*Dicrurus aeneus*	VII	a,b,c,d	2-50	41	Bamboo, Top & Lower Canopy, Flying
62	Lesser Racket-tailed Drongo	*Dicrurus remifer*	VII	a,c	4-7	3	Lower Canopy, Flying
	MALACONOTINAE: Vangini: Philentomas, woodshrikes & allies						
63	Large Woodshrike	*Tephrodornis gularis*	VII	b	8	1	Middle Canopy
	CINCLIDAE: Dippers		VII				
64	White-throated Dipper	*Cinclus cinclus*	VII	d	7	2	On the stone
65	Brown Dipper	*Cinclus pallasii*	VII	c,d	4-7	9	On the stone
	MUSCICAPIDAE: TURDINAE: Thrushes & shortwings						
66	Blue Rock Thrush	*Monticola solitarius*	VII	a,b,c	4-6	4	On the stone, Ground
67	Blue Whistling Thrush	*Myophonus caeruleus*	VII	a,b,c,d	3-15	11	Ground, On the stone, Bush
68	Eurasian Blackbird	*Turdus merula*	VII	a,b	4-10	4	Middle Canopy
	MUSCICAPINAE: Muscicapini: Old World flycatchers						
69	White-gorgeted Flycatcher	*Ficedula monileger*	VII	c	3	2	Bush
70	Little Pied Flycatcher	*Ficedula westermanni*	VII	b,c	4	4	Lower Canopy
71	Verditer Flycatcher	*Eumyias thalassina*	VII	c	2	3	Bamboo
72	Large Niltava	*Niltava grandis*	VII	c,d	3-11	22	Bamboo,Bush, Middle & Lower Canopy
73	Blue-throated Flycatcher	*Cyornis rubeculoides*	VII	d	2-5	2	Bush, Lower Canopy

74	Tickell's Blue Flycatcher	*Cyornis tickelliae*	VII	b	2	1	Bush	
75	Grey-headed Canary Flycatcher	*Culicicapa ceylonensis*	VII	a,b,c,d	2-12	24	Middle & Lower Canopy, Bush, Bamboo	
	Saxicolini: Chats & allies							
76	Hodgson's Redstart	*Phoenicurus hodgsoni*	VII	a,b	3	2	Bush, Ground	
77	White-capped Water Redstart	*Chaimarrornis leucocephalus*	VII	a,b,c,d	3-60	10	On the stone, Ground	
78	Plumbeous Water Redstart	*Rhyacornis fuliginosus*	VII	a,b,c,d	3-20	21	On the Stone, Bush, Ground	
79	Little Forktail	*Enicurus scouleri*	VII	a,b	3-7	2	On the stone	
80	Black-backed Forktail	*Enicurus immaculatus*	VII	a,b,c,d	3-6	7	On the stone, Ground	
81	Slaty-backed Forktail	*Enicurus schistaceus*	VII	a,b	3-5	3	On the stone, Ground	
82	White-crowned Forktail	*Enicurus leschenaulti*	VII	a,c	3-15	2	On the stone, Ground	
83	Siberian Stonechat	*Saxicola maura*	VII	d	2-5	3	Bush, Bamboo	
	STURNIDAE: Sturnini: Starlings & mynas							
84	Chestnut-tailed Starling	*Sturnus malabaricus*	VII	a	6	1	Lower Canopy	
	SITTIDAE: SITTINAE: Nuthatches							
85	Beautiful Nuthatch	*Sitta formosa*	VII	a,c	4-6	17	Middle & Lower Canopy	VU
	PARINAE: Typical tits							
86	Green-backed Tit	*Parus monticolus*	VII	a,d	3-6	6	Bush, Middle Canopy	
87	Yellow-cheeked Tit	*Parus spilonotus*	VII	a,b,c,d	2-15	81	Top, Middle & Lower Canopy, Bush, Bamboo	
88	Sultan Tit	*Melanochlora sultanea*	VII	a,c	5-7	7	Lower Canopy	
	PYCNONOTIDAE: Bulbuls							
89	Red-whiskered Bulbul	*Pycnonotus jocosus*	VII	a	3-5	17	Bamboo, Top Canopy	
90	Striated Bulbul	*Pycnonotus striatus*	VII	a,b	6-10	16	Top & Lower Canopy	
91	White-throated bulbul	*Alophoixus flaveolus*	VII	a,c	4-15	12	Middle Canopy, Bamboo	
92	Olive Bulbul	*Iole virescens*	VII	c,d	4-16	39	Top, Middle & Lower Canopy	
93	Ashy Bulbul	*Hemixos flavala*	VII	a,b,c	4-7	45	Bamboo, Middle Canopy	
94	Black Bulbul	*Hypsipetes leucocephalus*	VII	a,c	3-5	23	Middle Canopy, Bamboo	
	CISTICOLIDAE: African warblers (cisticolas, prinias & allies)							
95	Striated Prinia	*Prinia criniger*	VII	d	2	1	Bush	
96	Hill Prinia	*Prinia superciliaris*	VII	a,b,d	2-6	18	Bush, Bamboo	
	SYLVIIDAE: ACROCEPHALINAE: Tesias, warblers, tailorbirds & allies							
97	Slaty-bellied Tesia	*Tesia olivea*	VII	b,c	2-4	2	Bush	
98	Grey-bellied Tesia	*Tesia cyaniventer*	VII	a,b,c,d	1-5	16	Bush, on the Stone	
99	Brownish-flanked Bush Warbler	*Cettia fortipes*	VII	d	2-3	11	Bush	
100	Mountain Tailorbird	*Orthotomus cuculatus*	VII	a,b,c,d	2-5	38	Bush, Bamboo, Middle & Lower Canopy	
101	Common Tailorbird	*Orthotomus sutorius*	VII	b	2	2	Bush	
102	Dusky Warbler	*Phylloscopus fuscatus*	VII	a	2	1	Bush	
103	Blyth's Leaf Warbler	*Phylloscopus reguloides*	VII	d	3	3	Bush	
104	White-tailed Leaf Warbler	*Phylloscopus davisoni*	VII	a,b,c,d	2	12	Lower Canopy, Bush	
105	Yellow-vented Warbler	*Phylloscopus cantator*	VII	d	2-4	15	Bush	
106	Mountain Leaf Warbler	*Phylloscopus trivirgatus*	VII	b	3	2	Bush	
107	White-spectacled Warbler	*Seicercus affinis*	VII	c	4	1	Lower Canopy	
108	Grey-cheeked Warbler	*Seicercus poliogenys*	VII	a,b,c,d	1-5	68	Bush, Bamboo, Middle & Lower Canopy	
109	Chestnut-crowned Warbler	*Seicercus castaniceps*	VII	c,d	3	6	Lower Canopy, Bush	
110	Rufous-faced Warbler	*Abroscopus albogularis*	VII	b,c,d	2-6	108	Bamboo, Bush, Middle & Lower Canopy	
111	Yellow-bellied Warbler	*Abroscopus superciliaris*	VII	b,c,d	2-5	64	Middle & Lower Canopy, Bush, Bamboo	
	GARRULACINAE: Laughingthrushes							

112	White-crested Laughingthrush	*Garrulax leucolophus*	VII	d	3-8	87	Ground, Bush	
113	Greater Necklaced Laughingthrush	*Garrulax pectoralis*	VII	b	5	6	Bush	
114	Striated Laughingthrush	*Garrulax striatus*	VII	a,b,c,d	3-7	83	Ground, Bush, Lower & Middle Canopy	
115	Rufous-necked Laughingthrush	*Garrulax ruficollis*	VII	c,d	4-7	28	Bamboo, Bush, Lower Canopy	
116	Chestnut-backed Laughingthrush	*Garrulax nuchalis*	VII	d	7	6	Bush	NT
117	Scaly Laughingthrush	*Garrulux subunicolor*	VII	a	5	6	Bush	
118	Chestnut-crowned Laughingthrush	*Garrulax erythrocephalus*	VII	d	3	6	Bush	
119	Red-tailed Laughingthrush	*Garrulux milnei*	VII	b,d	6-7	12	Bush	
	SYLVINAE: Timaliini: Babblers							
120	Spot-throated Babbler	*Pellorneum albiventre*	VII	d	3-5	7	Bush	
121	White-browed Scimitar Babbler	*Pomatorhinus schisticeps*	VII	b,c	3-10	31	Bush, Middle Canopy	
122	Coral-billed Scimitar Babbler	*Pomatorhinus ferruginosus*	VII	a,c	3-5	19	Banana Tree, Bush	
123	Long- billed Wren Babbler	*Rimator malacoptilus*	VII	b	2	2	Bush	
124	Pygmy Wren Babbler	*Pnoepyga pusilla*	VII	c	2	1	Bush	
125	Rufous-fronted Babbler	*Stachyris rufifrons*	VII	a,c	3-5	10	Bush, Bamboo	
126	Golden Babbler	*Stachyris chrysaea*	VII	a,b,c,d	2-8	117	Bush, Bamboo, Middle & Lower Canopy	
127	Grey-throated Babbler	*Stachyris nigriceps*	VII	b,c,d	2-12	57	Bush, Bamboo, Middle & Lower Canopy	
128	Silver-eared Mesia	*Leiothrix argentauris*	VII	b,c,d	3-7	138	Bamboo, Bush, Middle & Lower Canopy	
129	Red-billed Leiothrix	*Leiothrix lutea*	VII	c	3	2	Lower Canopy	
130	Cutia	*Cutia nipalensis*	VII	a	4	4	Middle Canopy	
131	White-browed Shrike Babbler	*Pteruthius flaviscapis*	VII	a	4	2	Middle Canopy	
132	Black-eared Shrike Babbler	*Pteruthius melanotis*	VII	d	2	2	Middle Canopy	
133	Chestnut-fronted Shirke Babbler	*Pteruthius aenobarbus*	VII	a	4	3	Bush	
134	Rusty-fronted Barwing	*Actinodura egertoni*	VII	b,c,d	3-7	35	Bamboo, Middle & Lower Canopy	
135	Blue-winged Minla	*Minla cyanouroptera*	VII	a	3	4	Bush	
136	Red-tailed Minla	*Minla ignotincta*	VII	a,c	3	10	Bush, Bamboo	
137	Yellow-throated Fulvetta	*Alcippe cinerea*	VII	b,c	2-5	18	Lower Canopy, Bamboo, Bush	
138	Rufous-winged Fulvetta	*Alcippe castaneceps*	VII	b,c	2-6	15	Lower Canopy, Bush	
139	Rufous-throated Fulvetta	*Alcippe rufogularis*	VII	c	4	3	Bush	
140	Grey-cheeked Fulvetta	*Alcippe morrisonia*	VII	a,b,c	2-4	100	Bush, Bamboo, Lower Canopy	
141	Nepal Fulvetta	*Alcippe nipalensis*	VII	a,b,c,d	2-6	129	Bush, Bamboo, Lower Canopy	
142	Rufous-backed Sibia	*Heterophasia annectens*	VII	a	4	15	Middle Canopy	
143	Beautiful Sibia	*Heterophasia pulchella*	VII	a,b	5-10	3	Top & Lower Canopy	
144	Striated Yuhina	*Yuhina castaniceps*	VII	a,c,d	2- 10	119	Bush, Bamboo, Top, Middle & Lower Canopy	
145	White-naped Yuhina	*Yuhina bakeri*	VII	a,b,c,d	2-20	171	Bush, Bamboo, Middle & Lower Canopy	
146	Whiskered Yuhina	*Yuhina flavicollis*	VII	d	3	9	Lower Canopy	
147	Grey-headed Parrotbill	*Paradoxornis gularis*	VII	b	7	4	Lower Canopy	
148	Lesser Rufous-headed Parrotbill	*Paradoxornis atrosuperciliaris*	VII	a	2-5	19	Banana Tree, Bamboo	
149	Greater Rufous-headed Parrotbill	*Paradoxornis ruficeps*	VII	c	6	5	Lower Canopy	
	NECTARINIIDAE: NECTARINIINAE: Dicaeini: Flowerpeckers							
150	Yellow-vented Flowerpecker	*Dicaeum chrysorrheum*	VII	b,c	3	6	Middle & Lower Canopy	
151	Fire-breasted Flowerpecker	*Dicaeum ignipectus*	VII	a,b,c,d	2-7	20	Bamboo, Top, Middle & Lower Canopy	
	Nectariniini: Sunbirds & spiderhunters							
152	Green-tailed Sunbird	*Aethopyga nipalensis*	VII	a	6	1	Lower Canopy	
153	Black-throated Sunbird	*Aethopyga saturata*	VII	a,b,c,d	1-8	67	Bush, Bamboo, Middle &	

							Lower Canopy
154	Little Spiderhunter	*A. longirostra*	VII	c	6	1	Lower Canopy
155	Streaked Spiderhunter	*Arachnothera magna*	VII	a,b,c,d	2-19	20	Banana Tree, Top, Middle & Lower Canopy, Flying
	MOTACILLINAE: Wagtails & pipits						
156	White Wagtail	*Motacilla alba*	VII	a,d	3-7	9	On the Stone, Ground
157	Olive-backed Pipit	*Anthus hodgsoni*	VII	a,d	3-4	9	Ground, Bamboo
	ESTRILDINAE: Estrildini: Munias		VII				
158	White-rumped Munia	*Lonchura striata*	VII	a	2	8	Bush
	Carduelini: Finches, siskins, crossbills, grosbeaks & allies						
159	Gold- naped Finch	*Pyrrhoplectes epauletta*	VII	d	3	3	Lower Canopy
160	Scarlet Finch	*Haematospiza sipahi*	VII	c	4-8	16	Bamboo
161	Spot-winged Grosbeak	*Mycerobas melanozanthos*	VII	c	10	2	Top Canopy
	EMBERIZINAE: Emberizini: Buntings & allies						
162	Little Bunting	*Emberiza pusilla*	VII	d	2	4	Bush

VII= Yenam area

Terrestrial Ecology (Fauna)

Introduction

The structure of the world's ecosystems changed more rapidly in the second half of the twentieth century than at any time in recorded human history, and virtually all of Earth's ecosystems have now been significantly transformed through human actions. The most significant change in the structure of ecosystems has been the transformation of Earth's terrestrial surface.

Between 1960 and 2000, reservoir storage capacity quadrupled; as a result, the amount of water stored behind large dams is estimated to be three to six times the amount held by natural river channels. Forest systems are lands dominated by trees; they are often used for timber, fuelwood, and non-wood forest products. Forests include temporarily cut-over forests and plantations but exclude orchards and agroforests where the main products are food crops. The global area of forest systems has been reduced by one half over the past three centuries.

The ecosystems and biomes that have been most significantly altered globally by human activity include marine and freshwater ecosystems, temperate broadleaf forests, temperate grassland, Mediterranean forests, and tropical dry forests. Freshwater ecosystems have been modified through the creation of dams and through the withdrawal of water for human use. The construction of dams and other structures along rivers has moderately or strongly affected flows in 60% of the large river systems in the world. As water flows have declined, so have sediment flows, which are the source of nutrients important for the maintenance of estuaries. Worldwide, although human activities have increased sediment flows in rivers by about 20%, reservoirs and water diversions prevent about 30% of sediments from reaching the oceans, resulting in a net reduction of sediment delivery to estuaries of roughly 10%.

Ecosystem processes, including water, nitrogen, carbon, and phosphorus cycling, changed more rapidly in the second half of the twentieth century than at any time in recorded human history. Human modifications of ecosystems have changed not only the structure of the systems (such as what habitats or species are present in a particular location), but their processes and functioning as well. The capacity of ecosystems to provide services derives directly from the operation of natural biogeochemical cycles that in some cases have been significantly modified. In the water cycle, large reservoir construction has doubled or tripled the residence time of river water—the average time, that is, that a drop of water takes to reach the sea.

The proposed project is to construct seven dams at the upstream of Ayeyearwady river basin above Myitkyina. The two river sources, May Hkaa and Mali Hka, will be used in dam construction to generate hydroelectricity. The total catahment area of the project is about 49400 km^2 (43600 km^2 within Myanmar and 5800 km^2 within China).

The May Hka River, is the main source of Ayeyawady River, which originates at the southwest foot of Boshula Mountains within Chayu County of Tibet in China and flows into Myanmar via Yunnan Province. The river is called Ji Taiqu within the boundary of Tibet Autonomous Region, China. It is 90.5 km long with elevation of about 4720 m, catchment area of about 2350km^2, natural fall of 2570 m and average gradient of 28.4‰. The river is called Du Longjiang within the boundary of Yunan Province, China. It is 86 km long with catchment area of about 3414 km^2, natural fall of 1180 m and average gradient of 13.7‰.The Du Longjiang flows into Myanmar boundary at Maku of Gongshan County in Yunnan Province, China, where it is called May Hka River. May Hka River is 353km long with catchment area of 19900km^2 and natural fall of 1010m. Theoretically, its average power of hydropower reserves (main stream) is 12200MW.

The Mali Hka River rises from the mountains of northern Myanmar near the boundaries of China. This river has a total length of about 375km with catchment area of about 23100 km^2 and natural fall of about 4470m.The average gradient of the river above Man Nansai is 62‰ and downstream of Man Nansai is 0.9‰. Theoretically, its average power of hydropower reserves (main stream) is 6150 MW.

The development schemes of Ayeyawady River above Myitkyina of this project are as following.

May Hka River: Yenam (1010m) to Kawanglanghpu (875m) to Pisa (665m) to Wutsok (525m) to Chibwe (400m)
Mali Hka River: Lasa (370m)
Ayeyawady River: Myitsone (230m)

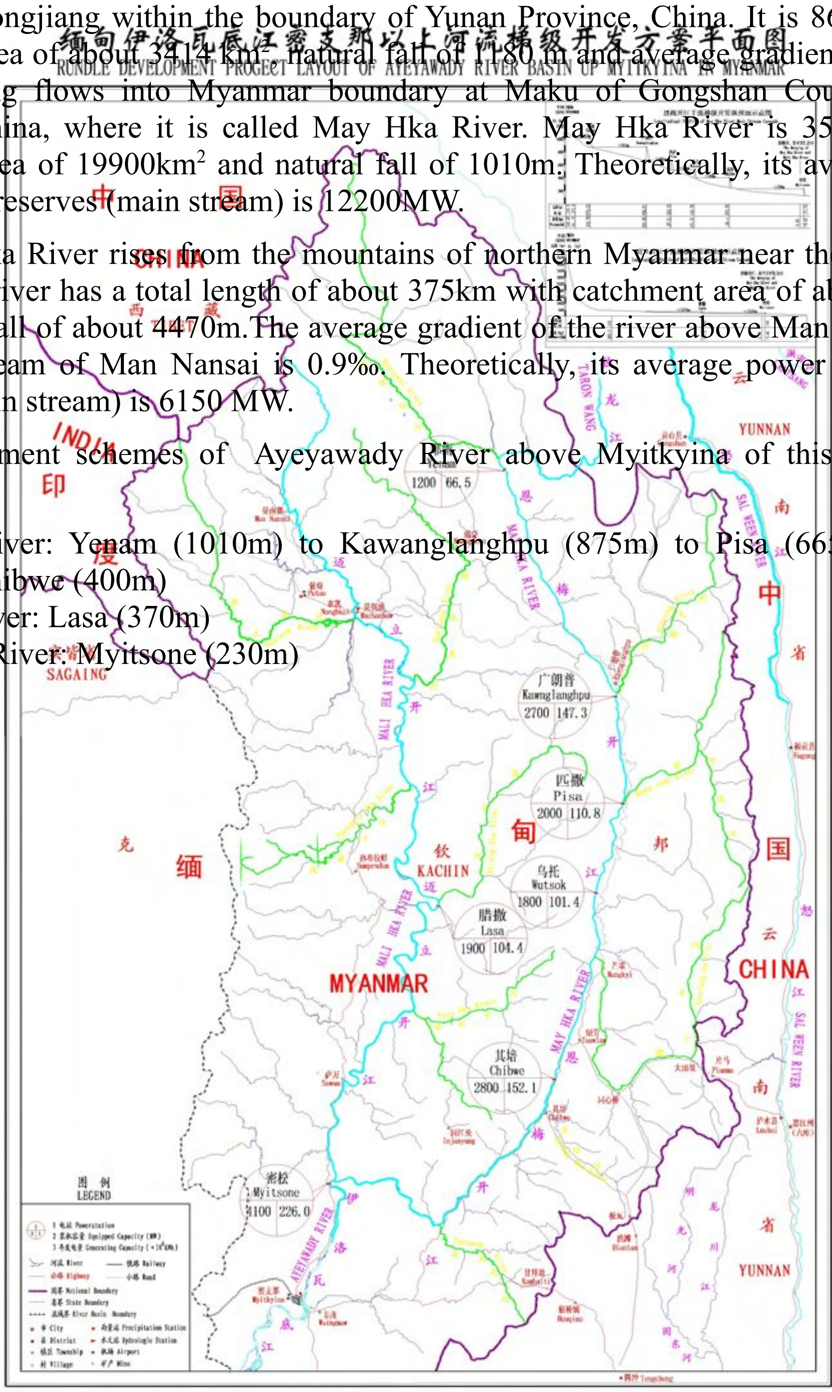


Figure 1 Rundle Development Project Layout of Ayeyawady River Basin up Myitkyina in Myanmar

The total installed capacity of cascade development of Ayeyawady River Basin above Myitkyina is 16500MW, with annual power generation of 90.85 billion kW·h.

Investigation Purpose

(2) To record the species diversities and to evaluate the habitats of the wildlife anmals.

(4) To study the ecosystem services of the project areas related to Flora and Fauna.

(5) To make recommendation and to suggest for mitigation of the impacts caused by construction of the seven Hydropower Dams.

Investigation Scope

The investigation region for the project focuses on the habitat types of the areas, diversity of the species, the possible impacts on fauna, and wildlife corridors of the proposed dams.

Investigation Items

The objectives for investigation and evaluation include ecosystems, habitats, mammals, birds, reptiles, amphibians, insects, and other sensitive objectives. The study on ecosystem is to describe main types of ecosystem in the investigation region. The study also includes factors influencing on the stability of ecosystem, such as natural and human factors. Quantitative evaluation of the species diversity status of the animals is also to be undertaken.

Methods of Animal Surveys

Mammals

For systematic survey, direct sighting and indirect investigation including track and sign survey were carried out. Small mammals like rats and squirrels were trapped using steel traps and cages. Large mammals were also recorded through trails. Bats were caught using mist nets and hand nets. Information of the mammals was also obtained from local hunters and villagers. Identification was carried out according to Lekagul and McNeely (1977); and Parr (2003).

Birds

Line transect method was used to record the bird species systematically. Birds were observed with 8-60 times telescopes and identified by combining with their songs, flying attitude, habit and feather. Living birds were caught to identify the species by trammel net. Bird surveys were made at two time phases, early morning and dusk. Migratory birds were also listed based on the references and information obtained from the local people. Identification was undertaken according to Grimmet et al. (1999); Rasmussen and Anderson (2005);Robson (2005, 2008).

Amphibian

The amphibians were usually observed during day and night period. In every belt transect, several subsections were plotted out, and set up three or five transect lines of 200 meters long along belt transect. The investigator walked at certain speed along the route, observed carefully the amphibian on both sides, and recorded the species and the number. In some places, survey routes were chosen according to habitat type. Several factors of habitat, elevation, vegetation, slope direction, slope location, soil, especially factors of water, were taken into account. Identification was carried out according to Smith(1931,1935,1943).

Reptile

The method used to investigate reptiles resembled that of amphibians. But in catching the snakes, attention was paid to avoid the bite. Possible distribution area of reptiles was selected to ascertain the line transect. In one line transect, five sample lines of 200 meters long was set. The lines covered different habitats in belt transect and investigators were responsible for observing and registering. Surveys were made twice in a day during day and night periods. Identification was carried out according to Smith(1931,1935,1943); Leviton et *al* (2002); Das (1997).

Butterflies

Butterflies were caught using insect nets or sweep-nets (50cm deep of net and 1m handle) along the transect lines. Transect lines were set up crossing different habitats. The butterflies caught were anaesthetized and stretched in paper envelopes to keep them in natural form. They were then brought to the camp and identified.The identified specimens were systematically recorded and photographed. Identification was undertaken according to Bingham (1905, 1907);Talbot (1939); Kinyon (2004);

Analysis and Assessment

The data from field survey and identification were analyzed using appropriate statistical methods by each hydropower plant. The current status of organisms in each place was reported and evaluated respectively. The environmental impact assessment of the project was made based on the recorded results and statistics.

Species diversity

In computation of the species diversity index value, the index of diversity (H') is an information statistic used as a diversity index and is probably the nearest value to a common standard. Shannon index is one of the families of intrinsic diversity indices. Equatability or eveness index value was computed using Shannon's equitability index (J') method. Shannon species richness index value and evenness (Equitability) index value were computed using the following formula.

$$H = \sum_{i=1}^{s} - (P_i * \ln P_i)$$

where:

H = the Shannon Diversity Index

P_i = fraction of the entire population made up of species i

S = numbers of species encountered

$\sum$ = sum from species 1 to species S

The ecologists usually use the term "Diversity" as a synonym for "variation", but they also sometimes use the idea of diversity in a different technical sense. Diversity index is a measure of variation and it is also inventory balance of an ecosystem or subunit of an ecosystem. The species richness is number of species present in a unit area. Evenness or equitability means the abundance of each species showing in part the distribution pattern of the species. The index of each of the measurement can be used to compare ecological units that may be of very different composition. The index values of the present study indicate the relative values of the studied 7 dam areas. In the present study, the levels of the diversity are mainly to compare among the dam areas and the highest and lowest values are just the relative values of the studied dam areas.

Findings of the surveys:

Myitsone

The proposed dam area includes the forest cover of Mizoram-Manipur-Kachin Rain Forests with highest bird species richness. Wildlife Conservation Society (WCS) and Smithsonian Institution's reptile survey in northwestern Myanmar made new records of flora and fauna. This large ecoregion also represents the semi-evergreen sub-montane rain forests. In the case of Myanmar, the predominant shifting cultivation practices signify a gradual but chronic degradation of the landscape in line with the nature of land transformation. As shifting cultivation continues to play a dominant role in forest type conversion, the typical transformation from one type of vegetation to another is apparent.

Threatened wildlife animals of the project area include 16 mammal species, 4 reptile species and 5 bird species (Tale 1,2,3). Chinese pangolin *Manis pentadactyla* is endangered species and the other 6 mammal species are listed as near-threatened species. Keeled box turtle *Pyxidea mouhotii* and Myanmar roofed turtle are recorded as endangered species of reptiles. Two bird species, Great Hornbill *Buceros bicornis* and Lesser-Fish Eagle *Ichthyophaga bumills*, were also recorded as near-threatened species. The recorded threatened species occur at the moist semi-evergreen forest. Some parts of the moist evergreen forest are observed as wildlife corridors for moving to the new appropriate habitats when it floods during construction phase.

Shannon species diversity H'index value of birds is 2.026 and Equitability J' index value is 0.832 (Table 19). The values indicate the high species variation and evenness of the bird distribution. The species richness value is 272. Species diversity index values of butterflies and herptile fauna are 2.037 and 1.241 and the Equitability index values are 0.892 and 0.727 respectively (Table 20,21). The respective species richness values are 192 and 51. The values also show the high species diversity.

In Myitsone dam project area, the products, as provisioning services, obtained from ecosystems are different kinds of food, which include the vast range of food products derived from plants and animals. Other products are fiber, fuel, natural medicines, pharmaceuticals, and ornamental resources. Fibers are obtained mainly from wood. Fuels are wood and other biological materials serve as sources of energy. Ornamental resources are animal and plant products, such as skins, shells, horns, antlers and flowers. People obtain fresh water from ecosystems and thus the supply of fresh water can be considered a provisioning service. Fresh water in the rivers is also a source of energy, because water is required for other life to exist, however, it could also be considered a supporting service. Some bird species of the proposed dam project area are observed as seed dispersers, which are also important component of ecosystem. Most butterfly species are also helping in pollination at both forests and cultivated lands. The recorded animals and diverse fauna and flora of the proposed project area are, therefore, parts of the ecosystem providing regulating services for human well-being. As cultural service, The Myitsone area provides non-material benefits of the ecosystem through recreation, and aesthetic experiences including as source of inspiration for art and advertising. The conjunction of Maikha and Malikha rivers has a natural beauty or aesthetic value of the ecosystem. The local people particularly from Myitkyina city choose the site to spend their leisure time. The place is also important for ecotourism.

As supporting services of the ecosystem, the river provide soil formation and soil fertility of the seasonal flooded areas, which influences human well-being in many ways. The vegetation cover along the river produces oxygen by photosynthesis.

Table. 1 Threatened species of mammals from Myitsone project area

Sr. no.	Common Name	Scientific Name	Habitat	IUCN Red list	CITES	Myanmar status
1	Chinese pangolin	*Manis pentadactyla*	Secondary forest, Moist evergreen forest,	EN	II	
3	Bengal slow loris	*Nycticebus bengalensis*	Secondary forest, Moist evergreen forest,	VU	I	
4	Assam macaque	*Macaca assamensis*	Secondary forest,	NT	II	
5	Stump-tailed macaque	*Macaca arctoides*	Moist evergreen forest,	VU	II	
6	Eastern hoolock gibbon	*Hoolock leuconedys*	Secondary forest, Moist evergreen forest,	VU	I	
7	Asiatic black bear	*Ursus thibetanus*	Moist evergreen forest,	VU	I	
8	Red panda	*Ailurus fulgens*	Semi-evergreen forest,	VU	I	
9	Asian golden cat	*Pardofelis temminckii*	Secondary forest, Moist evergreen forest,	NT	II	

10	Marbled cat	*Pardofelis marmorata*	Secondary forest, Semi-evergreen forest,	VU	II	
11	Sambar	*Rusa unicolor*	Secondary forest, Mixed evergreen forest,	VU		SP
12	Gaur	*Bos gaurus*	Moist evergreen forest,	VU	I	P
13	Southwest China (Chenese) serow	*Capricornis milneedwardsii*	Moist evergreen forest,	NT	I	
14	Red serow	*Capricornis rubidus*	Moist evergreen forest,	NT	I	
15	Black giant squirrel	*Ratufa bicolor*	Mixed-evergreen forest	NT	II	
16	Anderson's squirrel	*Callosciurus quinquestriatus*	Secondary forest, Mixed-evergreen forest	NT		

Table. 2 Threatened species of reptiles from Myitsone project area

No.	Common name	Scientific name	Habitat	IUCN, 2009	CITES, 2009
1	Burmese python	*Python molurus*	Moist evergreen forest,	NT	
2	Keeled box turtle	*Pyxidea mouhotii*	Semi-evergreen forest,	EN	
3	Indian black turtle	*Melanochelys trijuga*	Secondary forests	NT	
4	Myanmar roofed turtle	*Kachuga trivittata*	Semi-evergreen forest,	EN	II

Table. 3 Threatened species of birds from Myitsone project area

No.	Common name	Scientific name	Habitat	IUCN, 2009	CITES, 2009
1	Great Hornbill	*Buceros bicornis*	Moist evergreen forest,	NT	
2	Rufous-necked Hornbill	*Aceros nipalensis*	Moist evergreen forest,	V	
3	Lesser-Fish Eagle	*Ichthyophaga bumills*	Mixed ever green forest	NT	
4	Oriental Darter	*Anhinga melanogaster*	Mixed ever green forest	NT	
5	Chestnut-backed Laughingthrush	*Garrulax nuchalis*	Moist evergreen forest,	NT	

Lasa

The proposed dam area has combined forest cover of Mizoram-Manipur-Kachin Rain Forests and Northern Triangle subtropical forests. The Northern Triangle Subtropical Forests are one of the least explored and scientifically known places in the world. In 1997 a new species of small deer, the leaf muntjac, was discovered high in the mountains. This ecoregion remains as one of the few places in the Indo-Pacific region where conservation action can be effectively performed. The flora of the area is one of the most diverse regions in continental Asia, but it is also one of the least explored.

Among the recorded wildlife species during the survey in Lasa project area, 16 mammal species, 4 reptile species and 7 bird species were recorded as threatened species (Table 4,5,6). Chinese pangolin (*Manis pentadactyla*), Shortridge's langur (*Trachypithecus shortridgei*), and dhole (*Cuon alpinus*) are endangered species as listed in IUCN Red List. Keeled box turtle *Pyxidea mouhotii* and Myanmar roofed turtle *Kachuga trivittata* are recorded as endangered species of reptiles. The bird species, White-bellied Heron *Ardea insignis*, was also recorded as critically endangered species. The recorded threatened species occur at the moist semi-evergreen forest and subtropical forest at Lasa area. Some degraded forest parts were observed as wildlife corridors to move to the new appropriate habitats when it floods during construction phase. The ecoregion harbors one of the endemic species, *Muntiacus putaoensis*, which was discovered in 1997 during wildlife survey in the region. All threatened species that make up part of this ecoregion's mammal fauna are also of conservation importance.

Shannon species diversity H'index value of birds is 1.844 and Equitability J' index value was 0.804 (Table 19). The values indicate the high species variation, although this is slightly lower than that of Myitsone dam area. The species richness value is 197. Species diversity index values of butterflies and herptile fauna are 1.701 and 0.942 and the Equitability index values are 0.866 and 0.644 respectively (Table 20,21). The respective species richness values are 92 and 29, which are also lower than those of Myitsone dam area.

The threats of the ecosystem and biodiversity are continual extraction of timber in Lasa area and the increasing demand on the black market for timber to be transported. Wild animals are hunted by the local hunters to generate family income. Livelihood of the local people is dependent of provisioning services of the ecosystem.

Table. 4 Threatened species of mammals from Lasa project area

Sr. no.	Common Name	Scientific Name	Habitat	IUCN Red list	CITES
1	Chinese pangolin	*Manis pentadactyla*	Secondary forests, Tropical moist evergreen forests	EN	II
2	Bengal slow loris	*Nycticebus bengalensis*	Tropical moist evergreen forests	VU	I
3	Assam macaque	*Macaca assamensis*	Moist evergreen forests	NT	II
4	Stump-tailed macaque	*Macaca arctoides*	Tropical moist evergreen forests	VU	II
5	Shortridge's langur	*Trachypithecus shortridgei*	Tropical moist evergreen forests	EN	I
6	Eastern hoolock gibbon	*Hoolock leuconedys*	Tropical moist evergreen forests	VU	I
7	Dhole	*Cuon alpinus*	Secondary forests, Tropical moist evergreen forests	EN	II
8	Asiatic black bear	*Ursus thibetanus*	Tropical moist evergreen forests	VU	I
9	Sun bear	*Helarctos malayanus*	Tropical moist evergreen forests	VU	II
10	Large Indian civet	*Viverra zibetha*	Secondary forests, Tropical moist evergreen forests	NT	III
11	Clouded leopard	*Neofelis nebulosa*	Tropical moist evergreen forests	VU	II
12	Sambar	*Rusa unicolor*	Tropical moist evergreen forests	VU	
13	Gaur	*Bos gaurus*	Tropical moist evergreen forests	VU	I
14	Southwest China (Chenese) serow	*Capricornis milneedwardsii*	Tropical moist evergreen forests	NT	I
15	Red serow	*Capricornis rubidus*	Tropical moist evergreen forests	NT	I
16	Black giant squirrel	*Ratufa bicolor*	Tropical moist evergreen forests	NT	II

Table. 5 Threatened species of reptiles from Lasa project area

No.	Common name	Scientific name	Habitat	IUCN, 2009	CITES, 2009
1	Burmese python	*Python molurus*	Tropical moist evergreen forests	NT	
2	Keeled box turtle	*Pyxidea mouhotii*	Tropical moist evergreen forests	EN	
3	Indian black turtle	*Melanochelys trijuga*	Secondary forests, Tropical moist evergreen forests	NT	
4	Myanmar roofed turtle	*Kachuga trivittata*	Tropical moist evergreen forests	EN	II

Table. 6 Threatened species of birds from Lasa project area

No.	Common name	Scientific name	Habitat	IUCN, 2009	CITES, 2009
1	Great Hornbill	*Buceros bicornis*	Tropical moist evergreen forests	NT	
2	Rufous-necked Hornbill	*Aceros nipalensis*	Tropical moist evergreen forests	V	
3	Blyth's Kingfisher	*Alcedo hercules*	Secondary forest, Semi-evergreen forest,	NT	
4	Pallas's Fish Eagle	*Haliaeetus leucoryphus*	Secondary forest, Semi-evergreen forest,	V	
5	Grey-headed Fish Eagle	*Ichthyophaga ichthyaetus*	Semi-evergreen forest,	NT	
6	White-bellied Heron	*Ardea insignis*	Secondary forest, Semi-evergreen forest,	CR	
7	Chestnut-backed Laughingthrush	*Garrulax nuchalis*	Secondary forest, Semi-evergreen forest,	NT	

Chibwe

The proposed dam area is a part of a large ecoregion of Mizoram-Manipur-Kachin Rain Forests, which also represents the semi-evergreen submontane rain forests. These semi-evergreen forests are characterized by several species of Dipterocarpaceae that include *Dipterocarpus alatus, D. turbinatus,* and *D. griffithii,* and *Parashorea stellata, Hopea odorata, Shorea burmanica, Swintonia floribunda, Anisoptera scaphula, Eugenia grandis, Xylia xylocarpa, Gmelina arborea, Bombax insignis, B. ceiba, Albizia procera,* and *Castanopsis* spp. The dense understory includes some evergreen trees and a dense growth of bamboo, such as *Cephalostachyum pergracile* (*tin-wa*), *Gigantochloa nigrociliata,* and *Dendrocalamus hamiltonii.*

Threatened wildlife species recorded during the survey in Chiwe project area were 15 mammal species, one reptile species and 7 bird species (Table 7, 8, 9). Of the mammal species, Chinese pangolin *Manis pentadactyla* was found as endangered species and other 6 species as near-threatened species. Occurrence of threatened bird species like great hornbill *Buceros bicornis*, and rufous-necked hornbill *Aceros nipalensis*, indicated the healthy condition of the forest and their habitat. The hornbills are good indicators of intact forests because of their need for mature trees and low thresholds for disturbances. The habitats of the recorded threatened species are observed as moist semi-evergreen forest and subtropical forest.

The lower forests of the area harbor the stump-tailed macaque (*Macaca arctoides*) and the pig-tailed macaque (*Macaca nemestrina*). There are also several threatened species, including the red panda (*Ailurus fulgens*), clouded leopard (*Pardofelis nebulosa*), gaur (*Bos gaurus*), goral (*Nemorhaedus goral*), great Indian civet (*Viverra zibetha*), Assamese macaque (*Macaca assamensis*), and hoolock gibbon (*Hylobates hoolock*).

Shannon species diversity H'index value of birds is 2.142 and Equitability J' index value was 0.893 (Table 19). The values indicate the high species variation and evenness of the bird distribution. The species richness value is 251. Species diversity index values of butterflies and herptile fauna are 1.75 and 1.41 and the Equitability index values are 0.769 and 0.906 respectively (Table 20,21). The respective species richness values are 189 and 36. The values also show the high species diversity in the both faunae.

The products of ecosystem include different kinds of food like plants and animals. Fiber, fuel, natural medicines, and ornamental resources are also extracted by the local people. Diverse fauna and flora are observed as main components of ecological processes in the proposed dam project area.

Table. 7 Threatened species of mammals from Chibwe project area

Sr. no.	Common Name	Scientific Name	Habitat	IUCN Red list	CITES	Myanmar status
1	Chinese pangolin	*Manis pentadactyla*	Secondary forests, Semi-evergreen forests	EN	II	
2	Bengal slow loris	*Nycticebus bengalensis*	Semi-evergreen forests	VU	I	
3	Assam macaque	*Macaca assamensis*	Semi-evergreen forests	NT	II	
4	Stump-tailed macaque	*Macaca arctoides*	Semi-evergreen forests	VU	II	
5	Eastern hoolock gibbon	*Hoolock leuconedys*	Semi-evergreen forests	VU	I	
6	Asiatic black bear	*Ursus thibetanus*	Semi-evergreen forests	VU	I	
7	Red panda	*Ailurus fulgens*	Semi-evergreen forests	VU	I	
8	Asian golden cat	*Pardofelis temminckii*	Semi-evergreen forests	NT	II	
9	Marbled cat	*Pardofelis marmorata*	Semi-evergreen forests	VU	II	
10	Sambar	*Rusa unicolor*	Secondary forests, Semi-evergreen forests	VU		SP
11	Gaur	*Bos gaurus*	Semi-evergreen forests	VU	I	P
12	Southwest China (Chenese) serow	*Capricornis milneedwardsii*	Semi-evergreen forests	NT	I	
13	Red serow	*Capricornis rubidus*	Semi-evergreen forests	NT	I	
14	Black giant squirrel	*Ratufa bicolor*	Semi-evergreen forests	NT	II	
15	Anderson's squirrel	*Callosciurus quinquestriatus*	Semi-evergreen forests	NT		

Table. 8 Threatened species of reptiles from Chibwe project area

No.	Common name	Scientific name	Habitat	IU	CI

				CN, 2009	TES, 2009
1	Monocellate cobra	*Naja kaouthia*	Secondary forests, Semi-evergreen forests		II

Table. 9 Threatened species of birds from Chibwe project area

No.	Common name	Scientific name	Habitat	IUCN, 2009	CITES, 2009
1	Great Hornbill	*Buceros bicornis*	Semi-evergreen forest,	NT	
2	Rufous-necked Hornbill	*Aceros nipalensis*	Semi-evergreen forest,	V	
3	Blyth's Kingfisher	*Alcedo hercules*	Secondary forest	NT	
4	Rusty-bellied Shortwing	*Brachypteryx hyperythra*	Semi-evergreen forest,	NT	
5	Beautiful Nuthatch	*Sitta formosa*	Semi-evergreen forest,	VU	
6	Chestnut-backed Laughingthrush	*Garrulax nuchalis*	Semi-evergreen forest,	NT	
7	Lesser Shortwing	*Brachypteryx leucophrys*	Semi-evergreen forest,	NT	

Wusot

The area also lies in Mizoram-Manipur-Kachin Rain Forests. Many intact habitats are incorporated to create a more comprehensive and representative protected area network. The forests were logged heavily for their timber. Currently, the primary causes of deforestation are shifting cultivation, although illegal logging still occurs. Cutting trees for fuelwood and fodder is also an existing threat. Demand for wildlife and wildlife products from China market is a serious threat to these areas' biodiversity.

Threatened wildlife animals of the project area recorded during the survey were 10 mammal species, and 5 bird species (Table 10, 11). The recorded herptile species showed that there was no threatened species in the project area. The shortridge's langur *Trachypithecus shortridgei* was a single endangered mammal species in the Wusot project area. Two bird species, Great Hornbill *Buceros bicornis* and rufous-necked hornbill *Aceros nipalensis*, were also recorded as threatened species. The recorded threatened species occur at the moist evergreen forest. Some parts of the moist semi-evergreen forest were observed as wildlife corridors to move to the new appropriate habitats when it floods during construction phase.

Shannon species diversity H'index value of birds is 1.843 and Equitability J' index value was 0.891 (Table 19). The values indicate the high species variation and evenness of the bird distribution. The species richness value is 117. Species diversity index values of butterflies and herptile fauna are 1.797 and 1.2 and the Equitability index values are 0.895 and 0.923 respectively (Table 20,21). The respective species richness values are 102 and 20. The values show the relatively low species diversity in the both faunae.

Different kinds of food like plants and animals are included in the products of the ecosystem. Fiber, fuel, natural medicines, and ornamental resources are also extracted by the local people. Diverse fauna and flora are observed as main components of ecological processes in the proposed dam project area.

Table. 10 Threatened species of mammals from Wusot project area

Sr. no.	Common Name	Scientific Name	Habitat	IUCN Red list	CITES
1	Assam macaque	*Macaca assamensis*	Moist evergreen forests	NT	II
2	Stump-tailed macaque	*Macaca arctoides*	Moist evergreen forests	VU	II
3	Shortridge's langur	*Trachypithecus shortridgei*	Moist evergreen forests	EN	I
4	Eastern hoolock gibbon	*Hoolock leuconedys*	Moist evergreen forests	VU	I
5	Asiatic black bear	*Ursus thibetanus*	Moist evergreen forests	VU	I
6	Sun bear	*Helarctos malayanus*	Moist evergreen forests	VU	II
7	Marbled cat	*Pardofelis marmorata*	Moist evergreen forests	VU	II
8	Takin	*Budorcas taxicolor*	Moist evergreen forests	VU	II
9	Southwest China (Chenese) serow	*Capricornis milneedwardsii*	Moist evergreen forests	NT	I
10	Red serow	*Capricornis rubidus*	Moist evergreen forests	NT	I

Table. 11 Threatened species of birds from Wusot project area

No.	Common name	Scientific name	Habitat	IUCN, 2009	CITES, 2009
1	Great Hornbill	*Buceros bicornis*	Moist evergreen forests,	NT	
2	Rufous-necked Hornbill	*Aceros nipalensis*	Moist evergreen forest,	VU	
3	Wood Snipe	*Gallinago nemoricola*	Moist evergreen forest,	VU	
4	Beautiful Nuthatch	*Sitta formosa*	Moist evergreen forest,	VU	
5	Chevron-breasted Babbler	*Sphenocichla roberti*	Moist evergreen forest,	NT	

Pisa

The proposed dam area is situated in Mizoram-Manipur-Kachin Rain Forests. This ecoregion consists primarily of the large area of subtropical broadleaf forest but includes small, subregional-scale patches of temperate broadleaf forests and sub-alpine conifer forests. The subtropical forests are distributed roughly between 500 and 1,600 m.

Of the recorded wildlife animals of the project area, 7 mammal species, one reptile species, and one bird species were noted as threatened species (Table 12,13,14). Fishing cat *Prionailurus viverrinus* was found as a single endangered mammal species in the project area. The recorded threatened species occur at the moist evergreen forest. Some parts of the moist evergreen forest were observed as wildlife corridors to move to the new appropriate habitats when it floods during construction phase.

Shannon species diversity H'index value of birds is 1.766 and Equitability J' index value was 0.889 (Table 19). The values indicate the high species variation and evenness of the bird distribution. The species richness value is 97. Species diversity index values of butterflies and herptile faunae are 1.352 and 1.027 and the Equitability index values are 0.844 and 0.951 respectively (Table 20,21). The respective species richness values are 40 and 12. The values also show the lowest species diversity in the both faunae when compared to other proposed dam areas.

Shifting cultivation is common in the proposed dam project area converting the original vegetation to degraded forest cover and bamboo patches. Natural resources including vegetables, medicinal plants, ornamental materials and wild animals, are extracted from the ecosystem. The local people largely depend on the ecosystem services.

Table. 12 Threatened species of mammals from Pisa project area

Sr. no.	Common Name	Scientific Name	Habitat	IUCN Red list	CITES
1	Assam macaque	*Macaca assamensis*	Moist evergreen forests,	NT	II
2	Red panda	*Ailurus fulgens*	Moist evergreen forests,	VU	I
3	Fishing cat	*Prionailurus viverrinus*	Secondary forests, Moist evergreen forests	EN	II
5	Takin	*Budorcas taxicolor*	Moist evergreen forests	VU	II
6	Southwest China (Chenese) serow	*Capricornis milneedwardsii*	Mixed evergreen forests	NT	I
7	Red serow	*Capricornis rubidus*	Moist evergreen forests	NT	I

Table. 13 Threatened species of reptiles from Pisa project area

No.	Common name	Scientific name	Habitat	IU	CI

				CN, 2009	TES, 2009
1	King cobra	*Ophiophagus hannah*	Mixed evergreen forests		II

Table. 14 Threatened species of birds from Wusot project area

No.	Common name	Scientific name	Habitat	IUCN, 2009	CITES, 2009
1	White-cheeked Partridge	*Arborophila atrogularis*	Moist evergreen forest,	NT	

Kaunglanhpu

The proposed Kaunglanhpu dam area lies within the Northern Triangle Temperate Forests ecoregion in the northern part of Myanmar. The region is scientifically unexplored, and the biological information, especially of its flora, is still based on the early, pioneering exploration. The ecoregion is still largely covered with intact forests and supports the ecological processes and the biodiversity. The Chindwin, Mali Hka, and Mai Hka rivers originate in the region and flow south to converge in the lower reaches to form the Irrawaddy River.

The project area harbors some threatened wildlife species, containing 8 mammal species and 6 bird species (Table 15,16). No threatened species was found among the recorded herptile species. A single mammal species, *Cuon alpinus*, was noted as endangered species in the area. The two threatened hornbill species, *Buceros bicornis and Aceros nipalensis*, indicated that the forest covers and habitats were minimally disturbed because these two species inhabit only at the mature and healthy forests. The recorded threatened species occur at the mixed temperate forests.

Shannon species diversity H'index value of birds is 1.89 and Equitability J' index value was 0.782 (Table 19). The values indicate the high species variation and evenness of the bird distribution. The species richness value is 226. Species diversity index values of butterflies and herptile faunae are 1.561 and 0.801 and the Equitability index values are 0.864 and 0.719 respectively (Table 20,21). The respective species richness values are 64 and 13. The values also show the relatively low species diversity in the both faunae when compared to other proposed dam areas.

Fuel wood and other biological materials from the ecosystem serve as sources of energy. Animal and plant products, such as skins, shells, horns, antlers and flowers are also used as ornamental resources. Shifting cultivated lands are commonly observed in the area. Some bird species of the proposed dam project area are observed as seed dispersers, pollinators and pest control agents depending on their feeding habits indicating the importance of species diversity in ecosystem regulation. Most butterfly species are pollinators of the forests and cultivated lands. The recorded animals and diverse fauna and flora of the proposed project area are, therefore, parts of the ecosystem providing regulating services for human well-being.

Table. 15 Threatened species of mammals from Kaunglanhpu project area

Sr. no.	Common Name	Scientific Name	Habitat	IUCN Red list	CITES
1	Bengal slow loris	*Nycticebus bengalensis*	Mixed evergreen forests, Temperate forest	VU	I
2	Assam macaque	*Macaca assamensis*	Moist evergreen forests, Temperate forest	NT	II
3	Stump-tailed macaque	*Macaca arctoides*	Mixed temperate forests	VU	II
4	Dhole	*Cuon alpinus*	Secondary forests, Mixed temperate forests	EN	II
5	Asiatic black bear	*Ursus thibetanus*	Mixed evergreen forests, Temperate forest	VU	I
6	Takin	*Budorcas taxicolor*	Temperate forests	VU	II
7	Southwest China (Chenese) serow	*Capricornis milneedwardsii*	Mixed temperate forests	NT	I
8	Red serow	*Capricornis rubidus*	Mixed temperate forests	NT	I

Table. 16 Threatened species of birds from Kaunglanhpu project area

No.	Common name	Scientific name	Habitat	IUCN, 2009	CITES, 2009
1	Blyth's Tragopan	*Tragopan blythii*	Moist evergreen forest,	VU	
	Great Hornbill	*Buceros bicornis*	Mixed temperate forests,	NT	
2	Rufous-necked Hornbill	*Aceros nipalensis*	Moist evergreen forest,	V	
3	Beautiful Nuthatch	*Sitta formosa*	Moist evergreen forest,	VU	
4	Chestnut-backed Laughingthrush	*Garrulax nuchalis*	Moist evergreen forest,	NT	
5	Chevron-breasted Babbler	*Sphenocichla roberti*	Moist evergreen forest,	NT	
6	Snowy-throated Babbler	*Stachyris oglei*	Moist evergreen forest,	VU	

Renam

The proposed Renam dam project area is located in the ecoregion of Mesoran Manipur Kachin Moist Evergreen Forests. The forest type is montane forest with dense vegetation cover. The high peaks of the mountain ranges lie in a north-south pattern that stretches down toward the central plains of Myanmar.

A total of 35 mammal species were noted during the survey period, with the likelihood that many more remain to be recorded. The recorded threatened species of the project area include 15 mammal species and 6 bird species (Table 17, 18). The threatened mammal species in the area's assemblage that deserve conservation attention, are Chinese pangolin

Manis pentadactyla, Assam macaque *Macaca assamensis*, Stump-tailed macaque *Macaca arctoides*, Eastern hoolock gibbon *Hoolock leuconedys*, dhole *Cuon alpinus*, Asiatic black bear *Ursus thibetanus*, sun bear *Helarctos malayanus*, red panda *Ailurus fulgens*, asian golden cat *Pardofelis temminckii*, marbled cat *Pardofelis marmorata*, clouded leopard *Neofelis nebulosa*, takin *Budorcas taxicolor*. The threatened bird species include two hornbill species, *Buceros bicornis and Aceros nipalensis*, which inhabit at the mature and healthy forests.

Shannon species diversity H'index value of birds is 1.794 and Equitability J' index value was 0.811 (Table 19). The values indicate the high species variation and evenness of the bird distribution. The species richness value is 163. Species diversity index values of butterflies and herptile faunae are 1.127 and 0.736 and the Equitability index values are 0.736 and 0.935 respectively (Table 20,21). The respective species richness values are 34 and 16. The values also show the relatively low species diversity in the both faunae when compared to other proposed dam areas. The physical and biological conditions based on avifauna showed that Renam area is most similar to that of Kaunglanhpu (Fig.2).

Human populations are moving ever higher into the mountains, with increasing loss of forests through logging and slash and burn agriculture. Birds and mammals in these higher elevations depend on unfragmented habitats so that migration patterns can be maintained.

Firewood and other biological materials serve as sources of energy. Ornamental resources are animal and plant products, such as skins, shells, horns, antlers and flowers. Fresh water in the rivers is also a source of energy, and it could be considered as a supporting service. Some bird species of the proposed dam project area are observed as seed dispersers, which are also important component of ecosystem. Most butterfly species are pollinators in both forests and cultivated lands. The recorded animals and diverse fauna and flora of the proposed project area are, therefore, parts of the ecosystem providing regulating services for human well-being.

Table. 17 Threatened species of mammals from Renamproject area

Sr. no.	Common Name	Scientific Name	Habitat	IUCN Red list	CITES
1	Chinese pangolin	*Manis pentadactyla*	Secondary forests, Moist evergreen primary forest	EN	II
2	Assam macaque	*Macaca assamensis*	Moist evergreen primary forest	NT	II
3	Stump-tailed macaque	*Macaca arctoides*	Moist evergreen primary forest	VU	II
4	Eastern hoolock gibbon	*Hoolock leuconedys*	Moist evergreen primary forest	VU	I
5	Dhole	*Cuon alpinus*	Secondary forests, Mixed evergreen primary forest	EN	II
6	Asiatic black bear	*Ursus thibetanus*	Mixed evergreen primary forest	VU	I
7	Sun bear	*Helarctos malayanus*	Moist evergreen primary forest	VU	II
8	Red panda	*Ailurus fulgens*	Moist evergreen forests	VU	I

9	Asian golden cat	*Pardofelis temminckii*	Moist evergreen forests	NT	II
10	Marbled cat	*Pardofelis marmorata*	Moist evergreen forests	VU	II
11	Clouded leopard	*Neofelis nebulosa*	Moist evergreen forests	VU	II
13	Takin	*Budorcas taxicolor*	Moist evergreen forests	VU	II
14	Southwest China (Chenese) serow	*Capricornis milneedwardsii*	Mixed evergreen primary forest	NT	I
15	Red goral	*Naemorhedus baileyi*	Moist evergreen forests	VU	I

Table. 18 Threatened species of birds from Renam project area

No.	Common name	Scientific name	Habitat	IUCN, 2009	CITES, 2009
1	White-cheeked Partridge	*Arborophila atrogularis*	Moist evergreen primary forests	NT	
	Great Hornbill	*Buceros bicornis*	Moist evergreen primary forests	NT	
2	Rufous-necked Hornbill	*Aceros nipalensis*	Moist evergreen primary forests	V	
3	Blyth's Kingfisher	*Alcedo hercules*	Secondary forest, Moist evergreen forests	NT	
4	Grey-headed Fish Eagle	*Ichthyophaga ichthyaetus*	Moist evergreen forests	NT	
5	Beautiful Nuthatch	*Sitta formosa*	Moist evergreen forests	VU	
6	Chestnut-backed Laughingthrush	*Garrulax nuchalis*	Moist evergreen forests	NT	

Table 19. Species richness index values and diversities of birds at the proposed dam areas

Habitat	Species richness index (of birds)	Diversity index (Shannon H'Log Base 10)	Equitability index (Evenness J')
Myitsone	272	2.026	0.832
Lasa	197	1.844	0.804
Chibwe	251	2.142	0.893
Wusot	117	1.843	0.891
Pisa	97	1.766	0.889
Kaunglanhpu	226	1.84	0.782
Renam	163	1.794	0.811
Total	448		

Table 20. Species richness index values and diversities of butterflies at the proposed dam areas.

Habitat	Species richness index (of butterflies)	Diversity index (Shannon H'Log Base 10)	Equitability index(Evenness J')

Myitsone	192	2.037	0.892
Lasa	92	1.701	0.866
Chibwe	189	1.75	0.769
Wusot	102	1.797	0.895
Pisa	40	1.352	0.844
Kaunglanhpu	64	1.561	0.864
Renam	34	1.127	0.736
Total	345		

Table 21. Species richness index values and diversities of herptiles at the proposed dam areas

Habitat	Species richness index (of herptiles)	Diversity index (Shannon H'Log Base 10)	Equitability index(Evenness J')
Myitsone	51	1.241	0.727
Lasa	29	0.942	0.644
Chibwe	36	1.41	0.906
Wusot	20	1.2	0.923
Pisa	12	1.027	0.951
Kaunglanhpu	13	0.801	0.719
Renam	16	1.126	0.935
Total	100		

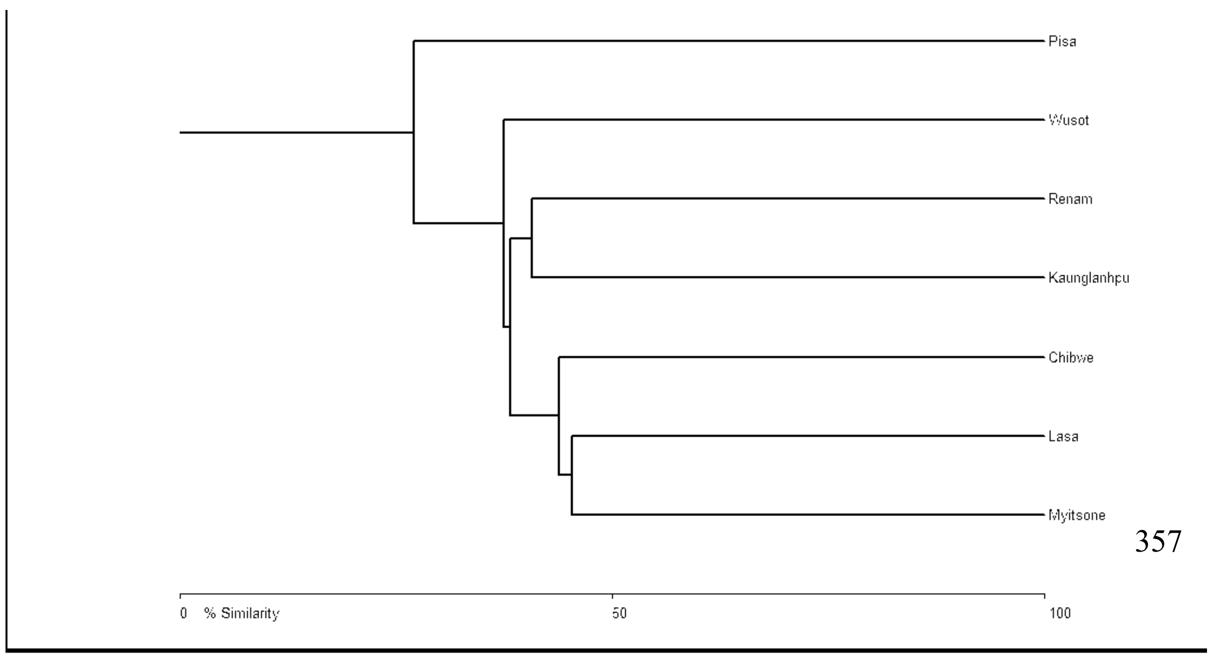


Figure 2. Similarity model based on avifauna of proposed dam areas

Discussion

The threats to biodiversity in this region stem from two main sources: land clearing for shifting cultivation, logging and hunting for food and income. Extensive illegal hunting poses the greatest danger to this ecoregion's biodiversity. In its supply of a thriving Chinese market, hunting is indiscrimate, targeting all species, from large mammals to small birds, reptiles, amphibians, and invertebrates. The proposed dam projects may be further supporting factor in reducing the species diversity and in changing of the life-support system in the region. According to the results of diversity index and equitability index values, relatively high diversity and abundance of wildlife animals occur at Myitsone and Chibwe areas, that also indicate that the management plan should be extensively undertaken in such most sensitive areas. Ecosystem services of the areas also contain various supporting factors to the local people.

The project will permanently submerge productive agricultural land as well as valuable natural habitats. The changes to the river could permanently harm fisheries. The area has substantial number of subsistence and commercial fisherman, who depend on the resource for both food and income. The large dams will degrade land and forests, wetlands and fisheries, and will certainly harm the rural poor who are dependent on forest and river water. In the proposed project areas, the local people depend mainly on the natural resources and the proposed project will probably affect on the local poor. Due to the forest clearing during the construction phase it will result in severe erosion and loss of habitat and biological diversity. Ecosystem services are the benefits people obtain from ecosystems. These include provisioning, regulating, and cultural services that directly affect people and the supporting services needed to maintain other services. Ecosystem services are a dominant influence on livelihoods of most poor people. Most of the world's poorest people live in rural areas and are thus highly dependent, directly or indirectly, on the ecosystem service of food production, including agriculture, livestock, and hunting.

A change in an ecosystem necessarily affects the plant and animal species in the system, and changes in species affect ecosystem processes. The distribution of species on earth is becoming more homogenous. By homogenous, it means that the differences between the set of species at one location on the planet and the set at another location are, on average, diminishing. The natural process of evolution, and particularly the combination of natural barriers to migration and local adaptation of species, leads to significant differences in the types of species in ecosystems in different regions. The extinction of species or the loss of populations results in the loss of the presence of species that had been unique to particular regions. The rate of invasion or introduction of species into new ranges will be high and continues to accelerate apace with growing trade and faster transportation.

Both the supply and the resilience of ecosystem services are affected by changes in biodiversity. Biodiversity is the variability among living organisms and the ecological complexes of which they are part. When a species is lost from a particular location or introduced to a new location, the various ecosystem services associated with that species are changed.

Recommendation and Mitigation

Systematic ecosystem management should be planned before construction phase of the proposed dam projects. Resettlement programme for the people, who can be affected by the proposed projects should be drawn. More generally, when a habitat is converted, an array of ecosystem services associated with the species present in that location is changed, often with direct and immediate impacts on people. Mismanagement of ecosystems threatens the livelihood of poor people and may threaten their survival. Some wild animals are also highly vulnerable to changes in ecosystem services.

Soil erosion which may be caused by land clearing during the construction phase is one of the indirect impacts of the projects. Such indirect impacts can be reduced by systematic ecosystem management plan.

Rescue programme should be prepared to save the animals which can not move to the suitable area when it floods during construction phase. Some existing protected forest and wildlife sanctuaries may be used in saving the animals from the expected flooded areas. In this case, threatened and endemic animal species should be focused to prevent them from locally extinction.

Monitoring surveys should be carried out during project operation phase, where species richness, diversity index values, and related model can be used in the environmental and wildlife management plan. Based on the results of the monitoring work, management plan be adjusted during the operation phase.

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Flora Report

Chapter I

1. Biodiversity Impact Assessment Report of Flora on Yenam Hydropower Dam

1.1. Introduction

The main objective of this report is to assess the potential impacts on plant diversity and habitat in inundated area of Yenam Hydropower Dam on Mayhka River near Pannandim township in Northern Kachin State, which will be constructed near future.

1.1.1. Location

The Yenam Hydropower Dam project area is located between 27º40´20"N, 97º 01´36"E and 27º48´18"N, 98º 98´97"E near Aliaung Village, in Panandim Township, on downstream confluence mouth of Mayhka River and Tarone Stream. Mayhka River is 353 km long with catchment area of 1990 Km^2 and natural fall 1010 m. Among five hydropower stations on Mayhka River, Yenam Hydropower Dam site is on the upstream of Mayhka River and may be the first one on Mayhka River. It will be a cascade dam. Mayhka River flows along the high mountain to south. River reaches above and around Yenam Dam site, is of medium or high mountains and gorge. The elevation of mountain peaks is 1800 to 4000 m. From the border between China and Myanmar, it flows in a direction of southeast. The river has a high drop with narrow valley sloped in V and steep bank slope. In general, the most environmentally benign hydroelectric dam sites are in upper tributaries, while the most problematic ones are on the large main stream of river. Yenam Hydropower dam may be such environmentally benign dam.

1.1.2. Topography

The Yenam Hydropower dam project area falls 27º40´ to 27º48´latitude and 97º 01´ to 98º 98´ longitude and reaches between 315.6 km from the confluence at Myitsone. The catchment area may be 5255 sq-km and the total flooded area will be 1147 hectare. The normal pool level will be 1010 m. The lowest elevation in studied area is 917 m and the highest is 1089 m. So some areas are below the normal pool level. The topography of the dam area is high land area of 900 m to 1089 m in intended flooded area. The topography of the catchment area of the dam is nearly ten thousand meter in height with snow-capped mountains of Hkakaborazi and Emawbum.

1.1.3. Climate

The climate of Yenam Hydropower Dam site is strongly seasonal and the character of Monsoon climate. There are three distinct seasons; a cool and dry season hot dry season warm and wet season are the same in accordance with the pattern of Kachin State. This pattern is rather uniform across the whole area. But the rain-fall tends to be higher and more prolonged in high mountainous area and the light showers are also frequent throughout the year. There are some occasional rains due to the northeast wind from China Sea. The average annual rain fall is 303.40 inches.

1.1.4. Forest in the context of Eco-region

The Yenam Dam site lies in WWF Eco-region of Northern Triangle Temperate forest. It is also located within the Priority Sites for conservation investment of Northern mountain forest complex. Its catchment area also comprises Hkakaborazi N.P and Hponganrazi W.S. which are the biodiversity hot-spots and globally outstanding conservation areas. The forests in this area include high land evergreen forest and oak forest. Some degraded forests due to shifting cultivation are also found.

1.1.5. Local people and their livelihood

The people dwelling this area include Kachin and Bamar. There are three large villages namely Aliaung Village, Yenam Village and Manton Village in Panandim Township. Most of the Kachin Tribes earning as farmers cultivating of Taungyar rice and vegetables. Some are earning as hunters. Most Bamar are government employee.

1.2. Aims and Objectives

1. To collect, identify and list the plant species in the area
2. To record the dominant tree species and evaluate the forest type
3. To study the impact of dam on the flora and to suggest the mitigation measure

1.3. Materials and Methods

1.3.1. Participants

The Myanmar flora team comprises 4 members, Dr Myint Aung, Daw Thin Thin Su, Daw Khin Khin Soe, U Tazar Aung and Chinese flora team.

1.3.2. Materials

Materials used for recording are strings for sample plotting, digital camera, maps compass, field press, data collection sheets, drying press, dryer, digging tools, heavy duty plastic bags, newspapers, alcohol, spray jug (for fixing specimens) 10 x lens, permanent markers and other field equipments.

1.3.3. Methods

One research team with four Myanmar scientists was organized and studies were conducted especially in the areas which may be inundated after the dam is constructed. The plant specimens were collected both in inundated areas and habitats of representative areas.

The Global Positioning System was used to navigate and mark coordinates between sample plots in each habitat. In order to obtain essential ecological data for predicting forest value and forest type, quadrants of varying size were set up and observed. Plant collection (all trees, shrubs and herbs) was carried out in random and by Transit line whenever possible to get the representative checklists of the plants in the studied area and all specimens are identified and recorded. DBH and Height classes at tree species are calculated based on the measurement of breast height diameters along with its height.

Field press and drying press were used to get voucher specimens and to store in herbarium. Habitat type’s altitude, topography, forest type, canopy cover and structure, light intensity, wind velocity and sign of disturbance were recorded. To know the habit of the plant species and to ensure the vegetation, photographic records were also carried out.

Leaves, inflorescences, floral structures and other vegetative parts of each plant specimens were collected and photographed and recorded as field notes.

1.4. Results

1.4.1. Floristic Composition in the study area

The total number of species collected in the Yenam dam site and intended flooded area is 505 species belonging to 342 genera of 110 families. (Appendix I).The forest types were determined in accordance with species composition. The dominant tree species, shrub species and herb species were also determined according to their species composition in the sample plots. (Appendix-II)

1.4.2. The human impacts in the study area

Shifting cultivation

The shifting cultivation is inevitable because of the major livelihood of the local people. The abandoned Taungyar, dominated with grasses like *Panicum* sp. and *Sorghum* sp. are found elsewhere especially near villages. The impact of shifting cultivation may lead to the loss of forest. The result is the formation of degraded forest and secondary forest.

1.5. Discussion and Conclusion

There are 113 tree species among 505 species collected in the area. *Syzygium* sp., *Lithocarpus* sp., *Castanopsis* sp., *Exbucklandia* sp., and *Eurya* sp. are 10m to 30m in height and 30cm to 150cm in girth.

The disturbance such as logging is scare due to improper infrastructure like transportation. Only shifting cultivation is seen as a threat to forests. The community development of the local people accommodated with conservation practice should be established and managed under the project so that the changes in their livelihood may protect the forest.

The natural vegetation pattern in the study area consists of mid elevation forests (800m - 100m), high land forests (<100m) and transition between low land and high land forests. Some degraded forests are also found due to human impacts.

The moisture of the forest is determined by seasonal water in-put. Light showers are frequent throughout the year in the study area. The species composition in the study is different due to topography. The valley and concave slope have rich species diversity and the ridges and convex slope have poor species diversity. The species composition is also different between slope facing north and slope facing south due to moisture content and different period of sun light receiving time.

The vegetation in high land area comprises of high land evergreen forest. *Exbucklandia* sp., *Engelhardtia* sp., *Eurya* sp., *Castanopsis* sp., *Syzygium* sp., and *Lithocarpus* sp., dominate in tree layers. Shrub layer is dominated by *Oxyspora* sp., *Symplocos* sp., *Musa* sp., and *Rhododendron* sp. The herb layer is dominated by *Selaginella* sp., *Adiantum* sp., and *Polypodium* sp.

The species composition in the mid-elevation forest shows the transition of low land high land vegetation. The tree layer is dominated by *Syzygium, Symplocos* sp., mixed with *Castanopsis* sp. The shrub layer is dominated by *Oxyspora* sp., and *Rhododendron* sp. The herb layer is dominated by *Selaginella* sp.

High land bamboo forests are also frequently found in the study area consisting of *Dendrocalamus hamiltonii,* and *Dendrocalmus giganteus*.

The shifting cultivations are frequent in the area near the villages and the abandoned area are dominated with grasses such as *Panicum* sp., and *Sorghum* sp.

To sustain the vegetation pattern, the existing national part and wildlife sanctuaries should be extended.

The Yenam Dam is the first dam on Mayhka River and it is also the uppermost dam. So the impact assessment study must continue to assess the cumulative environmental impacts of proposed additional dams on the same river. The implementation of mitigation measures for cumulative impacts should be completed or well underway prior to construction of second dam on the river.

1.6. Recommendation

1. The socioeconomic development and community development of the local community accommodating with conservation practice under the project expenditure should be planned out.
2. The existing national park and wildlife sanctuaries should be extend and new ones should be proposed.
3. The cumulative environmental impact assessment should be carried out since the additional dams are planned to construct on the downstream of same river.
4. Terrace cultivation should be encouraged and practised among local communities under projects expenditure.
5. The environmental impact assessment study concerning the construction of new access roads and power transmission lines should be carried out and mitigation measure must be proposed.
6. Terrace cultivation should be encouraged and practiced in the study area to prevent further deforestation under project expenditure.
7. The resettlement of displaced population including new housing, compensation, and creation of new jobs for the loss of livelihood of resettle population should be planned and worked out.
8. New access road from MyitKyina to Putao and MyitKyina to Chibwe should be planned and the siting of road should be in the environmentally and socially least damaging corridor.

Table – 1 Tree species in DBH class intervals in Yenam

DBH Classes	No. of species	Total number of individual	% of total species
< 30 cm	107	2484	42.13
30 – 60 cm	63	314	24.80
60 – 90 cm	28	80	11.02
90 – 120 cm	18	48	7.09
120 – 150 cm	16	24	6.30
150 – 180 cm	9	17	3.54
180 – 210 cm	4	9	1.57
210 -240 cm	3	4	1.18
240 – 270 cm	1	1	0.39
270 – 300 cm	1	2	0.39
300 – 330 cm	1	1	0.39
330 – 360 cm	1	1	0.39
360 – 390 cm	1	2	0.39
390 – 420 cm	1	2	0.39
420 – 450 cm	-	-	0.00
450 – 480 cm	-	-	0.00
480 – 510 cm	-	-	0.00
510 – 540 cm	-	-	0.00
540 – 570 cm	-	-	0.00
> 570 cm	-	-	0.00
Total	113	2989	100.00

Table – 2 Tree species in Height class intervals in Yenam

Height Classes	No. of species	Total number of individual	% of total species
< 3m	38	211	13.24
3 – 10 m	93	1747	32.40
10 – 17 m	80	642	27.87
17 – 24 m	47	287	16.38
24 – 31 m	29	102	10.10
31 – 38	-	-	0.00
> 38 m	-	-	0.00
Total	113	2989	100.00

Appendix – I Yenam Plant lists

No.	Scientific Name	Family	Habit	Common Name
1	*Acer* sp.1	Aceraceae	T	-
2	*Acer* sp.2	Aceraceae	T	-
3	*Acer* sp.3	Aceraceae	T	-
4	*Acmella calva* (CD)R. Jasen	Asteraceae	H	-
5	*Acmella* sp.	Asteraceae	H	-
6	*Acronychia* sp.	Rutaceae	ST	-
7	*Actinodaphne* sp.	Lauraceae	T	-
8	*Adiantum* sp.2	Pteridaceae	F	-
9	*Aeschynanthus* sp.	Gesneriaceae	S	-
10	*Agapetes* sp.	Ericaceae	Cl,Cr	-
11	*Agastache rugosa* (Fisch. & C.A.Mey.) Kuntze	Lamiaceae	H	-
12	*Ageratum conyzoides* L.	Asteraceae	H	-
13	Aglaia lawii (Wight) Sald.& Rama.	Meliaceae	T	-
14	*Aglaia* sp.1	Meliaceae	T	-
15	*Aglaia* sp.2	Meliaceae	T	-
16	*Ajuga nipponensis*Makino	Lamiaceae	H	-
17	*Ajuga* sp.	Lamiaceae	H	-
18	*Albizia* sp.	Mimosaceae	T	-
19	Albizia sp.	Mimosaceae	T	-
20	*Allamenda* sp.	Apocynaceae	Cl,Cr	-
21	*Allantodia similis* W.M. Chu	Dryopteridacea e	F	-
22	*Alnus trabeculosa* Hand.-Mazz.	Betulaceae	T	-
23	*Alocasia* sp.	Araceae	H	-
24	Alpinia zerumbet (Pers.) B.L. Burtt & R.M. Sm.	Zingiberaceae	H	-
25	*Alsophila*sp.	Cyatheaceae	F	-
26	*Amorphophallus* sp.	Araceae	H	-
27	*Andropogon* sp.	Poaceae	G	-
28	*Anemone cathayensis* Kitag. Ex Ziman & Kadota	Ranunculaceae	H	-

No.	Scientific Name	Family	Habit	Common Name
29	*Angiopteris* sp.	Marattiaceae	F	-
30	*Antidesma* sp.	Euphorbiaceae	T	-

31	Arachniodes sp.	Dryopteridaceae	F	-
32	*Aralia leschenaultii* (DC.) J. Wen	Araliaceae	ST	-
33	*Aralia* sp.	Araliaceae	ST	-
34	*Archidendron clyperaria* (Jack) Nielsen	Mimosaceae	T	-
35	*Ardisia* sp.1	Myrsinaceae	ST	-
36	*Ardisia* sp.2	Myrsinaceae	ST	-
37	*Arisaema propinquum* C. Nepal	Araceae	H	-
38	Artemisia sp.	Asteraceae	H	-
39	*Artemisia* sp.	Asteraceae	H	-
40	Arthromeris mairei (Brause) Ching	Polypodiaceae	F	-
41	*Arundinella* sp.	Poaceae	G	-
42	*Asplenium normale* Don	Aspleniaceae	F	-
43	Asplenium sp.1	Aspleniaceae	F	-
44	Asplenium sp.2	Aspleniaceae	F	-
45	Asplenium sp.3	Aspleniaceae	F	-
46	*Athyrium* sp.	Woodsiaceae	F	-
47	*Begonia* sp.1	Begoniaceae	H	-
48	*Begonia* sp.2	Begoniaceae	H	-
49	*Begonia* sp.3	Begoniaceae	H	-
50	*Betula* sp.1	Betulaceae	T	-
51	*Betula* sp.2	Betulaceae	T	-
52	*Bidens pilosa* L.	Asteraceae	H	-
53	*Bischofia javanica* Blume	Euphorbiaceae	T	Aukkywe
54	*Blumea* sp.	Asteraceae	H	-
55	*Boehmeria* sp.1	Urticaceae	S	-
56	*Boehmeria* sp.2	Urticaceae	S	-
57	*Boehmeria* sp.3	Urticaceae	S	-
58	*Brassica* sp.	Brassicaceae	H	-
59	*Breynia officinalis* Hemsl.	Euphorbiaceae	ST	-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
60	*Broussonetia* sp.	Moraceae	T	-
61	*Buddleja asiatica* Lour.	Buddlejaceae	S	-
62	Bulbophyllum odoratissimum (Sin.)	Orchidaceae	E	-

	Lindl			
63	*Bulbophyllum reptans* Griff.	Orchidaceae	E	-
64	Bulbophyllum sp.	Orchidaceae	E	-
65	Bulbophyllum sp.	Orchidaceae	E	-
66	*Bulbophyllum vufinum* Relb. f.	Orchidaceae	E	-
67	*Butea* sp.	Fabaceae	Cl,Cr	-
68	*Caesalpinia* sp.	Caesalpiniaceae	Cl,Cr	-
69	*Calanthe* sp.1	Orchidaceae	H	-
70	*Calanthe* sp.2	Orchidaceae	H	-
71	Callicarpa sp.	Verbenaceae	ST	-
72	*Camellia* sp.	Theaceae	S	-
73	*Canarium* sp.1	Burseraceae	T	-
74	*Canarium* sp.2	Rubiaceae	S	-
75	*Capperis* sp.	Capparaceae	Cl,Cr	-
76	*Carex filicina* Nees	Cyperaceae	G	-
77	*Carex*sp.	Cyperaceae	G	-
78	*Caryota gigas*Hahn ex hodel	Arecaceae	ST	Min-baw
79	*Castanopsis diversifolia* King	Fagaceae	T	-
80	*Castanopsis* sp.1	Fagaceae	T	-
81	*Castanopsis* sp.2	Fagaceae	T	-
82	*Castanopsis* sp.3	Fagaceae	T	-
83	*Castanopsis* sp.4	Fagaceae	T	-
84	*Castanopsis* sp.5	Fagaceae	T	-
85	*Castanopsis tribuloides* A.DC.	Fagaceae	T	-
86	*Cayratia* sp.	Vitaceae	Cl,Cr	-
87	Centalla sp.	Apiaceae	H	-
88	*Cerastium* sp.	Caryophyllaceae	H	-
89	*Chromolaena odorata* (L.) R.M. King & H. Robinson	Asteraceae	H	-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
90	*Chrysopogon aciculatus* (Retz.) Trin.	Poaceae	G	-
91	Cibotium barometz (L.) J. Sm.	Disksoniaceae	F	-
92	*Cinnamomum* sp.1	Lauraceae	T	-

93	*Cinnamomum* sp.2	Lauraceae	T	-
94	*Cinnamomum* sp.3	Lauraceae	T	-
95	*Citrus* sp.	Rutaceae	ST	-
96	*Clematis* sp.	Ranunculaceae	Cl,Cr	-
97	*Clinopodium sachalinense* Koidz.	Lamiaceae	S	-
98	*Cocculus laurifolius* DC.	Menispermaceae	S,Cl	-
99	Codonacanthus pauciflorus Nees (Herb)	Acanthaceae	S	-
100	Coelogyne *ecarinta* C. Schweinf.	Orchidaceae	E	-
101	*Coelogyne lactea* Rchb. f.	Orchidaceae	E	-
102	Coelogyne sp.	Orchidaceae	E	-
103	*Colpodium ponticum* (Balansa) Woronow	Poaceae	G	-
104	*Columnea* sp.	Gesneriaceae	Cl,Cr	-
105	Commelina sp.	Commelinaceae	H	-
106	*Corydalis bungeana* Turcz.	Papaveraceae	H	-
107	*Crassocephalum crepidioides* (Benth.) S. Moore	Asteraceae	H	-
108	Cryptochilus sp.	Orchidaceae	E	-
109	*Cyathea gigantea* (Wall. Ex Hook.) Holttum	Cyatheaceae	F	-
110	*Cyathula tomentosa* (Roth.) Moq.	Amaranthaceae	H	-
111	Cyrtococcum sp.	Poaceae	G	-
112	*Datura suaveolens*Humb. & Bonpl. ex. Willd	Solanaceae	S	-
113	*Debregeasia edulis* (Sieb. & Zucc.)Wedd.	Urticaceae	ST	-
114	Dendrobium sp.	Orchidaceae	E	-
115	*Desmodium heterophyllum* (Willd.) DC.	Fabaceae	S	-
116	*Desmodium* sp.	Fabaceae	S	-
117	*Dicentra* sp.	Papaveraceae	H	-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
118	*Dichroa febrifuga* Lour.	Hydrangeaceae	T	-
119	*Dichrocephala auriculata* (Thunb.) Druce	Asteraceae	H	-
120	*Dicliptera zelanica* Nees	Acanthaceae	H	-
121	*Dimocarpus* sp.	Sapindaceae	T	-
122	*Dioscorea* sp.	Dioscoreaceae	Cl,Cr	-

123	*Diospyros ehretioides* Wall.	Ebenaceae	T	-
124	*Diospyros* sp.	Ebenaceae	T	-
125	*Dipteris chinensis* Christ	Dipteridaceae	F	-
126	*Duchesnea indica* (Andrews) Focke	Rosaceae	S	-
127	*Edgeworthia gardneri*(Wall.) Meissn.	Thymelaeaceae	T	-
128	*Elaeocarpus lanceifolius* Roxb.	Elaeocarpaceae	T	-
129	*Elaeocarpus* sp.	Elaeocarpaceae	T	-
130	*Elatostema* sp.	Urticaceae	S	-
131	Eleusine sp**.**	Poaceae	G	-
132	*Elsholtzia* sp.	Lamiaceae	S	-
133	Embleia sp.	Primulaceae	H	-
134	Engelhardtia sp.	Juglandaceae	T	-
135	Engelhardtia spicata Blume	Juglandaceae	T	-
136	Entada phaseoloides (L.) Merr.	Mimosaceae	Cl,Cr	-
137	*Equisetum* sp.1	Equisetaceae	F	-
138	*Equisetum* sp.2	Equisetaceae	F	-
139	*Eragrostis* sp.	Poaceae	G	-
140	Eria pannea Lindl	Orchidaceae	E	-
141	*Eria tomentosa* (J. König) Hook. f.	Orchidaceae	E	-
142	*Eurya* sp.1	Theaceae	ST	-
143	*Eurya* sp.2	Theaceae	ST	-
144	*Eurya* sp.3	Theaceae	ST	-
145	*Exbucklandia populnea* (R. Br. ex Griff.) R.W. Br.	Hamamelidacea e	T	-
146	*Fagopyrum* sp.	Polygonaceae	S	-
147	*Fatsia japonica*(Thunb.) Denc. & Planch.	Araliaceae	ST	-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
148	*Ficus annulata* Blume	Moraceae	T	-
149	*Ficus auriculata* Lour.	Moraceae	T	-
150	*Ficus hirta var. roxburghii* Miq.	Moraceae	T	-
151	*Ficus semicordata* Buch.-Ham ex. J. E. Sm.	Moraceae	T	-
152	*Ficus* sp.1	Moraceae	T	-
153	*Ficus* sp.2	Moraceae	T	-

154	*Ficus* sp.3	Moraceae	T	-
155	*Ficus* sp.4	Moraceae	T	-
156	*Ficus* sp.5	Moraceae	T	-
157	*Ficus* sp.6	Moraceae	T	-
158	*Ficus* sp.7	Moraceae	T	-
159	*Ficus* sp.8	Moraceae	T	-
160	*Floscopa scandens* Lour.	Commelinaceae	H	-
161	*Frimbristylis* sp.	Cyperaceae	G	-
162	*Garcinia merguensis* Wight	Hypericaceae	ST	-
163	*Garcinia* sp.	Hypericaceae	ST	-
164	*Geum* sp.	Rosaceae	S	-
165	*Gleichenia* sp.1	Gleicheniaceae	F	-
166	*Gleichenia* sp.2	Gleicheniaceae	F	-
167	*Globba* sp.	Zingiberaceae	H	-
168	Glochidion sp.1	Euphorbiaceae	S	-
169	Glochidion sp.2	Euphorbiaceae	S	-
170	*Gnaphalium adnatum* Wall.	Asteraceae	H	-
171	*Gnaphalium* sp.	Asteraceae	H	-
172	*Goodyera prolera* Hook.	Orchidaceae	H	-
173	*Hedychium* sp.1	Zingiberaceae	H	-
174	*Hedychium* sp.2	Zingiberaceae	H	-
175	Helixanthera parasiticaE. Nepal	Loranthaceae		Parastic shrub
176	*Heptapleurum* sp.	Araliaceae	ST	-
177	*Hoya* sp.1	Asclepiadaceae	Cl,Cr	-
178	Hoya sp.2	Asclepiadaceae	Cl,Cr	-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
179	*Humata platylepis* (Bak.) Ching	Daralliaceae	F	-
180	*Hydrangea* sp.	Hydrangeaceae	T	-
181	Hydrocotyle sp.1	Apiaceae	Cl,Cr	-
182	Hydrocotyle sp.2	Apiaceae	Cl,Cr	-
183	*Hypericum japonicum* Thunb.	Hypericaceae	S	-
184	*Ilex* sp.1	Aqulifoliaceae	T	-
185	*Ilex* sp.2	Aquifoliaceae	T	-
186	*Ilex* sp.3	Aquifoliaceae	T	-

187	*Impatiens racemosa* DC. Prodn.	Balsaminaceae	H	-
188	*Ipomoea* sp.	Comvolvulaceae	Cl,Cr	-
189	*Ixeris chinensis* (Thunb.) Nakai	Asteraceae	H	-
190	*Ixora* sp.	Rubiaceae	S	-
191	Justicia sp.	Acanthaceae	S	-
192	*Lasianhus* sp.1	Rubiaceae	S	-
193	*Lasianhus* sp.2	Rubiaceae	S	-
194	*Lasianhus* sp.3	Rubiaceae	S	-
195	*Lemmaphyllum cunosum* Presl.	Polypodiaceae	F	-
196	*Lepisorus contortus* (Christ) Ching	Polypodiaceae	F	-
197	Lepisorus sp.1	Polypodiaceae	F	-
198	Lepisorus sp.2	Polypodiaceae	F	-
199	Lepisorus sp.3	Polypodiaceae	F	-
200	*Lindera* sp.	Lauraceae	T	-
201	*Lindernia procumbens* (Krocker) Borbas	Linderniaceae	H	-
202	*Lithocarpus* sp.1	Fagaceae	T	-
203	*Lithocarpus* sp.2	Fagaceae	T	-
204	*Lithocarpus* sp.3	Fagaceae	T	-
205	*Lithocarpus* sp.4	Fagaceae	T	-
206	*Lithocarpus* sp.5	Fagaceae	T	-
207	Litsea sp.1	Lauraceae	T	-
208	Litsea sp.2	Lauraceae	T	-
209	Litsea sp.3	Lauraceae	T	-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
210	Litsea sp.4	Lauraceae	T	-
211	Litsea sp.5	Lauraceae	T	-
212	*Luculia* sp.1	Rubiaceae	S	-
213	*Luculia* sp.2	Rubiaceae	S	-
214	*Lycopodium* sp.1	Lycopodiaceae	F	-
215	*Lycopodium* sp.2	Lycopodiaceae	F	-
216	*Lygodium* sp.1	Lygodiaceae	F	-
217	Lygodium sp.2	Lygodiaceae	F	-
218	*Macaranga siamensis* S.J Davies	Euphorbiaceae	T	-

219	*Machilus japonica* Siebold & Zucc.	Lauraceae	T	-
220	Machilus sp.1	Lauraceae	T	-
221	Machilus sp.2	Lauraceae	T	-
222	Machilus sp.3	Lauraceae	T	-
223	*Machilus* sp.4	Lauraceae	T	-
224	*Machilus* sp.5	Lauraceae	T	-
225	*Machilus thunbergii* Sieb. Et Zucc.	Lauraceae	T	-
226	*Maesa chisia* Godayari	Myrsinaceae	S	-
227	*Maesa montana* A.DC.	Myrsinaceae	ST	-
228	*Magnolia* sp.	Magnoliaceae	T	-
229	Malaxis calophylla (Rolbf.) Kuntz.	Orchidaceae	E	-
230	*Mallotus* sp.1	Euphorbiaceae	T	-
231	*Mallotus* sp.2	Euphorbiaceae	T	-
232	*Mallotus* sp.3	Euphorbiaceae	T	-
233	*Mariscus sumatrensis* (Retz.) Raynal	Cyperaceae	H	-
234	*Mazus japonica* Thunb.	Scrophulariaceae	H	-
235	*Melastoma* sp.1	Melastomataceae	S	-
236	*Melastoma* sp.2	Melastomataceae	S	-
237	*Melastoma* sp.3	Melastomataceae	S	-
238	*Melodorum* sp.	Annonaceae	T	-
239	Mentha sp.1	Lamiaceae	H	-
240	Mentha sp.2	Lamiaceae	H	-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
241	Mentha sp.3	Lamiaceae	H	-
242	Micropera rostrata (Roxb.) N.P. Balakr.	Orchidaceae	H	-
243	*Mikania micrantha* H.B.K	Asteraceae	Cl,Cr	-
244	*Molineria caputulata* (Lour.) Herb	Hypoxidaceae	H	-
245	*Morus ausralis*Poir.	Moraceae	T	-
246	*Musa* sp.	Musaceae	T	-
247	*Mussaenda* sp.1	Rubiaceae	S	-
248	*Mussaenda* sp.2	Rubiaceae	S	-
249	*Mussaenda* sp.3	Rubiaceae	S	-
250	*Nasturtium officinale* R. Br.	Brassicaceae	H	-

251	*Neolepisorus* sp.1	Polypodiaceae	F	-
252	*Neolepisorus* sp.2	Polypodiaceae	F	-
253	*Neolepisorus* sp.3	Polypodiaceae	F	-
254	*Nephrolepis* sp.	Neophrolepidaceae	F	-
255	Oberonia sp.	Orchidaceae	E	-
256	*Ophiorrhiza* sp.	Rubiaceae	S	-
257	*Opithandra* sp.	Gesneriaceae	H	-
258	Oplismenus compositus Beaure	Poaceae	G	-
259	*Oreocnide fruticosa* (Gaudich.) Hand.-Mazz.	Urticaceae	ST	-
260	Otochilus furcus Lindl.	Orchidaceae	H	-
261	Otochilus sp. 1	Orchidaceae	H	-
262	Otochilus sp. 2	Orchidaceae	H	-
263	*Oxalis corniculata* L.	Oxalidaceae	H	-
264	*Oxyspora paniculata* (D.Don) DC.	Melastomataceae	S	-
265	*Panicum* sp.	Poaceae	G	-
266	*Paris tetraphylla* A. Gray	Liliaceae	H	-
267	*Pellionia* sp.	Urticaceae	H	-
268	*Perilla* sp.	Lamiaceae	H	-
269	*Persea duchiei* L. Nepal	Lauraceae	T	-
270	*Persea* sp.	Lauraceae	T	-
271	*Philodendron* sp.	Araceae	H	-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
272	*Phlogacanthus thyrsiformis* (Hardwicke) Mabberley	Acanthaceae	T	-
273	*Phoebe*sp.	Lauraceae	T	-
274	Pholidota articulata Lindl.	Orchidaceae	E	-
275	*Pholidota imbricata* Lindl.	Orchidaceae	E	-
276	*Pholidota* sp.1	Orchidaceae	E	-
277	*Pholidota* sp.2	Orchidaceae	E	-
278	*Phragmite* sp.	Poaceae	G	Kyu
279	*Phrynium capitatum* Willd.	Marantaceae	H	Taungsin-phet
280	*Pilea* sp.	Urticaceae	S	-
281	*Piper longum* L.	Piperaceae	H	Nga-yok-kaung
282	*Piper* sp.1	Piperaceae	H	-

283	*Piper* sp.2	Piperaceae	H	-
284	*Piper* sp.3	Piperaceae	H	-
285	*Piper* sp.4	Piperaceae	H	-
286	*Piper* sp.5	Piperaceae	H	-
287	*Plantago major* L.	Plantaginaceae	H	Ah-gyaw-paung-ta-htaung
288	*Plectranthus* sp.	Lamiaceae	H	-
289	*Pleurospermum* sp.	Apiaceae	H	-
290	*Polyalthia* sp.	Annonaceae	T	-
291	Polyalthia *viridis* Craib	Annonaceae	T	-
292	*Polygonum hydropiper* L.	Polygonaceae	H	-
293	*Polygonum* sp.1	Polygonaceae	H	-
294	*Polygonum* sp.2	Polygonaceae	H	-
295	*Polygonum* sp.3	Polygonaceae	H	-
296	*Polygonum* sp.4	Polygonaceae	H	-
297	*Polygonum* sp.5	Polygonaceae	H	-
298	*Polygonum* sp.6	Polygonaceae	H	-
299	*Polygonum* sp.7	Polygonaceae	H	-
300	*Polypodiodes amoena* (Wall.ex.Mell.) Ching	Polypodiaceae	F	-
301	*Potentilla* sp.	Rosaceae	S	-
302	*Pothos* sp.	Araceae	Cl,Cr	-
303	*Pratia begoniifolia* G.Don	Campanulaceae	H	-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
304	*Premna* sp.	Verbenaceae		-
305	*Pronephrium lakhimpurense* (Ros.) Holtt	Thleypteridaceae	F	-
306	*Prunus persica* (L.) Batsch	Rosaceae	T	-
307	*Pteris aspericarlis* Wall.ex Hieron	Pteridaceae	F	-
308	*Pteris longipes* Don	Pteridaceae	F	-
309	*Pteris semipinnata* L.	Pteridaceae	F	-
310	Pterissp.	Vicciniaceae	Cl,Cr	-
311	*Pyrrosia* sp.	Polypodiaceae	F	-
312	Pyrrosia sp.	Polypodiaceae	F	-
313	Pyrrosia subfurfuracea (Hook.) Ching	Polypodiaceae	F	-
314	*Pyrus* sp.	Rosaceae	T	-
315	*Quercus* sp.	Fagaceae	T	-

316	*Ranunculus japonicus* Thunb.	Ranunculaceae	H	-
317	Rhamnus sp.	Rhamnaceae	H	-
318	*Rhamnus* sp.	Rhamnaceae	H	-
319	*Rhododendron simsii* Planch	Ericaceae	ST	-
320	*Ricinus communis* L.	Euphorbiaceae	ST	Kyetsu
321	*Rosa* sp.1	Rosaceae	S	-
322	*Rosa* sp.2	Rosaceae	S	-
323	Rotala sp.	Lythraceae	H	-
324	*Rubia cordifolia* L.	Rubiaceae	Cl,Cr	Pe-seint-ni-pin
325	*Rubus hirsutus* Thunb.	Rosaceae	S	-
326	*Rubus illecebrosus* Focke	Rosaceae	S	-
327	*Rubus lambertiana* Ser.	Rosaceae	S	-
328	*Rubus sieboldii* Blume	Rosaceae	S	-
329	*Rubus* sp.1	Rosaceae	S	-
330	*Rubus* sp.2	Rosaceae	S	-
331	*Rubus* sp.3	Rosaceae	S	-
332	*Rubus* sp.4	Rosaceae	S	-
333	*Rubus* sp.5	Rosaceae	S	-
334	*Rubus sumatranus*Miq.	Rosaceae	S	-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
335	Ruellia sp.	Acanthaceae	H	-
336	*Sambucus japonica*Blume	Caprifoliaceae	S	-
337	*Sarcochloa mys pulcherrima* Roxb.	Urticaceae	S	-
338	*Saurauia napaulensis* DC.	Actinidiaceae	ST	-
339	*Saurauia roxburghii* Wall.	Actinidiaceae	ST	-
340	*Saurauia* sp.1	Actinidiaceae	ST	-
341	*Saurauia* sp.2	Actinidiaceae	ST	-
342	*Saurauia* sp.3	Actinidiaceae	ST	-
343	Schefflera sp.1	Araliaceae	ST	-
344	Schefflera sp.2	Araliaceae	Cl,Cr	-
345	Schefflera sp.3	Araliaceae	Cl,Cr	-
346	Schefflera sp.4	Araliaceae	ST	-
347	*Schima wallichii* (DC.) Korth.	Theaceae	T	Laukya
348	*Scoparia dulcis* L.	Plantaginaceae	H	Dana-thuka

No.	Scientific Name	Family	Habit	Common Name
349	*Scripus* sp.	Cyperaceae	H	-
350	Scurrula sp.	Loranthaceae		Parastic shrub
351	*Selaginella* sp.1	Selaginellaceae	F	-
352	*Selaginella* sp.2	Selaginellaceae	F	-
353	*Selaginella* sp.3	Selaginellaceae	F	-
354	*Selaginella* sp.4	Selaginellaceae	F	-
355	*Setaria glauca* (L.) P.B.	Poaceae	G	-
356	*Smilax* sp.1	Smilacaceae	Cl,Cr	-
357	*Smilax* sp.2	Smilacaceae	Cl,Cr	-
358	*Smilax* sp.3	Smilacaceae	Cl,Cr	-
359	*Smilax* sp.4	Smilacaceae	Cl,Cr	-
360	*Solanum indicum* L.	Solanaceae	H	Khayan-kazaw
361	*Solanum nigrum* L.	Solanaceae	H	Baung-laung-nyo
362	*Solanum* sp.	Solanaceae	H	-
363	Sonerila sp.	Melastomatacea e	S	-
364	*Spermacoce* sp.	Rubiaceae	H	-
365	*Spiranthes sinensis* (Pers.) Ames	Orchidaceae	H	-
366	*Stachyphrynium spicatum* (Roxb.)K.Schum.	Marantaceae	H	Taungsin-hpet,Phet-sa-lut
367	*Stellaria* sp.1	Caryophyllacea e	H	-
368	*Stellaria* sp.2	Caryophyllacea e	H	-
369	*Stellaria* sp.3	Caryophyllacea e	H	-
370	Stenoloma chusnum (L.) Ching	Lindisaceae	F	-
371	*Stephania venosa* (Bl.) Spreng	Menispermacea e	Cl,Cr	-
372	*Sterculia* sp.1	Sterculiaceae	T	-
373	*Sterculia* sp.2	Sterculiaceae	T	-
374	*Steudnera discolor* W. Bull	Araceae	H	-
375	*Streptolirion* sp.	Commelinaceae	H	-
376	Styrax benzoides Craib	Styracaceae	ST	-
377	Symplocos sp.1	Symplocaceae	ST	-
378	Symplocos sp.2	Symplocaceae	ST	-
379	Symplocos sp.3	Symplocaceae	ST	-

380	Symplocos sp.4	Symplocaceae	ST	-
381	Symplocos sp.5	Symplocaceae	ST	-
382	Symplocos sp.6	Symplocaceae	ST	-
383	Symplocos sp.7	Symplocaceae	ST	-
384	*Syzygium megacarpum* (Craib) Rathakr. & N.C. Nair	Myrtaceae	T	-
385	*Syzygium* sp.1	Myrtaceae	T	-
386	*Syzygium* sp.2	Myrtaceae	T	-
387	*Syzygium* sp.3	Myrtaceae	T	-
388	*Taiwania cryptomeriodes* Hayata	Taxodiaceae	T	Tayok-khaung-bin
389	Tectaria sp.	Dryopteridacea e	F	-
390	*Thladiantha* sp.	Cucurbitaceae	Cl,Cr	-
391	Tripterospermum chinense (Migo) Harry Sm.	Gentiaceae	H	-
392	*Turpinia cochinensis* (Lour.) Merr.	Staphyleaceae	T	Daukya-ma
393	Turpinia nepalensis Wall.	Staphyleaceae	T	-
394	UN-1		S	-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
395	UN-2			-
396	UN-3	Fagaceae	T	-
397	UN-4			-
398	UN-5	Asteraceae	H	-
399	UN-6			-
400	UN-7		ST	-
401	UN-8		ST	-
402	UN-9	Poaceae	G	-
403	UN-10	Urticaceae		-
404	UN-11			-
405	UN-12			-
406	UN-13	Magnoliaceae	T	-
407	UN-14	Ericaceae		-
408	UN-15			-
409	UN-16	Asteraceae	Cl	-
410	UN-17	Poaceae	G	-
411	UN-18	Asteraceae	H	-

412	UN-19	Poaceae	G	-
413	UN-20	Poaceae	G	-
414	UN-21	Poaceae	G	-
415	UN-22	Orchidaceae	E	-
416	UN-23	Rubiaceae	S	-
417	UN-24			-
418	UN-25			-
419	UN-26			-
420	UN-27	Lauraceae		-
421	UN-28	Loranthaceae		-
422	UN-29			-
423	UN-30			-
424	UN-31			-
425	UN-32		Cl	-
426	UN-33			-
427	UN-34	Rubiaceae	S	-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
428	UN-35	Poaceae	G	-
429	UN-36	Commelinaceae		-
430	UN-37	Fabaceae		-
431	UN-38			-
432	UN-39		ST	-
433	UN-40			-
434	UN-41		ST	-
435	UN-42			-
436	UN-43			-
437	UN-44		ST	-
438	UN-45			-
439	UN-46			-
440	UN-47	Verbenaceae		-
441	UN-48			-
442	UN-49	Euphorbiaceae		-
443	UN-50	Sapindaceae		-
444	UN-51	Scrophulariaceae	H	-
445	UN-52	Cucurbitaceae	Cl	-
446	UN-53	Urticaceae	S	-

447	UN-54	Rubiaceae		-
448	UN-55			-
449	UN-56			-
450	UN-57			-
451	UN-58	Annonaceae	T	-
452	UN-59	Scrophulariaceae	H	-
453	UN-60	Theaceae	S	-
454	UN-61	Arecaceae	ST	-
455	UN-62	Poaceae	G	-
456	UN-63	Rutaceae	ST	-
457	UN-64			-
458	UN-65			-
459	UN-66	Gesneriaceae	H	-
460	UN-67			-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
461	UN-68			-
462	UN-69			-
463	UN-70			-
464	UN-71			-
465	UN-72	Annonaceae	T	-
466	UN-73			-
467	UN-74			-
468	UN-75		Cl	-
469	UN-76			-
470	UN-77			-
471	UN-78			-
472	UN-79	Menispermaceae	Cl	-
473	UN-80			-
474	UN-81	Lauraceae	T	-
475	UN-82			-
476	UN-83			-
477	UN-84	Verbenaceae		-
478	UN-85		Cl	-
479	UN-86			-
480	UN-87		Cl	-
481	UN-88		G	-

482	Uncaria sp.	Rubiaceae	Cl	-
483	*Urena lobata* L.	Malvaceae	S	Kat-sine
484	Vaccinium sp.1	Vicciniaceae	Cl	-
485	Vaccinium sp.2	Vacciniaceae	Cl	-
486	*Valeriana* sp.	Valerianaceae	H	-
487	*Vernonia cinerea* Less.	Asteraceae	H	-
488	*Vernonia* sp.1	Asteraceae	H	-
489	*Vernonia* sp.2	Asteraceae	H	-
490	*Vernonia* sp.3	Asteraceae	H	-
491	*Vernonia* sp.4	Asteraceae	H	-
492	*Vernonia* sp.5	Asteraceae	H	-
493	*Viola prionantha* Bunge	Violaceae	H	-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
494	*Viola* sp.	Violaceae	H	-
495	*Vitis* sp.1	Vitaceae	Cl	-
496	*Vitis* sp.2	Vitaceae	Cl	-
497	Vittaria sp.	Vittariaceae	F	-
498	*Vittaria* sp.	Vittariaceae	F	-
499	*Wallichia* sp.1	Arecaceae	ST	-
500	*Wallichia* sp.2	Arecaceae	ST	-
501	*Wendlandia* sp.	Rubiaceae	ST	-
502	Woodwardia sp.	Blenchnaceae	F	-
503	*Cymbidium eburneum* Lindl.	Orchidaceae	E	-
504	*Youngia japonica* (L.) DC.	Asteraceae	H	-
505	Ziziphus sp.	Rhamnaceae	S	-

B = Bamboo, Cl = Climber, Cr = Creeper, E = Epiphyte, F = Fern, G = Grass, H = Herb, S = Shrub, ST = Small Tree, T = Tree

Appendix – II Yenam Vegetation Type

No.	Locality	Vegatation Type	Latitude	Longitude	Altitude	Note
1.	Beside Tarone Stream, East Aliaung Village	High Land Evergreen	27° 40' 20.1"	98° 98' 97.3"	1022 m	*Exbucklandia populnea, Engelhardtia* sp. & *Eurya* sp. are found in tree layer. Shrub layer is dominated by *Oxyspora paniculata, Symplocos macrophylla* & *Maesa Montana.* Herb layer is dominated by *Selaginella* sp. & *Dipter is chinensis.*
2.	East Aliaung Village	High Land Evergreen	27° 41' 43.4"	98° 08' 00.8"	1035 m	
3.	West Aliaung Village	High Land Evergreen	27° 42' 45.8"	98° 06' 27.3"	1022 m	
4.	West Yenam	High land Secondary Forest	27° 41' 25.3"	98° 01' 28.5"	1023 m	*Syzygium* sp., *Symplocos* sp., *Acer* sp. & *Wendlandia tinctonia* are found in tree layer. Shrub layer is dominated by *Symplocos* sp. & *Luculia* sp.. Herb layer is dominated by *Selaginella* sp., *Adiantum* sp., *Asplenium* sp., *Polypodium* sp.,
5.	West Yenam	High land Secondary Forest	27° 41' 53.2"	98° 01' 42.3"	1054 m	
6.	West Yenam	High land Secondary Forest	27° 41' 31.9"	98° 01' 29.5"	1089 m	
7.	Between Manton and Yenam Village	High land Secondary Forest	27° 42' 57.3"	97° 58' 37.7"	983 m	
8.	Manton Village	High land Secondary Forest	27° 43' 36.2"	97° 52' 56.6"	1055 m	
9.	Manton Village	High land Secondary Forest	27° 43' 32.6"	97° 53' 01.3"	1064 m	
10.	West Yenam Village	High land Secondary Forest	27° 41' 43.6"	97° 01' 36.2"	1087 m	
11.	West Mantone Village	High land Secondary Forest	27° 43' 41"	97° 56' 15.4"	941 m	
12.	West Yenam, Changsone	High land Secondary Forest	27° 41' 19.0"	98° 01' 29.3"	958 m	

13.	West Yenam Village	High land Secondary Forest	27° 42' 22.6"	98° 03' 10.5"	974 m	
14.	West Mantone Village	High land Secondary Forest	27° 43' 18.1"	97° 57' 13.9"	938 m	
15.	West Mantone Village	High land Secondary Forest	27° 42' 01.8"	98° 01' 55.6"	1036 m	
16.	Between Manton and Yenam Village	High land Secondary Forest	27° 41' 56.3"	98° 01' 49.9"	1103 m	
17.	Manton	High land Secondary Forest	27° 43' 38.2"	97° 56' 27.3"	970 m	
18.	West Yenam, Changsone	High land Secondary Forest	27° 41' 25.3"	98° 01' 28.5"	1023 m	
19.	West Yenam, Changsone	High land Secondary Forest	27° 41' 27.3"	98° 01' 27.6"	1034 m	

No.	Locality	Vegatation Type	Latitude	Longitude	Altitude	Note
20.	West Mantone Village	Oak Forest	27° 43' 42.6"	97° 56' 08.3"	1038 m	*Castanopsis tribulodies, Castanopsis diversifiia, Castanopsis* sp., *Lithocarpus* sp., associate with *Syzygium* sp. are found in tree layer. Shrub layer is dominated by *Oxspora paniculata, Lasianthus* sp., *Symplocos macrophylla* & *Symplocos* sp., Herb layer is dominated by *Selaginella* sp.
21.	West Mantone Village	Oak Forest	27° 43' 18.9"	97° 56' 59.8"	1040 m	
22.	West Yenam	Oak Forest	27° 43' 15.7"	98° 57' 06.1"	984 m	
23.	West Mantone Village	Oak Forest	27° 43' 43.1"	97° 56' 03.0"	1059 m	
24.	West Aliaung Village	Oak Forest	27° 42' 31.3"	98° 06' 48.5"	1054 m	
25.	Myo Ma Ward Panandim Township	Degraded Forest	27° 43' 34.3"	97° 52' 18.6"	969 m	
26.	East Montone Village	Degraded Forest	27° 48' 18.5"	97° 52' 57.9"	1018 m	
27.	West Mantone Village	Degraded Forest	27° 42' 32.6"	98° 00' 30.0"	902 m	
28.	West Mantone Village	Degraded Forest	27° 42' 01.6"	98° 01' 54.4"	1001 m	
29.	West Mantone Village	Degraded Forest	27° 43' 42.1"	97° 56' 10.6"	1009 m	
30.	West Mantone Village	Bamboo Forest	27° 42' 02.1"	98° 01' 58.0"	1025 m	
31.	Yenam Village	Bamboo Forest	27° 42' 07.0"	98° 02' 15.8"	1052 m	
32.	Panandim	Bamboo Forest	27° 43' 36.3"	97° 52' 56.6"	998 m	
33.	Panandim	Settlement	27° 43' 34.3"	97° 52' 18.7"	1019 m	
34.	Aliaung Village	Settlement	27° 42' 12.9"	98° 07' 44.7"	995 m	
35.	South Panandim	Shifting Cultivation	27° 43' 38.2"	97° 53' 00.2"	958 m	*Brassica* sp., *Panicum* sp (Lu), *Sorghum* sp.
36.	West Yenam, Changsone	River Side	27° 41' 15.2"	98° 01' 28.6"	917 m	*Rhododendron* sp., *Dephnimorpha* sp.

37.	East Aliaung Village	River Side	27° 41' 14.0"	98° 08' 02.1"	1002 m	

Chapter II

2. Biodiversity Impact Assessment Report of Flora on Khaunglanphu Hydropower Dam

2.1. Introduction

The environmental impact assessment, especially on the plant diversity of intended inundated area of Khaunglanphu Dam on Mayhka River in Khaunglanphu Township Kachin State, which will be constructed in the near future, has been carried out in February and March 2009.

2.1.2. Location

The Khaunglanphu Hydropower Dam project site is located between 26º30´N, 98º 00´E and 27º30´N, 98º 40´E near Sangn hkun Hkyet village, in Khaunglanphu Township, on downstream confluence mouth of Mayhka River and Achanhti Stream. Mayhka River is 353 km long with catchment area of 19900 km^2 and natural fall 1010 m. Khaunglanphu Hydropower Dam site is on the upstream of Mayhka River and may be second one below the downstream of Yenam Hydropower Dam. It is one of the additional dams among five hydropower dams on Mayhka River which may be constructed in the near future. The dam site lies between high mountains and gorges. The elevation of Emawbum Mountain which comprises in the catchment area is 3100 m high. The river flows in the narrow V- shape valley and has steep bank slope. So the flooded area is narrow and long, along the river and stream. Total flooded area is 2407.2 hectare. It will be a cascade dam and may be environmentally benign dam.

2.1.3. Topography

The Khaunglanphu Hydropower dam project site falls 27º 01´ to 27º 06´ latitude and 98º 13´ to 98º 02´ longitude, in Khaunglanphu Township and 231 km away from the confluence at Myitsone. The catchment area is 3455 sq-km and the total flooded area is 2407 hectare. The normal pool level will be 875 m. The lowest elevation in the area study area is 705 m and the highest is 1450 m. The topography of the dam area is high land area of 800 m to 1540 m in estimated flooded area. In the catchment area of the dam there are 4000 m high snow-capped mountains.

2.1.4. Climate

Generally the climate of Khaunglanphu Hydropower Dam site is monsoon climate. There are three distinct seasons; cool and dry season, hot dry season, warm and wet rainy season. The wet raining season is from May to October. The average annual rain fall is 105.95 inches. The rainy fall is rather uniform across the whole area. But rainfall tends to be higher and more prolonged in higher mountainous area and the light showers are also frequent throughout the year. There may be some occasional rains due to the northeast wind from China.

2.1.5. Forest in the context of Eco-region

The Khaunglanphu Hydropower Dam area lies in WWF Eco-region of Northern Triangle Temperate forest. It is also located within the priority site for conservation investment of Northern mountain forest complex.

The Hkakaborizi NP, Hponganrazi W.S and Emawbum mountain forest exist in its catchment area. So the area is biodiversity hot-spot area and globally outstanding for conservation. The forest types are high land evergreen forest lowland evergreen forest and oak forest. Some degraded forests due to shifting cultivation may also be found.

2.1.6. Local people and their livelihood

The people dwelling this area include Kachin and Bamar. Most Bamar are government employees and live in Khaunglanphu Township. Most of the Kachin tribes are farmers cultivating Taungyar rice and vegetables. Some are hunters. The Ridam village would be inundated in future.

2.2. Aims and Objectives

1. To collect, identify and list the plant species in the area
2. To record the dominant tree species and evaluate the forest type
3. To study the impact of dam on the flora and to suggest the mitigation measure

2.3. Materials and Methods

2.3.1. Participants

The Myanmar flora team comprises 4 members, Dr Win Myint, Daw Khin Swe Lwin, Daw Ei Ei Phyoe and U Nay Phyo Aung, cooperation with Chinese flora team.

2.3.2. Materials

Materials used for recording are strings for sample plotting, digital camera, maps compass, field press, data collection sheets, drying press, dryer, digging tools, heavy duty plastic bags, newspapers, alcohol, spray jug (for fixing specimens) 10 x lens, permanent markers and other field equipments.

2.3.3. Methods

One research team with four Myanmar scientists was organized and studies were conducted especially in the areas which may be inundated after the dam is constructed. The plant specimens were collected both in inundated areas and habitats of representative areas.

A Global Positioning System was used to navigate and mark coordinates between sample plots in each habitat. In order to obtain essential ecological data for predicting forest value and forest type, quadrants of varying size were set up and observed. Plant collection (all trees, shrubs and herbs) was carried out in random and by Transit line whenever possible to get the representative checklists of the plants in the studied area and all specimens are identified and recorded. DBH and Height classes at tree species are calculated based on the measurement of breast height diameters along with its height.

Field press and drying press were used to get voucher specimens and to store in herbarium. Habitat type's altitude, topography, forest type, canopy cover and structure, light intensity, wind velocity and sign of disturbance were recorded. To know the habit of the plant species and to ensure the vegetation, photographic records were also carried out.

Leaves, inflorescences, floral structures and other vegetative parts of each plant specimens were collected and photographed and recorded as field notes.

2.4. Results

2.4.1. Species Composition in the study area

The total number of species collected in the Khaunglanphu Dam site and intended flooded area is 443 species belonging to 325 genera and 111 families. (Appendix - I)

The determination of forest types was carried out in accordance with their species composition. The dominancy of tree species, shrub species and herb species were also determined according to their species composition in sample plots. (Appendix-II)

2.4.2. The human impacts in the study area

Rice cultivation

The method of rice cultivation is shifting cultivation and terrace cultivation was seen in the study area. The impact of shifting cultivation would lead to the loss of forest and degraded forests. However the terrace cultivation is environmentally sound and should be encouraged since rice cultivation is major livelihood of local people and is inevitable.

Endangered Species

According to IUCN Red list (2000) the following species are recorded;

1. *Taiwania cryptomerioides* Hayata. VU

2.5. Discussion and Conclusion

The tree species are the value of the forest. *Castanopsis* sp., *Lithocarpus* sp., *Michelia campaca*, *Listea* sp., *Macaranga* sp., and *Ficus* sp., are dominating tree species in the study area. 45% of the tree species are 60-150 cm in girth and 5 to 17 m in height.

The degradation of forest is due to shifting cultivation. Terrace cultivation is found near Ridam village, Phulone village and Khunglanphu Township. This terrace cultivation practice is environmentally sound and it should be encouraged and aided local peoples to practise it under the project expenditure so that the degradation of forest could be prevented.

The disturbance such as logging is scare due to improper infrastructure. It may be possible if the new access roads to hydroelectric dam are constructed in future. The siting of new access roads should be in environmentally least damaging corridors and new protected area should be adopted and managed to avoid deforestation.

The forests in the study area consist of mid-elevation forest (800m -1000m) and highland forest (<1000 m) and transition between lowland and highland forest.

The moisture and temperature of the forest is determined by seasonal water input and elevation. Light shower rains are frequent throughout the year. There may be also occasional rains due to northeast wind from China. Therefore the moisture content of the study area is high enough.

The difference in elevation also determined the species composition in the forest. The valleys and concave slopes have rich in species diversity and ridges and convex slopes have less diversity. The natural vegetation pattern in the study area comprises highland evergreen forest, lowland evergreen forest and oak forest. Highland degraded forest and Bamboo forest are also found. Most species are evergreen belonging to the family Fagaceae and Lauraceae. *Michelia champaca* which is the valuable timber tree is also present in the evergreen forest. Species density is high in moist area near stream and intermediate in convex and ridges.

The tree species are the value of the forest. The dominant tree species are *Cinnamomum* sp., *Castanopsis* sp., *Lithocarpus* sp., *Macaranga* sp., *Schefflera* sp., and *Michelia champaca* are found in tree layer. The shrub layer is dominated by *Osbeckia* sp., *Tridax* sp., *Musa* sp., and *Smilax* sp. The herb layer is dominated by *Rubus* sp., *Begonia* sp., *Commelina* sp., and *Musa* sp.

The bamboo forests are also common in the study area consisting of *Dendrocalmus giganteus* and *D. hamiltonii.*

To sustain the forest in the catchment area, the existing national park and wildlife sanctuaries should be extended and new ones should be proposed.

Since the Khaunglanphu hydropower dam is a second dam on the Mayhka River the construction of dam should begin after Yenam Dam has completed. So the cumulative environmental impact assessment can be carried out and mitigation measure can be proposed.

2.6. Recommendation

1. Since Ridam Village is in inundated area the resettlement and livelihood of relocated people should be brought into due planning and management.
2. The socioeconomic development of the local community accommodating with conservation practice should be planned out under the project expenditure.
3. Emawbum Mountain area should be proposed as national park since it is existing in the catchment area.
4. The cumulative environmental impact assess should be carried out since the additional dams are planned to construct on the downstream of the same river.
5. Before the construction of the new access road and power transmission line, the environmental impact assessment should be carried out.
6. Terrace cultivation should be encouraged and practiced among local community under project expenditure.

Table - 1 Tree species in DBH class intervals in Khaunglanhpu

DBH Classes	No. of species	Total number of individual	% of total species
< 30 cm	27	84	17.76
30 - 60 cm	30	113	19.74
60 - 90 cm	32	100	21.05
90 - 120 cm	21	60	13.82
120 - 150 cm	16	37	10.53
150 - 180 cm	10	19	6.58

180 - 210 cm	7	14	4.61
210 -240 cm	6	8	3.95
240 - 270 cm	2	3	1.32
270 - 300 cm	-	-	0.00
300 - 330 cm	-	-	0.00
330 - 360 cm	-	-	0.00
360 - 390 cm	-	-	0.00
390 - 420 cm	-	-	0.00
420 - 450 cm	-	-	0.00
450 - 480 cm	-	-	0.00
480 - 510 cm	-	-	0.00
510 - 540 cm	-	-	0.00
540 - 570 cm	-	-	0.00
> 570 cm	1	1	0.66
Total	56	439	100.00

Table - 2 Tree species in Height class intervals in Khaunglanhpu

Height Classes	No. of species	Total number of individual	% of total species
< 3m	-	-	0.00
3 - 10 m	38	151	36.19
10 - 17 m	35	158	33.33
17 - 24 m	19	97	18.10
24 - 31 m	11	31	10.48
31 - 38	2	2	1.90
> 38 m	-	-	0.00
Total	56	439	100.00

Appendix – I Khaunglanhpu Plant Lists

No.	Scientific Name	Family	Habit	Common Name
1	*Acacia pennata* (L.) Willd.	Mimosaceae	Cl	Suboke-gyi
2	*Acanthus* sp.	Acanthaceae	H	-
3	*Achyranthes aspera* L.	Amaranthaceae	H	Kyetmauk-pan
4	*Acmella calva* (D.C) R.K.Jansen	Asteraceae	H	-
5	Actinodaphne sp.	Lauraceae	T	-
6	*Adiantum* sp.	Pteridaceae	F	-
7	*Adiantum tenerum* Sw.	Pteridaceae	F	-
8	Aegle sp.	Rutaceae	T	-
9	*Aeschynanthus* sp.	Gesneriaceae	S	-

10	*Agapetes macrantha* Hook. F.	Ericaceae	Cl,Cr	-
11	*Agapetes* sp.	Ericaceae	Cl,Cr	-
12	*Agastache rugosa* (Fisch. & C.A. Mey.) Kuntze	Lamiaceae	H	-
13	*Ageratum conyzoides* L.	Asteraceae	H	-
14	*Aglaonema commutatum* Schott	Araceae	H	Si-pwa-gamon
15	Ajuga nipponensis Makino	Lamiaceae	H	-
16	*Albizia* sp.	Mimosaceae	T	-
17	*Alnus nepalensis* D.Don	Betulaceae	T	Mywe-awe-zar-pin
18	*Alocasia macrorrhizos* (L.) G. Don	Araceae	H	Mahuya-pein,Pein-gyi
19	*Alocasia* sp.	Araceae	H	-
20	*Alseodaphne* sp.	Lauraceae	T	-
21	*Amomum corynostachyum* Wall.	Zingiberaceae	H	-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
22	*Amoora rohituka* Wight & Arn.	Meliaceae	T	Chaya-kaya,
23	*Amorphophallus paeoniifolius* (Dennst.) Nicolson	Araceae	H	Wa-u-bin, Wa-u-pin
24	*Anaphalis*sp.	Asteraceae	H	-
25	*Angiopteris hokouensis* Ching	Marattiaceae	F	-
26	*Antidesma* sp.	Euphorbiaceae	T	-
27	*Archidendron* sp.	Mimosaceae	T	-
28	*Ardisia* sp.1	Myrsinaceae	ST	-
29	*Ardisia* sp.2	Myrsinaceae	ST	-
30	*Ardisia* sp.3	Myrsinaceae	S	-
31	*Ardisia* sp.4	Myrsinaceae	S	-
32	*Arisaema amurense* Maxim.	Araceae	H	-
33	*Artemisia* sp.	Asteraceae	H	-
34	*Asplenium nidus* L.	Aspleniaceae	F	-
35	Bambusa teres Buch.-Ham. ex Wall.	Poaceae	B	Tabin-daing-wa
36	*Begonia semperflorens* Link & Otto	Begoniaceae	H	-
37	*Begonia* sp.	Begoniaceae	H	-
38	*Bidens*sp.	Asteraceae	H	-
39	*Boehmeria* sp. 1	Urticaceae	S	-
40	*Boehmeria* sp. 2	Urticaceae	S	-
41	*Boenninghausenia albiflora* (Hook.) Rchb. ex Meissner	Rutaceae	H	-

42	*Brahea* sp.	Arecaceae	ST	-
43	*Brassica nigra* (L.) Koch	Brassicaceae	H	Monnyin-net
44	*Breynia officinalis* Hemsl.	Euphorbiaceae	S	-
45	*Broussonetia* sp.	Moraceae	T	-
46	*Buddleja asiatica* Lour.	Beddlejaceae	S	Kyaung-migo, Mai-yun-puk
47	Bulbophyllum Odoratissimum (J.TC.Sm) Lindl	Orchidaceae	E	-
48	*Bulbophyllum* sp.1	Orchidaceae	E	-
49	*Bulbophyllum* sp.2	Orchidaceae	E	-
50	Butea sp.	Fabaceae	Cl,Cr	-
51	*C1ematis* sp.1	Ranunculaceae	Cl	-
52	*Callicarpa penpedunculata* R.Br.	Verbenaceae	T	-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
53	*Callicarpa* sp.	Verbenaceae	T	-
54	*Camellia* sp.1	Theaceae	S	-
55	*Camellia* sp.2	Theaceae	S	-
56	*Caniogaramme* sp.1	Hemionitidaceae	F	-
57	*Caniogaramme* sp.2	Hemionitidaceae	F	-
58	*Canna* sp.	Cannaceae	H	Budatharana
59	*Cannabis sativa* L.	Cannabinaceae	S	Se-gyauk
60	*Capparis* sp.	Capparaceae	Cl,Cr	-
61	*Carex filicina* Nees	Cyperaceae	H	-
62	*Caryota gigas*Hahn ex hodel	Arecaceae	T	minbaw
63	*Caryota urens* L.	Arecaceae	T	Taminbaw
64	*Castanopsis acuminatissima*(Bl.) A. DC.	Fagaceae	T	-
65	*Castanopsis calathiformis* (Skan) Resd &Wils	Fagaceae	T	-
66	*Castanopsis argyrophylla* King	Fagaceae	T	-
67	*Castanopsis armata* Spach	Fagaceae	T	-
68	*Celosia* sp.	Amaranthaceae	H	-
69	*Centranthera* sp.	Scrophulariaceae	H	-
70	*Cinnamomum* sp.1	Lauraceae	T	-
71	*Cinnamomum* sp.2	Lauraceae	T	-
72	*Citrus grandis* (L.) Osbeck	Rutaceae	ST	-
73	*C1ematis* sp.2	Ranunculaceae	Cl	-
74	*C1ematis* sp.3	Ranunculaceae	Cl	-
75	*Clematis* sp.3	Runanculaceae	Cl	-
76	*Clerodendrum imerme* L.	Verbenaceae	S	Pinle-kyauk-pan

77	*Codia myxa* L.	Boraginaceae	T	aung-thanut
78	*Coelogyne* sp.2	Orchidaceae	E	-
79	*Colocasia esculenta* (L.) Schott	Araceae	H	Mahuya-pein
80	*Colocasia* sp.	Araceae	H	-
81	*Commelina* sp.1	Commelinaceae	H	-
82	*Commelina* sp.2	Commelinaceae	H	-
83	*Commelina* sp.3	Commelinaceae	H	-
84	Cordia dichotoma Forst	Boraginaceae	T	Thanat
85	*Cordia* sp.	Boraginaceae	T	-
86	*Corydalis bungeana* Turcz.	Papaveraceae	H	-
87	*Crassocephalum crepidioides* (Benth.) S. Moore	Asteraceae	H	-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
88	*Crotalaria juncea* L.	Fabaceae	S	Pan-paiksan
89	*Cuphea hyssopifolia* Kunth	Lythraceae	H	-
90	*Cyathea crenata* (Sodiro) H. Christ	Cyatheaceae	Tree Fern	-
91	Cydonia cathayensis Hemsl.	Rosaceae	ST	-
92	Cymbidium sp.	Orchidaceae	E	-
93	Cymbopogon citratus Stapf.	Poaceae	G	Sabalin
94	*Cyperus* sp.	Cyperaceae	H	-
95	*Cyrtococcum* sp.	Poaceae	G	-
96	*Dalbergia* sp.2	Fabaceae	-	-
97	*Debregeasia longifolia* (Burm. f.) Wedd.	Urticaceae	ST	-
98	Dedrobium sp.	Orchidaceae	E	-
99	Demarcanthus sp.	Rutaceae	ST	-
100	*Dendrocalamus giganteus* Wall.ex Munro	Poaceae	B	Wabo-gyi
101	*Dendrocalamus hanitonii* Nees & Arn.ex Munro	Poaceae	B	Wabo-myet-sangye
102	*Desmodium heterophyllum* (Willd.) DC.	Fabaceae	S	-
103	*Desmodium* sp.1	Fabaceae	S	-
104	*Desmodium* sp.2	Fabaceae	S	-
105	*Desmodium* sp.3	Fabaceae	S	-
106	Dichorisandra sp.	Commelinaceae	H	-
107	*Dicliptera zelanica* Nees	Acanthaceae	H	-
108	*Dioscorea* sp.1	Dioscoreaceae	Cl,Cr	-
109	*Dioscorea* sp.2	Dioscoreaceae	Cl,Cr	-
110	Diospyros kaki L.f.	Ebenaceae	T	-
111	*Dipteris chinensis* Christ	Dipteridaceae	F	-

112	*Duchesnea* sp.	Rosaceae	H	-
113	*Eclipta* sp.	Asteraceae	H	-
114	Edgeworthia gardneri (Wall) Meissn	Thymelaeaceae	T	-
115	*Elaeocarpus* sp.1	Elaeocarpaceae	T	-
116	*Elaeocarpus* sp.2	Elaeocarpaceae	T	-
117	Elatostema sp.1	Urticaceae	S	-
118	Elatostema sp.2	Urticaceae	S	-
119	Elatostema sp.3	Urticaceae	S	-
120	*Elsholtzia* sp.	Lamiaceae	S	-
121	Endata sp.	Mimosaceae	Cl	-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
122	*Engelhardtia spicata* Blume	Juglandaceae	T	-
123	*Entada pursaetha* DC.	Mimosaceae	Cl	Do-nwe
124	*Epipremnum pinnatum* (L.) Engl.	Araceae	Cl,Cr	-
125	*Equisetum* sp.	Equisetaceae	F	-
126	*Eragrostis* sp.	Poaceae	G	-
127	*Erigeron* sp.	Asteraceae	H	-
128	*Erymgium foetidum*L.	Apiaceae	H	Shan-nan-nan
129	*Erythrina* sp.1	Fabaceae	T	-
130	*Erythrina* sp.2	Fabaceae	T	-
131	*Euphorbia* sp.	Euphorbiaceae	T	-
132	*Eurya* sp.	Theaceae	ST	-
133	*Exbucklandia populnea* (R. Br. ex Griff.) R.W. Br.	Hamamelidaceae	T	-
134	*Fagopyrum* sp.	Polygonaceae	H	-
135	*Ficus bemjamina* L.	Moraceae	T	Nyaung-thabye
136	*Ficus hirta* var. *hirta*Vahl.	Moraceae	T	-
137	*Ficus hirta* var. *roxburghii* Miq.	Moraceae	T	-
138	*Ficus* sp.1	Moraceae	T	-
139	*Ficus* sp.2	Moraceae	T	-
140	*Filicium decipiens* (Wightn &.Arn.) Thwaites	Sapindaceae	T	Da-yin-gauk-ywet-thitpin,
141	*Floscopa scandens* Lour.	Commelinaceae	H	-
142	Garcinia sp.	Hypericaceae	ST	-
143	*Gentiana depressa* C.Nepal.	Gentianaceae	H	-
144	Geum sp.	Rosaceae	H	-
145	*Gladiolus* sp.	Iridaceae	H	-
146	*Gleichenia flexuosa* Smith	Hymenophyllaceae	F	-
147	*Globba* sp.	Zingiberaceae	H	-

148	*Glochidion* sp.1	Euphorbiaceae	S	-
149	*Glochidion* sp.2	Euphorbiaceae	S	-
150	*Gmelnia oblongifolia* Roxb.	Verbenaceae	T	-
151	*Gnaphalium affine* D. Don	Asteraceae	H	-
152	*Goodyera prolera* Hook.	Orchidaceae	H	-
153	*Gymnopetalum* sp.	Cucurbitaceae	Cl,Cr	-
154	*Hedychium spicatum* Sm.	Zingiberaceae	H	-
155	*Hedyotis* sp.1	Rubiaceae	H	-
156	*Hedyotis* sp.2	Rubiaceae	H	-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
157	*Hemistrepta* sp.1	Asteraceae	H	-
158	*Hemistrepta* sp.2	Asteraceae	H	-
159	*Heracleum* sp.	Apiaceae	H	-
160	*Hibiscus* sp.	Malvaceae	S	-
161	*Hodgsonia macrocarpa* (Bl.) Cogn.	Cucurbitaceae	Cl,Cr	-
162	*Homonoia* sp.	Euphorbiaceae	S	-
163	*Hoya carnosa* R.Br.	Asclepiadiaceae	Cl,Cr	-
164	*Hoya* sp.1	Asclepidiaceae	Cl,Cr	-
165	*Hoya* sp.2	Asclepiadiaceae	Cl,Cr	-
166	*Hoya* sp.3	Asclepiadiaceae	Cl,Cr	-
167	*Hoya* sp.4	Asclepidiaceae	Cl,Cr	-
168	*Hoya* sp.5	Asclepidiaceae	Cl,Cr	-
169	*Hoya* sp.6	Asclepiadiaceae	Cl,Cr	-
170	*Humata* sp.	Davalliaceae	F	-
171	*Hydrangea aspera* D. Don	Hydrangeaceae	T	-
172	*Hydrocotyle* sp.	Apiaceae	H	myin-kwa
173	*Hygrophila* sp.	Acanthaceae	H	-
174	Hypericum sp.1	Hypericaceae	H	-
175	Hypericum sp.2	Hypericaceae	S	-
176	Ichnocarpus sp.	Apocynaceae	Cl,Cr	-
177	*Impatiens arcemosa* DC.Prodr.	Balsaminaceae	H	-
178	*Ipomoea* sp.1	Convolvulaceae	Cl,Cr	-
179	*Ipomoea* sp.2	Convolvulaceae	Cl,Cr	-
180	*Ixeridium chinense* (Thunb.) Tzvelev	Asteraceae	H	-
181	*Jasminum* sp.	Oleaceae	Cl	-
182	Justicia sp.	Acanthaceae	S	-
183	Kalanchoe sp.	Crassulaceae	H	-
184	*Kyllinga nemoralis* (J.R. & G. Forst.) Dandy ex Hutch.	Cyperaceae	H	Thone-daunt-myet

	& Dalziel			
185	*Leea* sp.1	Leeaceae	S	-
186	*Lepisorus macrospaerus* (Bak.) Ching	Polypodiaceae	F	-
187	*Lindenbergia indica* (L.) Kuntze	Scrophulariaceae	H	-
188	Lindera pulcherrima (Nees) Hook. f.	Lauraceae	T	-
189	*Lindernia* sp.1	Linderniaceae	H	-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
190	*Lindernia* sp.2	Linderniaceae	H	-
191	*Liparis viridiflora* (Blume) Lindl.	Orchidaceae	H	-
192	*Liparis*sp.	Orchidaceae	H	-
193	Listea sp.1	Lauraceae	T	-
194	Listea sp.2	Lauraceae	T	-
195	Listea sp.3	Lauraceae	T	-
196	Listea sp.4	Lauraceae	T	-
197	Listea sp.5	Lauraceae	T	-
198	Listea sp.6	Lauraceae	T	-
199	Listea sp.7	Lauraceae	T	-
200	*Lithocarpus craibianus* Barnett	Fagaceae	T	-
201	*Lithocarpus* sp.	Fagaceae	T	-
202	*Loranthus* sp.	Loranthaceae	Parasitic shrub	-
203	*Luculia* sp.	Rubiaceae	S	-
204	*Lycopodium* sp.	Lycopodiaceae	F	-
205	*Macaranga denticulata* Muell. Arg.	Euphorbiaceae	T	-
206	*Macaranga kurzii* (O.k.) Pax & Hoffm.	Euphorbiaceae	T	-
207	*Macaranga* sp.	Euphorbiaceae	T	-
208	*Maesa chisia* Godayari	Myrsinaceae	ST	-
209	*Maesa montana* A.DC.	Myrsinaceae	S	-
210	Maesa sp.	Myrsinaceae	S	-
211	M*agnolia sp.*	Magnoliaceae	T	-
212	Mahonia sp.	Berberidaceae	S	-
213	*Malaxis calophylla*(Rolbf.) Kuntz.	Orchidaceae	E	-
214	*Manglietia garrettii* Craib	Magnoliaceae	T	-
215	*Melastoma* sp.	Melastomastaceae	S	-
216	*Melocalamus compactiflorus* (Kurz) Benth.G	Poaceae	B	Wa-nwe

217	*Melothria* sp.	Cucurbitaceae	Cl,Cr	-
218	*Michelia champaca* L.	Magnoliaceae	T	-
219	*Microsorium membranaceum* (D.Don.) Ching	Polypodiaceae	F	-
220	*Molineria caputulata* (Lour.) Herb	Hypoxidaceae	H	-
221	*Momordica cochinchinensis* (Lour.) Spreng.	Cucurbitaceae	Cl,Cr	Taw-thabut
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
222	*Monstera deliciosa* Liebm.	Araceae	H	-
223	*Musa* sp.	Musaceae	H	-
224	Naringi sp.	Rutaceae	ST	-
225	*Nephroletis auriculata* (L)Trimen	Polypodiaceae	F	-
226	*Oldenlandia corymbosa* L.	Rubiaceae	H	-
227	*Oldenlandia* sp.	Rubiaceae	H	-
228	Oplismenus compositus (L.) P. Beauv.	Poaceae	G	Myet-letthe
229	Oreocinides sp.	Urticaceae	ST	-
230	*Oreocnide fruticosa* (Gaudich.) Hand.-Mazz.	Urticaceae	ST	-
231	*Oroxylum* sp.	Bignoniaceae	T	-
232	*Osbeckia* sp.	Melastomastaceae	H	-
233	*Osmunda* sp.	Osmundaceae	T	-
234	*Otochilus* sp.	Orchidaceae	H	-
235	*Otochilus*sp.	Orchidaceae	H	-
236	*Oxalis corniculata* L.	Oxalidaceae	H	Hmo-chin
237	*Oxyspora* sp.	Melastomataceae	S	-
238	*Panicum brevifolium* L.	Poaceae	G	-
239	Panicum sp.	Poaceae	G	-
240	*Phlogacanthus pubinervius* E. Nepal	Acanthaceae	S	-
241	*Pholidota imbricata* Lindl.	Orchidaceae	E	-
242	Phragmite sp.	Poaceae	G	-
243	*Phrynium capitatum* Willd.	Marantaceae	H	Taungsin-phet
244	*Phyllagathis* sp.	Melastomastaceae	H	-
245	*Phyllanthus* sp.	Euphorbiaceae	S	-
246	*Phyllanthus urinaria* L.	Euphorbiaceae	H	Mye-shit-sha
247	*Physalis* sp.	Solonaceae	H	-
248	*Pilea nummulariifolia* (Sw.) Wedd.	Urticaceae	S	-
249	Pilea sp.	Urticaceae	S	-
250	*Piper longum* L.	Piperaceae	Cl,Cr	Nga-yok-kaung

No.	Scientific Name	Family	Habit	Common Name
251	*Piper* sp.1	Piperaceae	Cl,Cr	-
252	*Piper* sp.2	Piperaceae	H	-
253	*Piper thwaitseii* C. DC.	Piperaceae	H	-
254	*Piper wallichii* (Miq.) Hant.-Man	Piperaceae	S	-
255	*Plantago major* L.	Plantaginaceae	H	-
256	Plectranthussp.	Lamiaceae	H	-
257	*Poa annua* L.	Poaceae	G	-
258	*Pogonatherum* sp.	Poaceae	G	-
259	Polianthes sp.	Amaryllidaceae	H	-
260	*Polygonatum* sp.	Convallariaceae	H	-
261	*Polygonum* sp.1	Polygonaceae	H	-
262	*Polygonum* sp.2	Polygonaceae	H	-
263	*Polygonum* sp.3	Polygonaceae	H	-
264	*Polygonum* sp.4	Polygonaceae	H	-
265	*Polygonum* sp.5	Polygonaceae	H	-
266	*Polypoliodes amoena* (Wall.ex Mell.)Ching	Polypodiaceae	F	-
267	*Polystichum attenuatum* Tagawa et A.Iwats.	Dryopteridaceae	F	-
268	*Pothos* sp.1	Araceae	Cl,Cr	-
269	*Pothos* sp.2	Araceae	Cl,Cr	-
270	*Pratia begoniifolia* G.Don	Campanulaceae	S	-
271	Pronephrium lakhimpurense (Ros.) Holtt.	Thelypteridaceae	F	-
272	*Pronephrium* sp.	Thelypteridaceae	F	-
273	Pronephrium triphyllum (Sw.)Holtt.	Thelypteridaceae	F	-
274	*Prunus dulcis* (Mill.) D.A. Webb	Rosaceae	T	-
275	*Prunus persica* Benth.& Hook.f.	Rosaceae	T	-
276	*Pteris cretica* L.Var.nervosa (Thumb.) Chinget S.H.Wu	Pteridaceae	F	-
277	*Pteris* sp.	Pteridaceae	F	-
278	*Pteris*sp	Pteridaceae	F	-
279	*Pyrrosia lingua* (Thunb.) Farwell	Polypodiaceae	F	-
280	Pyrrosia sp.	Polipodiaceae	F	-
281	*Pyrus communis* L.	Rosaceae	T	-
282	*Rhododendron* sp.1	Ericaceae	ST	-
283	*Rhododendron* sp.2	Ericaceae	ST	-
284	*Rhododendron* sp.3	Ericaceae	ST	-

285	*Ricinus communis* L.	Euphorbiaceae	ST	Kyetsu
286	*Rosa* sp.	Rosaceae	S	-
287	*Rubia cordifolia* L.	Rubiaceae	Cl,Cr	Pe-seint-ni-pin
288	*Rubus moluccanus* L.	Rosaceae	S	-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
289	*Rubus* sp.1	Rosaceae	S	-
290	*Rubus* sp.2	Rosaceae	S	-
291	*Rubus* sp.3	Rosaceae	S	-
292	*Rubus*sp.4	Rosaceae	S	-
293	*Ruellia* sp.	Acanthaceae	H	-
294	*Saurauia napaulensis* DC.	Actinidiaceae	ST	-
295	*Saurauia* sp.1	Actinidiaceae	ST	-
296	*Saurauia* sp.2	Actinidiaceae	ST	-
297	*Saurauia* sp.3	Actinidiaceae	ST	-
298	*Schefflera petelotii* Merr.	Araliaceae	T	-
299	*Schefflera* sp.1	Araliaceae	T	-
300	*Schefflera* sp.2	Araliaceae	Cl,Cr	-
301	*Schefflera* sp.3	Araliaceae	Cl,Cr	-
302	*Schima khasiana* Dyer	Theaceae	T	-
303	*Schoutenia* sp.	Tiliaceae	T	-
304	*Selaginella* sp.1	Selaginellaceae	F	-
305	*Selaginella* sp.2	Selaginellaceae	F	-
306	*Senecio scandens* Buch.-Ham. ex D. Don	Asteraceae	Cl,Cr	-
307	*Setaria* sp.1	Poaceae	G	-
308	*Setaria* sp.2	Poaceae	G	-
309	*Smilax aspericaulis* Wall.	Smilaceae	Cl,Cr	-
310	*Smilax macrophylla* Roxb.	Smilaceae	Cl,Cr	-
311	*Smilax* sp.1	Smilaceae	Cl,Cr	-
312	*Smilax* sp.2	Smilaceae	Cl,Cr	-
313	*Smilax* sp.3	Smilaceae	Cl,Cr	-
314	*Solanum nigrum* Linn	Solonaceae	H	-
315	*Solanum* sp.1	Solanaceae	H	-
316	*Solanum* sp.2	Solonaceae	H	-
317	*Solanum* sp.3	Solonaceae	H	-
318	*Solanum* sp.4	Solonaceae	H	-
319	*Solanum torvum* Swartz	Solonaceae	H	-
320	*Spondias* sp.	Anacardiaceae	T	-
321	*Stachyphrynium spicatum* (Roxb.) K.Shum	Marantaceae	H	-
322	*Stephania discolor* Spreng	Menispermaceae	Cl	-

323	*Stephania* sp.1	Menispermaceae	Cl	-
324	*Stephania* sp.2	Menispermaceae	Cl	-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
325	Streptolirion volubile Edgew.	Commelinaceae	H	-
326	Strobilanthessp.	Acanthaceae	S	-
327	*Styrax* sp.	Styracaceae	ST	-
328	*Symplocos* sp.	Symplocaceae	S	-
329	*Syngonium*sp.	Araceae	H	-
330	*Taiwania cryptomerioides* Hayata	Taxodiaceae	T	Tayok-khaung-bin
331	*Tapeinochilos ananassae* (Hassk.) K. Schum.	Costaceae	H	-
332	*Tectaria* sp.	Aspidiaceae	F	-
333	*Terminalia* sp.	Combretaceae	T	-
334	*Thespesia* sp.2	Malvaceae	ST	-
335	*Thladiantha dubia* Bunge	Cucurbitaceae	Cl,Cr	-
336	*Torenia* sp.1	Linderniaceae	H	-
337	*Torenia* sp.2	Linderniaceae	H	-
338	*Trema orientalis* L.	Ulmaceae	ST	-
339	*Trigonotis amblyosepala* Nakai & Kitag.	Boraginaceae	-	-
340	*Triraphis madagascariensis* (Kunth) Hook. f. ex Prain	Poaceae	G	-
341	Tropidiasp.	Orchidaceae	H	-
342	UN-1	Apiaceae	H	-
343	UN-2	Zingiberaceae	H	-
344	UN-3	-	-	-
345	UN-4	Convolvulaceae	Cl,Cr	-
346	UN-5	Asteraceae	H	-
347	UN-6	Cucurbitaceae	Cl,Cr	-
348	UN-7	Poaceae	G	-
349	UN-8	Gesneriaceae	S	-
350	UN-9	Malvaceae	S	-
351	UN-10	Lauraceae	T	-
352	UN-11	Lauraceae	T	-
353	UN-12	-	-	-
354	UN-13	Rubiaceae	Cl,Cr	-
355	UN-14	-	Cl	-
356	UN-15	-	Cl	-
357	UN-16	-	-	-
358	UN-17	-	ST	-
359	UN-18	Euphorbiaceae	-	-

No.	Scientific Name	Family	Habit	Common Name
360	UN-19	-	Cl	-
361	UN-20	Melastomastaceae	S	-
362	UN-21	-	Cl	-
363	UN-22	Lauraceae	T	-
364	UN-23	Araliaceae	T	-
365	UN-24	-	-	-
366	UN-25	-	-	-
367	UN-26	Poaceae	B	-
368	UN-27	-	-	-
369	UN-28	-	Cl	-
370	UN-29	-	-	-
371	UN-30	Lauraceae	T	-
372	UN-31	-	-	-
373	UN-32	Rubiaceae	S	-
374	UN-33	-	Cl	-
375	UN-34	Euphorbiaceae	-	-
376	UN-35	-	-	-
377	UN-36	-	T	-
378	UN-37	-	T	-
379	UN-38	-	S	-
380	UN-39	-	-	-
381	UN-40	-	-	-
382	UN-41	-	-	-
383	UN-42	Bignoniaceae	T	-
384	UN-43	-	Cl	-
385	UN-44	Menispermaceae	Cl	-
386	UN-45	-	-	-
387	UN-46	-	-	-
388	UN-47	-	-	-
389	UN-48	-	Cl	-
390	UN-49	-	S	-
391	UN-50	Apiaceae	H	-
392	UN-51	-	-	-
393	UN-52	-	-	-
394	UN-53	Euphorbiaceae	-	-
395	UN-54	Urticaceae	S	-
396	UN-55	Scrophulariaceae	H	-
No.	Scientific Name	Family	Habit	Common Name
397	UN-56	-	-	-

398	UN-57	Acanthaceae	H	-
399	UN-58	Asteraceae	H	-
400	UN-59	Malvaceae	S	-
401	UN-60	Rutaceae	ST	-
402	UN-61	Annonaceae	T	-
403	UN-62	Asteraceae	H	-
404	UN-63	Lamiaceae	H	-
405	UN-64	Asteraceae	H	-
406	UN-65	Asteraceae	H	-
407	UN-66	Verbenaceae	T	-
408	UN-67	Euphorbiaceae	-	-
409	UN-68	Zingiberaceae	H	-
410	UN-69	-	-	-
411	UN-70	Euphorbiaceae	-	-
412	UN-71	Lauraceae	T	-
413	UN-72	Lamiaceae	H	-
414	UN-73	Asteraceae	H	-
415	UN-74	Boraginaceae	T	-
416	UN-75	Poaceae	G	-
417	UN-76	Asteraceae	H	-
418	UN-77	Orchidaceae	E	-
419	UN-78	Meliaceae	T	-
420	UN-79	Lamiaceae	H	-
421	UN-80	Fabaceae	-	-
422	*Urena lobata* L.	Malvaceae	S	Kat-sine
423	Urtica sp.	Urticaceae	S	-
424	*Vaccinium* sp.	Vicciniaceae	Cl,Cr	-
425	*Vernonia* sp.1	Asteraceae	S	-
426	*Vernonia* sp.2	Asteraceae	S	-
427	*Vernonia* sp.3	Asteraceae	S	-
428	*Vernonia* sp.4	Asteraceae	S	-
429	*Viola acuminata* Ledeb.	Violaceae	H	-
430	*Viola prionantha* Bunge	Violaceae	H	-
431	*Vitis japonica* Thunb.	Vitaceae	Cl,Cr	-
432	*Vitis* sp.1	Vitaceae	Cl,Cr	-
433	*Vitis* sp.2	Vitaceae	Cl,Cr	-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
434	*Vitis* sp.3	Vitaceae	Cl,Cr	-
435	*Vittaria ensiformis* Sw.	Vittariaceae	F	-
436	*Vittaria* sp.	Vittariaceae	F	-

437	*Vittaria* sp.	Vittariaceae	F	-
438	*Wattakaka* sp.	Asclepiadiaceae	Cl,Cr	Gwe-dauk-nwe
439	*Woodwardia* sp.	Blenchnaceae	T	-
440	*Zingiber* sp.	Zingiberaceae	H	-
441	*Ziziphus* sp.1	Rhamnaceae	S	-
442	*Ziziphus* sp.2	Rhamnaceae	S	-
443	*Ziziphus* sp.3	Rhamnaceae	Cl,Cr	-

B = Bamboo, Cl = Climber, Cr = Creeper, E = Epiphyte, F = Fern, G = Grass, H = Herb, S = Shrub, ST = Small Tree, T = Tree

Appendix – II Khaunglanhpu Vegetation Type

No.	Locality	Vegatation Type	Latitude	Longitude	Altitude	Notes
1	East bank of Maykha river around Khaunglanhpu	Oak forest	27˚ 04′ 02.5″	98˚ 20′ 25.8″	705 m	*Castanopsis tribuloides, Castanopsis diversiflia, Castanopsis* sp., *Lithocarpus* sp. assosiate with *Macaranga denticulata, Spondias* sp.& *Cinnamoum* sp. are found in tree layer. Shrub layer is dominated by *Osbeckia* sp., *Rubus* sp..Herb layer is dominated by *Commelina* sp., *Polygonum* sp. ,and *Plantago* sp..
2	West side of Maykha river, near Ridam village	Oak forest	27˚ 12′ 45.2″	98˚ 13′ 14.9″	725 m	
3	Near Confluence of Achanhti & Maykha rivers	Oak forest	27˚ 02′ 20.1″	98˚ 21′ 43.5″	743 m	
4	East side of Maykha river, near Ridam village	Oak forest	27˚ 11′ 23.7″	98˚ 15′ 03.7″	772 m	
5	Down stream of Confluence of Achanhti & Maykha rivers	Oak forest	27˚ 02′ 14.1″	98˚ 21′ 54.5″	776 m	
6	Near Confluence of Achanhti & Maykha rivers, down stream	Oak forest	27˚ 02′ 33.7″	98˚ 21′ 41.1″	831 m	
7	East bank of Maykha river around Khaunglanhpu	Oak forest	27˚ 04′ 09.8″	98˚ 20′ 28.7″	807 m	
8	Around the confluence of Achanhti & Maykha rivers	High land evergreen forest	27˚ 03′ 21.6"	98˚ 21′ 22.0″	1258 m	*Saurauia* sp., *Spondias* sp., *Cinnamomum* sp., *Litsea cubeba*, *Macaranga diversifolia* are found in tree layer, associate with *Ficus* sp., *Elaeocarpus* sp..Shrub layer is dominated by *Maesa* sp., *Ploygonum* sp., *Phlogacanthus pubinervius*, and *Buddleja* sp. Herb layer is dominated by *Begionia* sp., *Commelina* sp., *Oxalis* sp., and *Viola* sp.
9	West side of Achanti River, near Khaunglanhpu	High land evergreen forest	27˚ 04′ 23.1"	98˚ 21′ 58.5″	1330 m	
10	West side of Achanti River, near Khaunglanhpu	High land evergreen forest	27˚ 03′ 47.5"	98˚ 22′ 04.3″	1341 m	
11	Achanti River side, near Khaunglanhpu	High land evergreen forest	27˚ 04′ 23.1"	98˚ 21′ 19.0″	1350 m	
No.	**Locality**	**Vegatation Type**	**Latitude**	**Longitude**	**Altitude**	**Notes**
12	West side of Maykha river, near Khaunglanhpu	High land evergreen forest	27˚ 03′ 47.7	98˚ 21′ 36.2″	1434 m	

13	Near the old track between Htiriwunkhaung & Khaunglanhpu	High land evergreen forest	27° 06′ 04.5	98˚ 21′ 04.9″	1430 m	
14	East bank of Maykha river around Khaunglanhpu	High land secondary forest	27° 03′ 47.6″	98˚ 21′ 04.9″	2191 m	*Michelia champaca.*, *Schefflera* sp., *Cinnamomum* sp. & *Saurauia napaulensis* are found in tree layer. Shrub layer is dominated by *Smilax* sp. & *Asplenium* sp.. Herb layer is dominated by *Begonia semperflorens.*, *Adiantum* sp.,*Ploygonum* sp.
15	West bank of Achanti river and around Khaunglanhpu	High land secondary forest	27° 05′ 58.4"	98˚ 21′ 28.8″	1100 m	
16	West bank of Achanti river and around Khaunglanhpu	High land secondary forest	27° 04′ 05.8"	98˚ 21′ 46.3″	1247 m	
17	West side of Maykha river,near Khaunglanhpu	Bamboo forest	27° 03′ 35.6"	98˚ 21′ 30.3″	1535 m	
18	East side of Maykha river, near Ridam village	Bamboo forest	27˚ 11′ 35.5″	98˚ 15′ 45.6″	763 m	*Dendrocalamus hamiltonii Ness.*, *D. giganteus Munro.*,& *Melocalamus compactiflorus*
19	Around the confluence of Achanhti & Maykha rivers	Bamboo forest	27° 01′ 42.8"	98˚ 21′ 44.7″	905 m	
20	East side of Maykha river, near Khaunglanhpu	Bamboo forest	27° 03′ 40.7"	98˚ 22′ 00.7″	925 m	
21	Down stream of Confluence of Achanhti & Maykha rivers	Bamboo forest	27° 02′ 34.5″	98˚ 21′ 45.2″	730 m	
22	Down stream of Confluence of Achanhti & Maykha rivers	Bamboo forest	27° 02′ 05.4″	98˚ 21′ 67.8″	756 m	
23	Around the confluence of Achanhti & Maykha rivers	Bamboo forest	27° 02′ 27.4"	98˚ 21′ 46.9″	764 m	
24	West side of Maykha river, near Ridam village	Shifting Cultivation	27° 03′ 40.5″	98° 21′ 56.6″	1540 m	Brassica sp., *Panicum* sp., *Sorghum* sp.
25	East side of Maykha river,near Khaunglanhpu	Shifting Cultivation	27° 02′ 27.4″	98˚ 21′ 46.9″	764 m	
26	West side of Achanti river,near Khaunglanhpu	Shifting Cultivation	27° 04′ 39.5″	98° 22′ 35.6″	1233 m	
27	Near the old track between Htiriwunkhaung & Khaunglanhpu	Shifting Cultivation	27° 05′ 58.4″	98° 28′ 21.8″	1690 m	
28	East side of Maykha river, near Ridam village	Terrace Cultivation	27° 05′ 55.5″	98° 20′ 29.0″	663 m	
29	West side of Maykha river,near Khaunglanhpu	Terrace Cultivation	27° 03′ 32.4″	98˚ 21′ 38.9″	750 m	Paddy
30	West side of Maykha river,near Phulone village	Terrace Cultivation	27° 03′ 32.4″	98˚ 21′ 38.7″	1493 m	

Chapter III

3. Biodiversity Impact Assessment Report of Flora on Pisa and Wusok Hydropower Dam

3.1. Introduction

The biodiversity impact assessment, especially on the plant diversity in intended inundated area and the surrounding area of Pisa and Wusok Dams on Mayhka River which will be constructed in the near future, has been carried out in April 2009. The study includes forest type and vegetation, species composition and dominant species, potential impacts both for long term and short term and possible mitigation measures.

3.1.2. Location

The Pisa Hydropower Dam project area is located on the stream next to the Wusok dam, lies between 26º44´N and 98º 22´E in Tsawlaw Township and about one kilometre downstream confluence mouth of Mayhka River and Mekharame stream near one rapid of Mayhka River. The catchment area is approximately 16689 Km^2 and total flooded area is 689.4 hectare. Normal pool level is 875 m and total strange capacity is 5.35 Gm^3. The dam site is on the upstream of the Mayhka River and it may be third one below the down-stream of Khaunglanhpu Dam. It is one of the additional dams among five hydropower dam on Mayhka River. The Wusok Dam lies between 26º31´N and 98º 18 ´E and about 34.5km distance from Pisa Dam. There are eight rapids on the upstream of the dam. The catchment area is 3153 sq-km and total flooded area is 497.3 hectare. The storage capacity is 3.31Gm^3. This is the fourth dam on the upstream of the Myahka River below the downstream of the Pisa Dam. It is also one of the five dams on the same river Mayhka.

Both Pisa and Wusok Dam sites lie in the high mountain and gorges. The Mayhka River in this region flows in the narrow V shape valley and has steep bank slope. The flooded areas of dams are narrow and long along the river. So both dams are cascade dams and may be environmentally benign dams.

3.1.3. Topography

The bulk of Pisa and Wusok Dams area falls 26º31´to 26º44´N latitude and 98º 18´ to 98º 22´E longitude and reach between Pashe Village on the south and along Mayhka River up to 48 kilometre upstream. There are nine rapids within 48 kilometre due to high elevation. (Map- 4) The elevation becomes more than 1500 m near rapids. The river flows along the narrow valley. The topography of the area is high land of above 900 m in elevation.

3.1.4. Climate

The climate of Pisa and Wusok Dams area in general is also seasonal and monsoon climate. In accordance with the pattern of Kachin State, there are three distinct seasons, cool dry, hot dry and warm wet. Vegetation pattern in some valleys which receive the cool wind blowing from the snow capped mountains is different from that of valleys in which the warm wind flows. The pine forests are found along mountain tracks in cool wind blowing areas. The rainfall is uniform across the whole area and annual average is near 100 inches. The light showers are frequent throughout the year.

3.1.5. Forest in the context of Eco-region

The Pisa and Wusok Dams areas lie in two WWF Eco-regions of Northern Triangle temperate forest and Mizoram-Manipur-Kachin moist evergreen forest. It is also located near the priority site for conservation investment of Northern mountain forest complex.

The forests in the catchment areas of the dams are the same that of Mayhka including Hkakaborazi N.P Hponganrazi W.S and Emawbum mountain forests. So the areas are the biodiversity hot-spot areas and globally outstanding for conservation. The forest types are highland evergreen forests, low land evergreen forests, oak forests, secondary degraded forests and bamboo forests. The degraded forests are the result of shifting cultivation.

3.1.6. Local people and their livelihood

There are only two villages namely Pashe Village and Warup Village near Wusok dam and Chaungdam Village near Pisa dam. People dwelling in these areas are very sparse and also village are very scattered. Most of the dwellers are Kachin and their livelihood is very simple cultivating Taungyar rice and vegetables, breeding poultry, hunting and fishing.

3.2. Aims and Objectives

1. To collect, identify and list the plant species in the area
2. To record the dominant tree species and evaluate the forest type
3. To study the impact of dam on the flora and to suggest the mitigation measure

3.3. Materials and Methods

3.3.1. Participants

There are six Myanmar members in Myanmar flora team: Dr Myint Aung, Dr Kahlayar lu, Dr Kyaw Soe Naing, Daw Thin Thin Su, Daw Khin Khin Soe and U Tay Zar Aung Aung and Chinese flora team.

3.3.2. Materials

Materials used for recording are strings for sample plotting, digital camera, maps compass, field press, data collection sheets, drying press, dryer, digging tools, heavy duty plastic bags, newspapers, alcohol, spray jug (for fixing specimens) 10 x lens, permanent markers and other field equipments.

3.3.3. Methods

One research team with six Myanmar scientists was organized and studies were conducted especially in the areas which may be inundated after the dam is constructed. The plant specimens were collected both in inundated areas and habitats of representative areas.

The Global Positioning System was used to navigate and mark coordinates between sample plots in each habitat. In order to obtain essential ecological data for predicting forest value and forest type, quadrants of varying size were set up and observed. Plant collection (all trees, shrubs and herbs) was carried out in random and by Transit line whenever possible to get the representative checklists of the plants in the studied area and all specimens are identified and recorded. DBH and Height classes at tree species are calculated based on the measurement of breast height diameters along with its height.

Field press and drying press were used to get voucher specimens and to store in herbarium. Habitat type's altitude, topography, forest type, canopy cover and structure, light intensity, wind velocity and sign of disturbance were recorded. To know the habit of the plant species and to ensure the vegetation, photographic records were also carried out.

Leaves, inflorescences, floral structures and other vegetative parts of each plant specimens were collected and photographed and recorded as field notes.

3.4. Results

3.4.1. Floristic Composition in the study area

The total number of species collected in the Pisa Dam area is 351 species and Wusok Dam area is 323 species belonging to the 96 different families. (Appendix- I, II)

The forest types are determined in accordance with species composition in the respective area. According to their species composition in sample plots the dominant tree species, shrub species and herb species were determined. (Appendix- III)

3.4.2. The human impact in the study area

The rice cultivation is the inevitable livelihood of the local communities. The cultivated lands were created by burning forests. The shifting cultivation is the only method used by local people. The result is the degradation and loss of forests so terrace cultivation and irrigated cultivation should be introduced and practised.

3.5. Discussion and Conclusion

The evergreen tree species; *Castanopsis* sp., *Quercus* sp., *Lithocarpus* sp., associated with *Dipteroarpus* sp., *Mallotus* sp., *Ficus* sp., and *Sterculia* sp., dominate in the study area. However only 38.0% are above 60 cm and 62 % are under 60 cm in girth and 13% is 5 m and 87 % above 5 m in height. Thus one can estimate the value of the forest.

The tree species are the value of the forest. The degradation of forest is only due to shifting cultivation. However since the population dwelling in this area is very sparse, the shifting cultivation is not the major issue.

The disturbance such as logging is scare due to improper infrastructure. But it will be possible if new access roads to hydroelectric dams are constructed. So to prevent de-forestation, new protected areas and national parks such as Emawbum N.P should be established and strict laws should be enforced.

The natural vegetation pattern in the study area composes of low land evergreen forest and oak forest patches with bamboo forests and degraded forests. The species richness is moderate. The understory and canopy layers are typically mixed evergreen. Most of the emergent trees are deciduous. The species density is lower in the areas away from streams and ridges and convex areas. The moist sites are more in species richness than the dry sites formed due to different elevation.

The dominant tree species are *Dipterocarpus* sp., *Saurauia* sp., *Ficus* sp., *Mallotus* sp., *Musa* sp., *Sterculia* sp., *Castanopsis* sp., *Quercus* sp., *Lithocarpus* sp., in the layer. The shrub layer is dominated by *Gnetum* sp., *Wallichia* sp., *Rubia* sp., *Schefflera* sp., *Eurya* sp., *Stachyphrynium* sp., and *Canthium* sp.

The herb layer is dominated by *Pteris* sp., *Aslpenium* sp., *Hedychium* sp., *Melastoma* sp., *Cyprus* sp., *Selaginella* sp., *Begonia* sp., *Piper* sp., and *Pronephrium* sp.

The degraded forest dominated by shrubs and banana is found near villages. Bamboo forests are found near villages and rivers.

The oak forest dominated by *Quercus* sp., *Castanopsis* sp., *Lithocarpus* sp., associated with *Sterculia* sp., *Mallotus* sp., and *Eurya* sp., are also found in study area.

The Pisa Dam is the third dam and Wusok Dam is the fourth dam on the Mayhka River. Pisa Dam lies between the downstream of Khaunglanhpu Dam and upstream of Wusok Dam and about 40km distance from Khaunglanhpu Dam and about 35 km distance from Wusok Dam.

So the likely impacts of series of dam on the same river system may be inevitable. Implementation of mitigation measures for cumulative impacts assessment should be completed or well underway prior to construction of second dam, then third, then forth and then fifth dam on the river.

3.6. Recommendation

1. The cumulative environmental impact assessment should be carried out since the series of dams are planned to construct on the same river.
2. The construction of second dams should begin only after the first dam construction is completed and well under running condition.
3. The extension of existing national parks and wildlife sanctuaries and establishing new ones and catchment area management should be immediately started.
4. The socioeconomic development and community development of local people should be planned out.

Table – 1 Tree species in DBH class intervals in Wusok

DBH Classes	No. of species	Total number of individual	% of total species
< 30 cm	94	726	38.84
30 - 60 cm	54	212	22.31
60 - 90 cm	29	45	11.98
90 - 120 cm	24	39	9.92
120 - 150 cm	10	13	4.13
150 - 180 cm	8	11	3.31
180 - 210 cm	8	13	3.31
210 -240 cm	6	6	2.48
240 - 270 cm	1	2	0.41
270 - 300 cm	3	3	1.24
300 - 330 cm	1	1	0.41
330 - 360 cm	3	5	1.24
360 - 390 cm	-	-	0.00
390 - 420 cm	-	-	0.00
420 - 450 cm	-	-	0.00
450 - 480 cm	1	1	0.41
480 - 510 cm	-	-	0.00
510 - 540 cm	-	-	0.00
540 - 570 cm	-	-	0.00
> 570 cm	-	-	0.00
Total	110	1077	100.00

Table - 2 Tree species in Height class intervals in Wusok

Height Classes	No. of species	Total number of individual	% of total species
< 3m	8	32	3.32
3 - 10 m	81	429	33.61
10 - 17 m	81	425	33.61
17 - 24 m	33	91	13.69
24 - 31 m	35	97	14.52
31 - 38	1	1	0.41
> 38 m	2	2	0.83
Total	110	1077	100.00

Appendix -I Wusok Plant Lists

No.	Scientific Name	Family Name	Habit	Common Name
1	Acmella sp.	Asteraceae	H	-
2	Adiantum sp.	Adiantaceae	F	-
3	Aeschynanthus sp.	Gesneriaceae	S	-
4	Aeschynanthus sp.	Gesneriaceae	S	-
5	*Ageratum conyzoides* L.	Asteraceae	H	-
6	Aglaia sp.	Meliaceae	T	-
7	*Alangium* sp.	Alangiaceae	T	-
8	Allantodia similis W.M.Chu	Dryopteridaceae	F	-
9	Alnus nepalensis D. Don	Betulaceae	T	-
10	*Alphonsea* sp.	Annonaceae	ST	-
11	*Alpinia zerumbet* (Pers.) B.L. Burtt & R.M. Sm.	Zingiberaceae	H	-
12	Ampelopsis sp.	Vitaceae	Cl, Cr	-
13	Angiopteus holsouersis Ching	Angiopteridaceae	F	-
14	Antidesma sp.	Euphorbiaceae	T	-
15	Antrophyum sp.	Vittariaceae	F	-
16	Aralia sp.	Araliaceae	T	-
17	*Archidendron clyperaria* (Jack) Nielsen	Mimosaceae	T	-
18	Ardisia sp.1	Myrsinaceae	ST	-
19	Ardisia sp.2	Myrsinaceae	ST	-
20	Ardisia sp.3	Myrsinaceae	ST	-
21	*Arenga triandra* Roxb.	Arecaceae	T	Taw kun thi
22	Arisaema sp.	Araceae	H	-
No.	Scientific Name	Family Name	Habit	Common Name
23	Asechynanthus sp.1	Gesneriaceae	S	-
24	Asechynanthus sp.2	Gesneriaceae	S	-

25	Asplenium prolongatum Hook	Aspleniaceae	F	-
26	Asplenium sp.1	Aspleniaceae	F	-
27	Asplenium sp.2	Aspleniaceae	F	-
28	Asplenium sp.3	Aspleniaceae	F	-
29	Asplenium sp.4	Aspleniaceae	F	-
30	Asplenium sp.5	Aspleniaceae	F	-
31	Asplenium sp.6	Aspleniaceae	F	-
32	Athyriopsis sp.	Athyriaceae	F	-
33	Begonia sp.1	Begoniaceae	H	-
34	Begonia sp.2	Begoniaceae	H	-
35	Begonia sp.3	Begoniaceae	H	-
36	Begonia sp.4	Begoniaceae	H	-
37	Begonia sp.5	Begoniaceae	H	-
38	Betula sp.	Betulaceae	T	-
39	*Bichofia tritiflorus* HK	Euphorbiaceae	T	-
40	Blechnum oreintale L.	Blechnaceae	F	-
41	*Boehmeria platyphyllum* Buch. - Ham. ex D.don	Urticaceae	S	Khwetayaw
42	Boehmeria sp.1	Urticaceae	S	-
43	Boehmeria sp.2	Urticaceae	S	-
44	Boehmeria sp.3	Urticaceae	H	-
45	*Breynia officinalis* Hemsl.	Euphorbiaceae	T	-
46	*Broussonetia* sp.1	Moraceae	T	-
47	*Broussonetia* sp.2	Moraceae	T	-
48	Bulbophyllum Odoratissimum (J.TC.Sm) Lindl	Orchidaceae	E	-
49	Bulbophyllum sp.1	Orchidaceae	E	-
50	Bulbophyllum sp.2	Orchidaceae	E	-
51	Butea sp.	Fabaceae	Cl	-
52	Calanthe triplicata (Willem.) Ames	Orchidaceae	H	-
53	*Callicarpa* sp.	Verbenaceae	T	Kyunnalein
54	Canthium sp.	Rubiaceae	S	-
55	Carallia sp.	Rhizophoraceae	T	-
56	*Caryota gigas* Hahn ex hodel	Arecaceae	T	-
57	*Castanopsis calathiformis* (Skan) Resd &Wils	Fagaceae	T	-
58	*Castanopsis* sp.	Fagaceae	T	-
No.	**Scientific Name**	**Family Name**	**Habit**	**Common Name**
59	Cayratia japonica (Thunb.) Gagnep.	Vitaceae	Cl	Langpum
60	Cayratia sp.	Vitaceae	Cl, Cr	-
61	Cinnamomum sp.1	Lauraceae	T	-
62	Cinnamomum sp.2	Lauraceae	T	-

63	Cinnamomum sp.3	Lauraceae	T	-
64	Cinnamomum sp.4	Lauraceae	T	-
65	Citrus sp.	Rutaceae	ST	-
66	Clerodendrum sp.1	Verbenaceae	S	-
67	Clerodendrum sp.2	Verbenaceae	S	-
68	Colona sp.	Tiliaceae	ST	-
69	Colysis sp.	Polypodiaceae	F	-
70	Commelina sp.1	Commelinaceae	H	-
71	Commelina sp.2	Commelinaceae	H	-
72	Costus sp.	Costaceae	H	-
73	Cotoneaster sp.	Rosaceae	S	-
74	Crassocephalum crepidioides (Benth.) S. Moore	Asteraceae	H	-
75	Cyathula sp.	Amaranthaceae	H	-
76	Cyclosorus sp.	Thelypteridaceae	F	-
77	Dalbergia sp.	Fabaceae	S	-
78	Daphanimorpha sp.	Thymelaceae	T	-
79	*Debregeasia* sp.	Urticaceae	ST	-
80	*Decaspermum*sp.	Myrtaceae	T	-
81	Dendrobium Sulcatum Lindl.	Orchidaceae	E	-
82	Dichorisandra sp.	Commelinaceae	H	-
83	*Dichrocephala bicolor* (Roth) Schltdl.	Asteraceae	H	-
84	Diospyros sp.1	Ebenaceae	ST	-
85	Diospyros sp.2	Ebenaceae	ST	-
86	Dipteris Chinensis Christ	Polypodiaceae	F	-
87	Dipterocarpus obtusifolius Teysm.	Dipterocarpaceae	T	-
88	Dryopteris sp.1	Dryopteridaceae	F	-
89	Dryopteris sp.2	Dryopteridaceae	F	-
90	Ehretia sp.	Boraginaceae	ST	-
91	Elaeocarpus decipiens Hemsl.	Elaeocarpaceae	T	-
92	*Elaeocarpus* sp.	Elaeocarpaceae	T	-
93	Elatostema sp.1	Urticaceae	S	-
94	Elatostema sp.2	Urtiacaceae	S	-
95	Elsholtzia sp.1	Lamiaceae	H	-
No.	**Scientific Name**	**Family Name**	**Habit**	**Common Name**
96	Elsholtzia sp.2	Lamiaceae	H	-
97	*Entada phaseoloides* (L.) Merr. U	Fabaceae	Cl	Donwe
98	Epigeneiumsp.	Orchidaceae	E	-
99	Equisetum sp.	Equisetaceae	F	-
100	Eria discolor Lindl.	Orchidaceae	E	-

101	Eria sp.	Orchidaceae	E	-
102	Erigeron sp.	Asteraceae	H	-
103	Fagopyrum sp.	Polygonaceae	H	-
104	Festuca sp.	Poaceae	G	-
105	*Ficus auriculata* Lour.	Moraceae	T	-
106	*Ficus hirta* Vahl.	Moraceae	T	-
107	*Ficus semicordata* Buch.-Ham. ex J.E. Sm.	Moraceae	T	-
108	Ficus sp.1	Moraceae	T	-
109	Ficus sp.2	Moraceae	T	-
110	Ficus sp.3	Moraceae	T	-
111	Ficus sp.4	Moraceae	T	-
112	Ficus sp.5	Moraceae	T	-
113	*Galinsoga ciliata* (Raf.) S.F. Blake	Asteraceae	H	-
114	Garcinia sp.	Hypericaceae	T	-
115	Globba sp.	Zingiberaceae	H	-
116	Glochidion sp.	Euphorbiaceae	ST	-
117	*Gnaphalium affine* D. Don	Asteraceae	H	-
118	Gnephalium sp.	Asteraceae	H	-
119	*Gnetum gnemon* L.	Gnetaceae	S	-
120	Goodyera prolera Hook.	Orchidaceae	H	-
121	Habenaria sp.	Orchidaceae	H	-
122	Habenaria sp.	Orchidaceae	H	-
123	Hedychium sp.1	Zingibearaceae	H	-
124	Hedychium sp.2	Zingibearaceae	H	-
125	*Houttuynia cordata* Thunb.	Saururaceae	H	-
126	Hoya sp.1	Asclepiadaceae	Cl	-
127	Hoya sp.2	Asclepiadaceae	Cl	-
128	*Hydrangea aspera* D. Don	Hydrangeaceae	T	-
129	*Hydrocotyle* sp.	Apiaceae	Cr	-
130	Ilex micrococca Maxim.	Aquifoliaceae	T	-
131	Ilex sp.1	Aquifoliaceae	T	-
132	Ilex sp.2	Aquifoliaceae	T	-
No.	**Scientific Name**	**Family Name**	**Habit**	**Common Name**
133	Ilex sp.3	Aquifoliaceae	T	-
134	*Impatiens* sp.1	Balsaminaceae	H	-
135	*Impatiens* sp.2	Balsaminaceae	H	-
136	Indigoferasp.	Fabaceae	S	-
137	Itea sp.	Escalloniaceae	T	-
138	*Knema furfuracea* (HK. F.et Th.) Warb.	Myristicaceae	T	-

139	Laminum sp.	Lamiaceae	H	-
140	Lannea sp.	Anacardiaceae	T	-
141	Lasianthus sp.1	Rubiaceae	ST	-
142	Lasianthus sp.2	Rubiaceae	S	-
143	Leea sp.1	Leeaceae	S	-
144	Leea sp.2	Leeaceae	S	-
145	Lemmaphyllum sp.	Polypodiaceae	F	-
146	Lemmaphyllum microphyllum C. Presl	Polypodiaceae	F	-
147	Ligustrum sp.	Oleaceae	ST	-
148	Lindernia sp.	Linderniaceae	H	-
149	Liparis viridiflora (Blume) Lindl	Orchidaceae	H	-
150	Lithocarpus sp.	Fagaceae	T	-
151	*Litsea cubeba* (Lour.) Pers.	Lauraceae	T	-
152	Litsea macrophylla Bl.	Lauraceae	T	-
153	Litsea sp.1	Lauraceae	T	-
154	Litsea sp.2	Lauraceae	T	-
155	Lycopodium sp.1	Lycopodiaceae	F	-
156	Lycopodium sp.2	Lycopodiaceae	F	-
157	Lycopodium sp.3	Lycopodiaceae	F	-
158	Lycopodium sp.4	Lycopodiaceae	F	-
159	Macaranga sp.1	Euphorbiaceae	T	-
160	Macaranga sp.2	Euphorbiaceae	T	-
161	Machilus sp.	Lauraceae	T	-
162	Maesa sp.1	Myrsinaceae	S	-
163	Maesa sp.2	Myrsinaceae	S	-
164	Maesa sp.3	Myrsinaceae	S	-
165	*Mallotus piniculatus* Muell. Arg.	Euphorbiaceae	T	-
166	Mallotus sp.	Euphorbiaceae	T	-
167	Mariscus sumatrensis (Retz.) Raynal	Cyperaceae	H	-
168	*Mazus japonica* Thunb.	Scorophulariaceae	H	-
169	Melastoma sp.1	Melastomataceae	S	-
No.	**Scientific Name**	**Family Name**	**Habit**	**Common Name**
170	Melastoma sp.2	Melastomataceae	S	-
171	Melastoma sp.3	Melastomataceae	S	-
172	Meliosma sp.1	Meliosmaceae	ST	-
173	Meliosma sp.2	Meliosmaceae	ST	-
174	*Microsorium* sp.	Polypodiaceae	F	-
175	Mikania micrantha H.B.K.	Asteraceae	S	-
176	Mitrephora sp.	Annonaceae	ST	-

177	*Molineria caputulata* (Lour.) Herb	Hypoxidaceae	H	-
178	Morus sp.	Moraceae	T	-
179	Murraya sp.	Rutaceae	ST	-
180	Mussaenda sp.	Rubiaceae	Cl	-
181	Myrica sp.	Myricaceae	ST	-
182	*Neolepisours* sp.	Polypodiaceae	F	-
183	Neolepisours sp.	Polypodiaceae	F	-
184	Neottopteris sp.	Aspleniaceae	F	-
185	Nephrolepis sp.	Aspleniaceae	F	-
186	Nothaphoebesp.	Lauraceae	T	-
187	Nothaphoebesp.	Lauraceae	T	-
188	*Ostodes paniculata* Blume	Euphorbiaceae	T	-
189	*Oxalis corniculata* L.	Oxalidaceae	H	Hmo gyin
190	*Oxyspara paniculata* (D.Don.) DC.	Melastomalaceae	S	-
191	Panicum sp.1	Poaceae	G	-
192	Panicum sp.2	Poaceae	G	-
193	Philodendron sp.	Araceae	Cl	-
194	*Phlogacanthus thyrsiformis* (Hardwicke) Mabberley	Acanthaceae	T	-
195	*Phoebe* sp.1	Lauraceae	T	-
196	*Phoebe* sp.2	Lauraceae	T	-
197	*Phrynium capitatum* Willd.	Marantaceae	H	-
198	Phyllanthus sp.	Euphorbiaceae	S	-
199	Piper sp.1	Piperaceae	H	-
200	Piper sp.2	Piperaceae	H	-
201	Piper sp.3	Piperaceae	H	-
202	Polyalthia sp.	Annonaceae	ST	-
203	*Polygonum capitatum* Buch-Ham.ex D.Don	Polygonaceae	H	-
204	Polygonum sp.1	Polygonaceae	S	-
205	Polygonum sp.2	Polygonaceae	H	-
No.	**Scientific Name**	**Family Name**	**Habit**	**Common Name**
206	Polygonum viviaprum L.	Polygonaceae	H	-
207	Polypodiodes amoena (wall .ex Mell) Ching	Polypodiaceae	F	-
208	Polystichum sp.1	Dryopteridaceae	F	-
209	Polystichum sp.2	Dryopteridaceae	F	-
210	*Pothos* sp.	Araceae	Cl	Kintatnwe
211	Pratia begoniifolia G.Don	Campanulaceae	H	-
212	Pronephrium sp.	Thelypteradaceae	F	-
213	*Pronephrium triphyllum* (Sw.)Holtt.	Thelypteridaceae	F	-
214	Pronephriumsp.	Thelypteridaceae	F	-

215	Pteris aspericaulis Wall ex Hieron	Pteridaceae	F	-
216	Pteris sp.1	Pteridaceae	F	-
217	Pteris sp.2	Pteridaceae	F	-
218	Pterocymbiumsp.	Sterculiaceae	T	-
219	*Pterospermum cinnamonemum* Kurz	Sterculiaceae	T	-
220	*Pycreus samguinolentus* Nees	Cyperaceae	H	-
221	Pyrrosia Sheareri (Bale) Ching	Polypodiaceae	F	-
222	Quercus sp.1	Fagaceae	T	-
223	Quercus sp.2	Fagaceae	T	-
224	Quercus sp.3	Fagaceae	T	-
225	Randia sp.	Rubiaceae	S	-
226	R*anunculus sp.*	Ranunculaceae	S	-
227	Rhodeleia sp.	Haemalidaceae	T	-
228	*Rhododendron simsii* Planch.	Ericaceae	ST	-
229	Rhododendron sp.	Ericaceae	ST	-
230	*Rubia cordifolia* L.	Rubiaceae	Cl, Cr	Peseintnipin
231	Rubus sp.	Rosaceae	S	-
232	Rubus sp.	Rosaceae	S	-
233	**Sambucus sp.**	Caprifoliaceae	S	-
234	*Saurauia napaulensis* DC.	Actinidiaceae	T	-
235	Saurauia sp.1	Actinidiaceae	ST	-
236	Saurauia sp.2	Actinidiaceae	ST	-
237	Saurauia sp.3	Actinidiaceae	ST	-
238	Saxifraga sp.	Saxifragaceae	H	-
239	Schefflera sp.	Araliaceae	Cl	-
240	Schima sp.	Theaceae	T	-
241	Scleriasp.	Cyperaceae	H	-
242	*Selaginella ciliaris* (Retz.) Spring	Selaginellaceae	F	-
No.	**Scientific Name**	**Family Name**	**Habit**	**Common Name**
243	Selaginella sp.	Selaginellaceae	F	-
244	Senecio sp.	Asteraceae	H	-
245	Smilax sp.	Smilacaceae	Cl	-
246	*Solanum indicum* L.	Solanaceae	H	-
247	*Stachyphrynium spicatum* (Roxb.)K.Schum.	Marantaceae	H	Taungsin hpet thay
248	Sterculia sp.5	Sterculiaceae	T	-
249	*Stephania venosa* (Blume) Spreng.	Menispermaceae	Cl	Sindonmanwe, Taungkya
250	*Sterculia balanghas* L.	Sterculiaceae	T	-
251	Sterculia sp.1	Sterculiaceae	T	-
252	Sterculia sp.2	Sterculiaceae	T	-

253	Sterculia sp.3	Sterculiaceae	T	-
254	Sterculia sp.4	Sterculiaceae	T	-
255	Strobilanthes sexennis Nees.	Acanthaceae	H	-
256	Strobilanthes sp.	Acanthaceae	S	-
257	*Symplocos microphylla* Wight	Symplocaceae	ST	-
258	Symplocos sp.	Symplocaceae	S	-
259	Syzygium sp.	Myrtaceae	T	-
260	Tacca sp.	Araceae	H	-
261	Taxus sp.	Taxaceae	T	-
262	Tectaria simonsii (Bak) Ching	Aspidiaceae	F	-
263	Tectaria sp.	Aspidiaceae	F	-
264	Tithonia diversifolia A. Gray	Asteraceae	S	-
265	Torenia sp.	Linderniaceae	ST	-
266	UN-1		S	-
267	UN-2		T	-
268	UN-3		ST	-
269	UN-4			-
270	UN-5		ST	-
271	UN-6	Lauraceae	T	-
272	UN-7		S	-
273	UN-8	Asteraceae	H	-
274	UN-9		ST	-
275	UN-10	Poaceae	G	-
276	UN-11	Asclepiadaceae	Cl	-
277	UN-12			-
278	UN-13	Ornagraceae	S	-
No.	**Scientific Name**	**Family Name**	**Habit**	**Common Name**
279	UN-14	Rosaceae	S	-
280	UN-15	Araceae	H	-
281	UN-16	Urticaceae	S	-
282	UN-17	Euphorbiaceae	T	-
283	UN-18			-
284	UN-19	Rubiaceae		-
285	UN-20	Mimosaceae	H	-
286	UN-21	Poaceae	G	-
287	UN-22		T	-
288	UN-23	Araceae	H	-
289	UN-24	Urticaceae	S	-
290	UN-25	Gesneriaceae	S	-

291	UN-26		F	-
292	UN-27	Lauraceae	T	-
293	UN-28	Lauraceae	T	-
294	UN-29	Zingibearaceae	H	-
295	UN-30	Zingiberaceae	H	-
296	UN-31	Musaceae	H	-
297	UN-32		T	-
298	UN-33		S	-
299	UN-34		T	-
300	UN-35	Actinidiaceae	ST	-
301	UN-36	Rubiaceae	S	-
302	UN-37	Annonaceae	T	-
303	UN-38	Orchidaceae	E	-
304	UN-39	Stephyllaceae	T	-
305	UN-40	Rubiaceae	S	-
306	UN-41			-
307	UN-42		Cl	-
308	UN-43		S	-
309	Uncaria sp.	Rubiaceae	Cl, Cr	-
310	*Urena lobata* L.	Malvaceae	H	-
311	Urtica sp.	Utricaceae	ST	-
312	Vernonia sp.	Asteraceae	Cl	-
313	*Viccinium* sp.	Vicciniaceae	Cl	-
314	Viola sp.	Violaceae	H	-
315	Vitex sp.	Vitaceae	ST	-
No.	**Scientific Name**	**Family Name**	**Habit**	**Common Name**
316	Vitis sp.	Vitaceae	Cl	-
317	Vitis sp.	Vitaceae	T	-
318	*Wallichia siamensis* Becc.	Arecaceae	ST	Minbaw
319	Wendlandia sp.	Rubiaceae	T	-
320	*Wisteria chinensis* Sweet	Fabaceae	Cl	-
321	Wisteria sp.	Fabaceae	Cl	-
322	*Youngia japonica* (L.) DC.	Asteraceae	H	-
323	Ziziphus sp.	Rhamnaceae	ST	-

B = Bamboo, Cl = Climber, Cr = Creeper, E = Epiphyte, F = Fern, G = Grass, H = Herb, S = Shrub, ST = Small Tree, T = Tree

Appendix - II Piza Plant Lists

No.	Scientific Name	Family Name	Habit

1	*Agapetes* sp.	Ericaceae	S
2	*Aldingia* sp.	Hamamelidaceae	T
3	*Ardisia* sp.	Myrsinaceae	S
4	*Ardisia*sp.	Myrsinaceae	S
5	*Ardisia*sp.	Myrsinaceae	S
6	*Artemisia*sp.	Acanthaceae	H
7	*Camellia*sp.	Theaceae	S
8	*Caricarpa*sp.	Verbenaceae	S
9	*Caricarpa*sp.	Verbenaceae	S
10	*Caricarpa*sp.	Verbenaceae	T
11	*Caricarpa*sp.	Verbenaceae	T
12	*cuyemu*	Rubiaceae	S
13	*daqing*	Verbenaceae	S
14	*daqing*	Verbenaceae	S
15	*Embelia* sp.	Myrsinaceae	Cl
16	*Embelia* sp.	Myrsinaceae	Cl
17	*Embelia* sp.	Myrsinaceae	Cl
18	*Embelia* sp.	Myrsinaceae	S
19	*Eurya* sp.	Theaceae	T
20	*Eurya* sp.	Theaceae	S
21	*Eurya* sp.	Theaceae	T
22	*Eurya* sp.	Theaceae	S
23	*Ficus* sp.	Moraceae	T
24	*Ficus* sp.	Moraceae	T
No.	**Scientific Name**	**Family Name**	**Habit**
25	*Ficus* sp.	Moraceae	T
26	*Ficus* sp.	Moraceae	T
27	*Haijinsha* sp.		F
28	*Hedyotis*sp.	Rubiaceae	H
29	*Ilex* sp.	Aquifoliaceae	T
30	*Jasminum*sp.	Oleaceae	Cl
31	*Jasminumsp.*	Oleaceae	Cl
32	*Leea*sp.	Vitaceae	S
33	*Litsea* sp.	Lauraceae	T
34	*Machilus*sp.	Lauraceae	T
35	*Maesa*sp.	Myrsinaceae	S
36	*Maesa*sp.	Myrsinaceae	S
37	*Maesa*sp.	Myrsinaceae	S
38	*Maesa*sp.	Myrsinaceae	S

39	*Maesa*sp.	Myrsinaceae	S
40	*Maesa*sp.	Myrsinaceae	S
41	*Maesa*sp.	Myrsinaceae	S
42	*Maesa*sp.	Myrsinaceae	S
43	*Maesa*sp.	Myrsinaceae	S
44	*Mussaenda*sp.	Rubiaceae	Cl
45	*Mussaenda*sp.	Rubiaceae	Cl
46	*Olea* sp.	Oleaceae	S
47	*Olea* sp.	Oleaceae	S
48	*Ophiorrhiza* sp.	Rubiaceae	H
49	*Ophiorrhiza* sp.	Rubiaceae	H
50	*Ophiorrhiza* sp.	Rubiaceae	H
51	*Photinia*	Rosaceae	S
52	*Rhododendron* sp.	Ericaceae	S
53	*Rubus* sp.	Rosaceae	S
54	*Rubus* sp.	Rosaceae	S
55	*Rubus* sp.	Rosaceae	S
56	*Rubus* sp.	Rosaceae	S
57	*Smilax*sp.	Smilacaceae	Cl
58	*Smilax*sp.	Smilacaceae	Cl
59	*Smilax*sp.	Smilacaceae	Cl
60	*Smilax*sp.	Smilacaceae	S
61	*Styrax* sp.	Styracaceae	T
No.	**Scientific Name**	**Family Name**	**Habit**
62	*Toddalia* sp.	Rutaceae	Cl
63	UN-1	Hamamelidaceae	T
64	UN-2		F
65	UN-3		F
66	UN-4		F
67	UN-5	Ericaceae	S
68	UN-6	Lauraceae	T
69	UN-7	Gesneriaceae	H
70	UN-8	Loranthaceae	Parasitic shrub
71	UN-9	Orchidaceae	S
72	UN-10		T
73	UN-11	Leguminosae	S
74	UN-12	Smilacaceae	Cl
75	UN-13	Caprifoliaceae	S
76	UN-14		F

77	UN-15	Araliaceae	T
78	UN-16	Orchidaceae	H
79	UN-17		S
80	UN-18	Apiaceae	H
81	UN-19		F
82	UN-20	Melastamataceae	S
83	UN-21		F
84	UN-22	Lardizabalaceae	Cl
85	UN-23		Cl
86	UN-24	Acanthaceae	H
87	UN-25	Lauraceae	T
88	UN-26	Moraceae	S
89	UN-27		S
90	UN-28	Lauraceae	T
91	UN-29	Saurauiaceae	T
92	UN-30	Caprifoliaceae	Cl
93	UN-31		F
94	UN-32		F
95	UN-33		F
96	UN-34	Papilionaceae	Cl
97	UN-35	Gesneriaceae	H
98	UN-36	Chloranthaceae	S
No.	**Scientific Name**	**Family Name**	**Habit**
99	UN-37	Orchidaceae	H
100	UN-38	Orchidaceae	H
101	UN-39	Caryophyllaceae	H
102	UN-40		Cl
103	UN-41	Orchidaceae	H
104	UN-42	Hydrangiaceae	T
105	UN-43	Orchidaceae	H
106	UN-44	Orchidaceae	H
107	UN-45	Araliaceae	T
108	UN-46	Fagaceae	T
109	UN-47	Rubiaceae	S
110	UN-48		S
111	UN-49	Asteraceae	S
112	UN-50	Loranthaceae	Parasitic shrub
113	UN-51	Orchidaceae	H
114	UN-52		F

115	UN-53	Symplocaceae	S
116	UN-54	Alangiaceae	T
117	UN-55	Rubiaceae	S
118	UN-56	Asteraceae	H
119	UN-57		B
120	UN-58	Celastraceae	S
121	UN-59	Rubiaceae	S
122	UN-60	Cucurbitaceae	Cl
123	UN-61	Orchidaceae	H
124	UN-62	Caprifoliaceae	T
125	UN-63	Bamboo	B
126	UN-64	Sabiaceae	Cl
127	UN-65	Lauraceae	T
128	UN-66	Escalloniaceae	T
129	UN-67	Euphobiaceae	S
130	UN-68		T
131	UN-69	Vitaceae	Cl
132	UN-70	Euphobiaceae	S
133	UN-71	Orchidaceae	H
134	UN-72		F
135	UN-73		T
No.	**Scientific Name**	**Family Name**	**Habit**
136	UN-74	Lamiaceae	H
137	UN-75	Liliaceae	H
138	UN-76	Orchidaceae	E
139	UN-77	Rubiaceae	Cl
140	UN-78	Orchidaceae	H
141	UN-79	Lauraceae	T
142	UN-80	Lamiaceae	H
143	UN-81	Liliaceae	H
144	UN-82	Urticaceae	H
145	UN-83	Liliaceae	H
146	UN-84	Melastamataceae	S
147	UN-85		H
148	UN-86	Urticaceae	H
149	UN-87	Menispermaceae	Cl
150	UN-88	Cucurbitaceae	Cl
151	UN-89	Lauraceae	T
152	UN-90	Saurauiaceae	T

153	UN-91	Urticaceae	H
154	UN-92	Symplocaceae	T
155	UN-93		T
156	UN-94	Urticaceae	T
157	UN-95	Euphobiaceae	T
158	UN-96		F
159	UN-97	Rubiaceae	S
160	UN-98	Orchidaceae	H
161	UN-99		T
162	UN-100	Rubiaceae	S
163	UN-101	Urticaceae	S
164	UN-102	Polygonaceae	H
165	UN-103	Urticaceae	H
166	UN-104	Lobeliaceae	H
167	UN-105	Begoniaceae	H
168	UN-106	Styracaceae	T
169	UN-107	Melastamataceae	S
170	UN-108	Urticaceae	S
171	UN-109		F
172	UN-110	Rubiaceae	H
No.	**Scientific Name**	**Family Name**	**Habit**
173	UN-111		S
174	UN-112	Rubiaceae	H
175	UN-113	Asteraceae	H
176	UN-114	Urticaceae	H
177	UN-115		F
178	UN-116	Zingiberaceae	H
179	UN-117	Rubiaceae	H
180	UN-118		S
181	UN-119		H
182	UN-120	Orchidaceae	H
183	UN-121		F
184	UN-122	Rubiaceae	S
185	UN-123	Symplocaceae	T
186	UN-124		S
187	UN-125	Urticaceae	H
188	UN-126	Solanaceae	H
189	UN-127	Asteraceae	H
190	UN-128		H

191	UN-129	Lauraceae	T
192	UN-130	Vitaceae	Cl
193	UN-131	Hydrangiaceae	S
194	UN-132	Rubiaceae	S
195	UN-133	Melastamataceae	S
196	UN-134	Buddlejaceae	S
197	UN-135	Scrophulariaceae	H
198	UN-136	Theaceae	S
199	UN-137	Begoniaceae	H
200	UN-138		F
201	UN-139		F
202	UN-140		F
203	UN-141	Symplocaceae	T
204	UN-142	Campanulaceae	H
205	UN-143	Rubiaceae	S
206	UN-144	Thymelaeaceae	S
207	UN-145	Asteraceae	H
208	UN-146	Cyperaceae	H
209	UN-147	Violaceae	H
No.	**Scientific Name**	**Family Name**	**Habit**
210	UN-148	Scrophulariaceae	H
211	UN-149	Euphobiaceae	T
212	UN-150	Orchidaceae	H
213	UN-151	Saurauiaceae	T
214	UN-152	Poaceae	H
215	UN-153	Anacardiaceae	T
216	UN-154	Orchidaceae	H
217	UN-155	Loranthaceae	S
218	UN-156	Violaceae	H
219	UN-157	Melastamataceae	S
220	UN-158	Urticaceae	H
221	UN-159	Rubiaceae	H
222	UN-160	Asteraceae	H
223	UN-161	Begoniaceae	H
224	UN-162	Balsaminaceae	H
225	UN-163	Acanthaceae	S
226	UN-164	Asteraceae	H
227	UN-165	Urticaceae	H
228	UN-166	Piperaceae	H

229	UN-167		S
230	UN-168	Commelinaceae	Cl
231	UN-169	Polygonaceae	H
232	UN-170		F
233	UN-171	Gesneriaceae	H
234	UN-172		H
235	UN-173		H
236	UN-174	Polygonaceae	H
237	UN-175	Rubiaceae	H
238	UN-176	Myrsinaceae	S
239	UN-177	Simaroubaceae	T
240	UN-178		S
241	UN-179	Acanthaceae	H
242	UN-180	Rubiaceae	H
243	UN-181	Lauraceae	T
244	UN-182	Urticaceae	H
245	UN-183	Ferns	F
246	UN-184	Cyperaceae	H
No.	**Scientific Name**	**Family Name**	**Habit**
247	UN-185	Rubiaceae	H
248	UN-186	Bamboo	B
249	UN-187		F
250	UN-188	Asteraceae	H
251	UN-189	Anacardiaceae	T
252	UN-190	Styracaceae	T
253	UN-191	Acanthaceae	H
254	UN-192	Chloranthaceae	S
255	UN-193	Lobeliaceae	H
256	UN-194	Asteraceae	Cl
257	UN-195	Euphobiaceae	T
258	UN-196	Rubiaceae	S
259	UN-197	Asteraceae	H
260	UN-198	Umbelliferae	H
261	UN-199	Orchidaceae	H
262	UN-200		F
263	UN-201	Violaceae	H
264	UN-202	Asteraceae	H
265	UN-203	Rubiaceae	S
266	UN-204		T

267	UN-205	Loranthaceae	S
268	UN-206	Acanthaceae	H
269	UN-207	Papilionaceae	Cl
270	UN-208	Orchidaceae	H
271	UN-209	Euphobiaceae	S
272	UN-210	Rubiaceae	S
273	UN-211	Urticaceae	H
274	UN-212	Poaceae	H
275	UN-213	Melastamataceae	S
276	UN-214	Euphobiaceae	T
277	UN-215		S
278	UN-216	Loganiaceae	Cl
279	UN-217	Ulmaceae	S
280	UN-218	Gesneriaceae	H
281	UN-219	Asteraceae	H
282	UN-220	Begoniaceae	H
283	UN-221	Euphobiaceae	S
No.	**Scientific Name**	**Family Name**	**Habit**
284	UN-222		F
285	UN-223	Asteraceae	H
286	UN-224		F
287	UN-225	Loganiaceae	S
288	UN-226	Menispermaceae	Cl
289	UN-227	Cyperaceae	H
290	UN-228	Poaceae	G
291	UN-229	Solanaceae	S
292	UN-230		S
293	UN-231	Ochidaceae	H
294	UN-232	Asteraceae	H
295	UN-233	Polygonaceae	H
296	UN-234	Rubiaceae	H
297	UN-235	Rosaceae	H
298	UN-236		S
299	UN-237	Poaceae	H
300	UN-238	Rutaceae	S
301	UN-239	Rubiaceae	S
302	UN-240	Lauraceae	T
303	UN-241	Gesneriaceae	H
304	UN-242	Mimosaceae	Cl

305	UN-243	Orchidaceae	H
306	UN-244	Rubiaceae	T
307	UN-245	Araceae	H
308	UN-246	Euphobiaceae	S
309	UN-247	Rubiaceae	S
310	UN-248	Magnoliaceae	S
311	UN-249	Poaceae	H
312	UN-250	Loranthaceae	Parasitic shrub
313	UN-251	Asteraceae	H
314	UN-252	Melastamataceae	H
315	UN-253		F
316	UN-254		F
317	UN-255	Rubiaceae	S
318	UN-256		H
319	UN-257		Cl
320	UN-258		F
No.	**Scientific Name**	**Family Name**	**Habit**
321	UN-259		F
322	UN-260	Urticaceae	H
323	UN-261	Urticaceae	Cl
324	UN-262		F
325	UN-263		F
326	UN-264	Theaceae	T
327	UN-265	Orchidaceae	E
328	UN-266	Volaceae	H
329	UN-267	Rosaceae	S
330	UN-268	Anacardiaceae	T
331	UN-269		T
332	UN-270	Asteraceae	H
333	UN-271	Fumariaceae	H
334	UN-272		F
335	UN-273	Thymelaeaceae	S
336	UN-274	Leguminosae	Cl
337	UN-275		T
338	UN-276	Lauraceae	T
339	UN-277	Asteraceae	H
340	UN-278	Fagaceae	T
341	UN-279	Asclepiadaceae	Cl
342	UN-280	Amaryllidaceae	H

343	UN-281	Papilionaceae	S
344	UN-282	Rubiaceae	S
345	UN-283	Euphobiaceae	T
346	UN-284	Polygonaceae	H
347	UN-285	Lauraceae	T
348	*Uncaria* sp.	Rubiaceae	Cl
349	*Uncaria* sp.	Rubiaceae	Cl
350	*Viola* sp.	Violaceae	H
351	*Wendlandia*sp.	Rubiaceae	T

B = Bamboo, Cl = Climber, Cr = Creeper, E = Epiphyte, F = Fern, G = Grass, H = Herb, S = Shrub, ST = Small Tree, T = Tree

Appendix – III Wusok Vegetation Type

No.	Locality	Vegatation Type	Latitude	Longitude	Altitude	Notes
1	Warup Village	Low land Evergreen	26° 32′ 18.0″	98° 18′ 25.9″	458 m	
2	Warup Village	Low land Evergreen	26° 32′ 14.2″	98° 18′ 24.5″	457 m	
3	Warup Village	Low land Evergreen	26° 32′ 15.6″	98° 18′ 24.0″	461 m	*Dipterocarpus obtusifolius*, *Ilex microcacce*, *Saurauia* sp., assosiate with *Ficus* sp.3, *Elaeocarpus* sp. in tree layer. Shrub layer is dominated by *Schefflera* sp., *Canthium* sp., *Oxyspora paniculata*. Herb layer is dominated by *Aslpenium* sp., *Pronephrium* sp., *Pronephrium triphyllum*, *Pseudocyclosourus* sp..
4	Warup Village	Low land Evergreen	26° 31′ 37.3″	98° 18′ 14.9″	516 m	
5	Warup Village	Low land Evergreen	26° 28′ 44.1″	98° 17′ 21.8″	461 m	
6	Between Pashe and Warup Village	Low land Evergreen	26° 30′ 58.3″	98° 18′ 02.6″	530 m	
7	Between Pashe and Warup Village	Low land Evergreen	26° 30′ 34.0″	98° 17′ 55.9″	526 m	
8	Between Pashe and Warup Village	Low land Evergreen	26° 30′ 20.8″	98° 17′ 51.7″	509 m	
9	North Pashe Village, left side of Mayhka River	Low land Secondary Forest	26° 29′ 19.0″	98° 17′ 26.1″	508 m	
10	North Pashe Village, left side of Mayhka River	Low land Secondary Forest	26° 29′ 02.0″	98° 17′ 26.4″	468 m	*Mallotus* sp., *Sterculia* sp.1, *Maesa* sp., *Callicarpa* sp. assosiate with are found in

11	Warup Village	Low land Secondary Forest	26° 29′ 23.0″	98° 17′ 21.6″	579 m	tree layer. Shrub layer is dominated by *Gnetum* sp., *Wallichia siamensis*, *Stachyphrynium spicatum*, *Arenga triandra*, *Eurya* sp.,*Symplocos macrophylla*. Herb layer is dominated by *Pteris* sp., *Melastoma* sp., *Tectaria simonsii*, *Selaginella* sp., *Begonia* sp., *Piper* sp., *Pronephrium* sp. & *Commelina* sp.
12	East Pashe Village	Low land Secondary Forest	26° 29′ 47.1″	98° 17′ 44.4″	525m	
13	East Pashe Village	Low land Secondary Forest	26° 29′ 46.3″	98° 87′ 45.3″	528m	
14	East Pashe Village	Oak Forest	26° 30′ 10.6″	98° 17′ 49.5″	500 m	Castonopsis calathiformis, Quercus sp., Lithocarpus sp., C. tribuloides, Castanopsis sp. assosiate with Sterculia sp.1, Saurauia sp., are found in tree layer.Shrub layer is dominated by Stachyphrynium spicatum, Eurya sp.. Herb layer is dominated by Pteris sp., Piper sp., Arenga sp., Pronephrium sp..
15	East Pashe Village	Oak Forest	26° 30′ 03.0″	98° 17′ 47.5″	503 m	
16	North Pashe Village, left side of Mayhka River	Oak Forest	26° 29′ 19.1″	98° 17′ 26.1″	508 m	
17	North Pashe Village, left side of Mayhka River	Oak Forest	26° 29′ 20.1″	98° 17′ 23.8″	547 m	
18	East Pashe Village, near Mayhka River	Bamboo Forest	26° 28′ 39.8″	98° 17′ 28.1″	440 m	

No.	Locality	Vegatation Type	Latitude	Longitude	Altitude	Notes
19	East Pashe Village, near Mayhka River	Bamboo Forest	26° 28′ 51.2″	98° 17′ 23.2″	474 m	
20	Warup Village	Bamboo Forest	26° 31′ 48.3″	98° 18′ 20.0″	544 m	
21	Warup Village	Shifting Cultivation	26° 32′ 11.5″	98° 18′ 28.4″	543 m	
22	Warup Village	Shifting Cultivation	26° 32′ 13.1″	98° 18′ 28.8″	539 m	
23	East Pa shae Village	Shifting Cultivation	26° 29′ 40.3″	98° 60′ 40.5″	516 m	6 or 7 yr. Abandoned field
24	Pashe	Degraded Forest (Shrub)	26° 07' 21.6"	98° 13' 14.6"	311 m	
25	North Pashe Village, left side of Mayhka River	Degraded Forest (Shrub)	26° 16′ 30.0″	98° 18′ 13.2″	731 m	
26	North Pashe Village, left side of Mayhka River	Degraded Forest (Shrub)	26° 16′ 21.9″	98° 18′ 26.4″	612 m	
27	North Pashe Village, left side of Mayhka River	Degraded Forest (Shrub)	26° 16′ 24.3″	98° 18′ 22.8″	660 m	
28	North Pashe Village, left side of Mayhka River	Degraded Forest (Shrub)	26° 16′ 44.1″	98° 18′ 11.5″	823 m	

29	North Pashe Village, left side of Mayhka River	Banana Forest	26° 29′ 09.8″	98° 17′ 26.3″	476 m	

Chapter IV

4. Biodiversity Impact Assessment Report of Flora on Chibwe Hydropower Dam

4.1. Introduction

During April and May 2009, the biodiversity impact assessment study especially on plant diversity in inundated area and surrounding area of Chibwe Dam on Mayhka River, which will be constructed in the near future, has been carried out.

The report will include forest types and vegetation, floristic composition and dominant species, potential long term and short term impacts and the mitigation measure to reduce the impacts.

4.1.1. Location

The Chibwe Hydropower Dam project area is located on the downstream next to the Wusok Dam on the same river, Mayhka. It lies between 25º58´N and 98º 09´ E and reaches about 20 kilometre on upstream confluence mouth of Myahka River and Chibwe Stream near Mandon Village, in Chibwe Township. Total catchment area is 3796 sq-km and reaches about 60 kilometre upstream. Normal pool level is 400m and total storage capacity is 19.39 Gm^3. It is the fifth dam on Mayhka River and lies below the downstream of Wusok Dam on the same river.

Dam site lies in the lowland area but Mayhka River flows in narrow Valley of High Mountain and has steep slope. The flooded area is long and narrow in upstream and a little broad near dam site. So this dam is a cascade dam and may be environmentally benign dam.

4.1.2. Topography

The bulk of Chibwe Dam area falls 25º26´- 25º57´ N and 98º 09´- 98º 17´ E and reaches between Mandon Village on the south and along Mayhka River up to 40 kilometre upstream where Ngawchanhka River flows into Mayhka River at 26º18´N and 98º 18´ E. There are two rapids in the upstream above the confluence mouth of Mayhka River and Ngawchanhka River. The elevation of upstream above the junction of Mayhka and Ngawchanhka is above 1000 m and that of downstream below the junction is 800 m (map). The topography of dam site is low land and its elevation is 400 m near river bank.

4.1.3. Climate

According to the pattern of Kachin State the climate of Chibwe Dam area has three seasons, a cool and dry season between Novembers and February, warm and dry season between March and May and warm and wet season between June and October. The annual rain fall is rather uniform.

4.1.4. Forest in the context of Eco-region

The project area lies in WWF Eco-regions of Mizoram-Manipur-Kachin moist evergreen forest. The catchment area of Chibwe Dam includes Bumphabum W.S and Emawbum Mountain forest and is one of the hotspot outstanding areas for conservation. The forest types are highland evergreen forests, lowland evergreen forests, oak forests, bamboo forests, degraded forests, and low-land secondary forests.

4.1.5. Local people and their livelihood

People dwelling in this area include Rawaw and Lachate (Kachin tribes) Bamar and Chinese. The majority is Lachate Tribes. Their livelihood is very simple, cultivating Taungyar rice and vegetables, breeding poultry, hunting and fishing. Shifting cultivation is common and terrace cultivation is scarcely found. Commercial logging is also common and is the major livelihood of cease-fire groups, special region I (NDAK) and special region II (KIA). This commercial logging is the major issue of deforestation and greatest environmental impact in the area.

There are four large villages in the area namely Tantin village, Hpala Village, Mandon Village and Myaw naw Village. Tan tin Village and Hpala Village are near river bank and will be inundated after the dam has been constructed.

4.2. Aims and Objectives

1. To collect, identify and list the plant species in the area
2. To record the dominant tree species and evaluate the forest types
3. To study the impact of dam on the flora and to suggest the mitigation measure

4.3. Materials and Methods

4.3.1. Participants

Five members of Myanmar flora team are U Nyo Maung, Dr Kahlayar lu, Dr Kyaw Soe Naing, Daw Thin Thin Su and U Tay Zar Aung and Chinese flora team.

4.3.2. Materials

Materials used for recording are strings for sample plotting, digital camera, maps compass, field press, data collection sheets, drying press, dryer, digging tools, heavy duty plastic bags, newspapers, alcohol, spray jug (for fixing specimens) 10 x lens, permanent markers and other field equipments.

4.3.3. Methods

One research team with five Myanmar scientists was organized and studies were conducted especially in the areas which may be inundated after the dam is constructed. The plant specimens were collected both in inundated areas and habitats of representative areas.

The Global Positioning System was used to navigate and mark coordinates between sample plots in each habitat. In order to obtain essential ecological data for predicting forest value and forest type, quadrants of varying size were set up and observed. Plant collection (all trees, shrubs and herbs) was carried out in random and by Transit line whenever possible to get the representative checklists of the plants in the studied area and all specimens are identified and recorded. DBH and Height classes at tree species are calculated based on the measurement of breast height diameters along with its height.

Field press and drying press were used to get voucher specimens and to store in herbarium. Habitat type's altitude, topography, forest type, canopy cover and structure, light intensity wind, wind velocity and sign of disturbance were recorded. To know the habit of the plant species and to ensure the vegetation, photographic records were also carried out.

Leaves, inflorescences, floral structures and other vegetative parts of each plant specimens were collected and photographed and recorded as field notes.

4.4. Results

4.4.1. Floristic Composition in the study area

The total number of species collected in the Chibwe Dam site and potential flooded area is 555 species belonging to 341 genera and 128 families. (Appendix - I)

The forest types are determined in accordance with species composition in the respective area. The dominant tree species, shrub species and herb species were determined depending on the composition on the same plot. (Appendix-II)

Native rice species and varieties were also collected and identified and sample seeds were also kept in the herbarium.

4.4.2. The human impact in the study area

Logging

The commercial and illegal logging has been started since last five years and still exists in the study area. (Plate -1) The forests in the low land area below 800 m in elevation is subjected to commercial and illegal logging. The primary forests are found only in the area of high mountain region and deep slope where there is no proper transportation. The degraded forests can be seen everywhere. The deforestation may lead to climate change and decrease in rainfall as a long term impact. Due to soil erosion the sedimentation in the dam will affect the storage capacity of dam.

Shifting cultivation

The shifting cultivation is inevitable because it is the major livelihood of the local people. Taungyar is the main source of their earning and it was found both in lowland area and high mountain area. The abandoned Taungyar dominated with grasses

Panicum sp., and *Sorghum* sp., are found elsewhere especially near villages. Deforestation is inevitable due to shifting cultivation. Some terrace cultivation was also found in the study area. This practice should be encouraged. (Plate – 3(a), (b))

Involuntary Displacement

Since some villages are in the flooded area, the involuntary displacement may be the main adverse social impact. The main mitigation measure is the resettlement of displaced population including new housing, replacement lands and other materials assistance, as needed.

The loss of infrastructure

Some parts of motor car road from Chibwe to Tsawlaw will be inundated. New access road from Chibwe to Tsawlaw will be necessary. The siting of new motor car road should be environmentally and socially least damaging corridors. Road engineering should ensure proper drainage to protect waterways and minimize erosion.

Endangered species: According to the IUCN Res list (2003), the following species are recorded;

1. *Cephalotaxus griffithii* Hook. f.	LR
2. *Taiwania cryptomeriodes* Hayata	VU

4.5. Discussion and Conclusion

Among the 555 species collected in the study area, 204 species are tree species which are the value of the forest. *Schima wallichii*, *Dunbanga* sp., *Fagus* sp., *Cinnamomum* sp., *Polyalthia* sp., and *Ficus* sp., *Lithocarpus* sp., *Castanopsis* sp., *Quercus* sp., are found to be dominant. 40% of the tree species are less than 10m in height and 60% are more than 10 m. 53% of the tree species are less than 60 cm and 70% are more than 60cm in girth. The timber value is more or less moderate.

The forests in the study area are subjected to various kinds of disturbance such as logging, shifting cultivation and mining. Insufficient protection status of the study area and its surrounding enhances the exploitation of natural resources. Lack of law enforcement and strict regulation for waste disposal produced by mining is the immediate issue. This will lead to long term deforestation and it in turn leads into erosion and sedimentation in the dam and reduces the life of the dam.

The general vegetation pattern in the study area comprises the high land evergreen forest and oak forest in high mountain area (>1200 m), the low land evergreen forest (>800 m) in mid-elevation area and bamboo forest, secondary forest and degraded shrub forest in lowland area (>800 m). Deforestation is caused by commercial and illegal logging, shifting cultivation and gold mining on river bank.

The high land evergreen forest and oak forest comprise *Castanopsis* sp., *Lithocarpus* sp., *Quercus* sp., *Fagus* sp., and *Schima* sp. dominate in the tree layer, *Arenga* sp., *Calamus* sp., *Melastoma* sp., *Aglaia* sp., and *Rhododendron* sp., dominate in the shrub layer and *Begonia* sp., *Asplenium* sp., *Elatostema* sp., *Calanthe* sp., and *Tectaria* sp., dominate in herb layer.

The bamboo forest is dominated by *Dendrocalamus hamiltonii* and *Dendrocalamus giganteus.* The degraded shrub forests are dominated by *Musa* sp., *Bauhinia* sp., *Chromolaena* sp., and *Mikania* sp.

The valuable forest trees like *Tectona grandis*, *Xylia xylocarpa*, *Pterocarpus macrocarpus*, *Michelia champaca*, *Dalbergia* sp. and *Dipterocarpus* species has almost disappeared due to commercial logging and illegal logging.

The construction of series of dams on a same river system will lead to cumulative impacts. The cumulative environmental impacts assessment must be carried out before the first dam was constructed. The implementation of mitigation measure for cumulative impacts should be completed or well underway prior to construction of second dam on the same river.

4.6. Recommendation

1. One or more compensatory protected area should be established and managed under project to offset the loss of natural habitat to flooding.
2. Reforestation should be carried out and manage as soon as possible.
3. Law and regulations conserving with logging and mining technique and waste disposal, should be immediately adopted and enforced.
4. The resettlement of displaced population including new housing, compensation, creation of new jobs for the loss of livelihood and other material assistance should be planned by consultation and participatory decision-making by both the resettled and host population.
5. The cost of new access road from Chibwe to Tsawlaw project cost should be managed under the dam project expenditure.
6. The construction of Chibwe Dam should start after the upper dam (Wusok Dam) has been completed and mitigation measure for cumulative impacts has been completed or well underway.

Terrace cultivation and long term plantation should be encouraged and practised to reduce shifting cultivation.

Table - 1 Tree species in DBH class intervals in Chibwe

DBH Classes	No. of species	Total number of individual	% of total species
< 30 cm	171	1385	31.26
30 - 60 cm	121	553	22.12
60 - 90 cm	84	213	15.36
90 - 120 cm	50	106	9.14
120 - 150 cm	37	65	6.76
150 - 180 cm	21	37	3.84
180 - 210 cm	19	24	3.47
210 -240 cm	16	20	2.93
240 - 270 cm	8	9	1.46
270 - 300 cm	8	8	1.46
300 - 330 cm	4	4	0.73
330 - 360 cm	3	3	0.37
360 - 390 cm	2	2	0.55

390 - 420 cm	-	-	0.00
420 - 450 cm	-	-	0.00
450 - 480 cm	-	-	0.00
480 - 510 cm	1	1	0.18
510 - 540 cm	1	1	0.18
540 - 570 cm	-	-	0.00
> 570 cm	1	1	0.18
Total	204	2432	100.00

Table - 2 Tree species in Height class intervals in Chibwe

Height Classes	No. of species	Total number of individual	% of total species
< 3m	38	211	13.24
3 - 10 m	93	1747	32.40
10 - 17 m	80	642	27.87
17 - 24 m	47	287	16.38
24 - 31 m	29	102	10.10
31 - 38	-	-	0.00
> 38 m	-	-	0.00
Total	113	2989	100.00

Table - 3 Native Rice Species in Chibwe

No.	Scientific Name	Family Name	Local Name
1	*Oryza indicum* L. Cultivar Kauk - Nyin - Ni	Poaceae	Kauk - Nyin - Ni
2	*Oryza indicum* L. Cultivar Kauk - Kyan	Poaceae	Kauk - Kyan
3	*Oryza indicum* L. Cultivar Kauk - Nyin - Phyu	Poaceae	Kauk - Nyin - Phyu
4	*Oryza indicum* L. Cultivar Kauk - Daung - Tit	Poaceae	Kauk - Daung - Tit
5	*Oryza indicum* L. Cultivar Kauk - Nyin - Phyu	Poaceae	Kauk - Nyin - Phyu
6	*Oryza indicum* L. Cultivar Khaw - Nar	Poaceae	Khaw - Nar
7	*Oryza japonica* Cultivar Sat - Gar	Poaceae	Sat - Gar
8	*Oryza japonica* Cultivar Net - Paw - Kauk	Poaceae	Net - Paw - Kauk
9	*Oryza japonica* Cultivar Ja - Time	Poaceae	Ja - Time
10	*Oryza japonica* Cultivar Kauk - Sar	Poaceae	Kauk - Sar

Appendix - I Chibwe Plant Lists

No.	Scientific Name	Family	Habit	Common Name
1	*Abroma angusta* (L.) L. f.	Sterculiaceae	ST	-
2	*Acacia pennata* (L.) Willd.	Mimosaceae	Cl,Cr	-
3	*Acanthopanax* sp.	Araliaceae	T	-
4	*Acer calcaratum* Gagnep.	Aceraceae	T	-

5	*Acer oblongum* Wall. ex DC.	Aceraceae	T	-
6	*Acer* sp.	Aceraceae	T	-
7	*Actinodaphne* sp.	Lauraceae	T	-
8	*Adiantum* sp.	Pteridaceae	F	-
9	*Aegle* sp.	Rutaceae	ST	-
10	*Aeschynanthus* sp.1	Gesneriaceae	S	-
11	*Aeschynanthus* sp.2	Gesneriaceae	S	-
12	*Ageratum conyzoides* L.	Asteraceae	H	-
13	*Ageratum* sp.	Asteraceae	H	-
14	*Aglaia* sp.1	Meliaceae	T	-
15	*Aglaia* sp.2	Meliaceae	T	-
16	*Aglaia* sp.3	Meliaceae	T	-
17	*Aglaonema* sp.	Araceae	H	-
18	*Alangium begoniifolia* (Roxb.) Baill.	Alangiaceae	T	-
19	*Alangium chinense* (Lour.) Harms	Alangiaceae	T	Taw-posa
20	*Alangium* sp.	Alangiaceae	T	-
21	*Albizia chinensis* (Osbeck.) Merr.	Mimosaceae	T	Bonmeza
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
22	*Albizia lucidior* (Steud.) Nielsen	Mimosaceae	T	Thanthat
23	*Albizia* sp.1	Mimosaceae	T	-
24	*Albizia* sp.2	Mimosaceae	T	-
25	*Allantodia similis* W.M. Chu	Dryopteridaceae	F	-
26	*Alnus nepalensis* D. Don	Betulaceae	T	-
27	*Alocasia* sp.1	Araceae	H	-
28	*Alocasia* sp.2	Araceae	H	-
29	*Alphosea* sp.	Annonaceae	T	-
30	*Alpinia zerumbet* (Pers.) B.L. Burtt & R.M. Sm.	Zingiberaceae	H	-
31	*Alstonia scholaris* (L.) R.Br.	Apocynaceae	T	Taung-mayo
32	*Alstonia* sp.	Apocynaceae	T	-
33	*Andropogon* sp.	Poaceae	G	-
34	*Antidesma montanum* Blume	Euphorbiaceae	ST	-
35	*Antrophyum* sp.	Pteridaceae	F	-
36	*Aporusa* sp.	Euphorbiaceae	S	-
37	*Aralia montana* Blume	Araliaceae	T	-
38	*Aralia* sp.1	Araliaceae	T	-
39	*Aralia* sp.2	Araliaceae	T	-
40	*Archidendron* sp.	Mimosaceae	T	-
41	*Ardisia* sp.	Myrsinaceae	T	-

42	*Areca* sp.	Arecaceae	ST	-
43	*Arenga triandra* Roxb.	Arecaceae	ST	-
44	*Arisaema concinnum* Schott.	Araceae	H	-
45	*Arisaema* sp.1	Araceae	H	-
46	*Arisaema* sp.2	Araceae	H	-
47	*Artemisia* sp.1	Asteraceae	H	-
48	*Artemisia* sp.2	Asteraceae	H	-
49	*Artemisia* sp.3	Asteraceae	H	-
50	*Asplenium* sp.1	Aspleniaceae	F	-
51	*Asplenium* sp.2	Aspleniaceae	F	-
52	*Aster* sp.	Asteraceae	H	-
53	*Atalantia roxburghiana* Hk.f.	Rutaceae	ST	-
54	*Athyrium clarkei* Bedd.	Dryopteridaceae	F	-
55	*Baccaurea* sp.	Euphorbiaceae	T	-
56	*Balakata baccata* (Roxb.) Esser	Euphorbiaceae	T	-
57	*Bauhinia* sp.1	Caesalpiniaceae	Cl,Cr	-
58	*Bauhinia* sp.2	Caesalpiniaceae	Cl,Cr	-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
59	*Bauhinia* sp.3	Caesalpiniaceae	Cl,Cr	-
60	*Bauhinia* sp.4	Caesalpiniaceae	S	-
61	*Begonia griffithii* Hook.	Begoniaceae	H	-
62	*Begonia* sp.1	Begoniaceae	H	-
63	*Begonia* sp.2	Begoniaceae	H	-
64	*Betula schmidtii* Regel	Betulaceae	T	-
65	*Betula* sp.1	Betulaceae	T	-
66	*Betula* sp.2	Betulaceae	T	-
67	*Betula utilis* D. Don	Betulaceae	T	-
68	*Bolbitis heteroclita* (Presl.) Ching	Dryopteridaceae	F	-
69	*Brassaiopsis* sp.	Araliaceae	T	-
70	*Breynia officinalis* Hemsl.	Euphorbiaceae	S	-
71	*Bridelia stipularis* (L.) Blume	Euphorbiaceae	T	-
72	*Bromus* sp.	Poaceae	G	-
73	*Buchanania*sp.	Anacardiaceae	T	-
74	*Buddleja asiatica* Lour.	Buddlejaceae	S	-
75	*Buddleja* sp.	Buddlejaceae	S	-
76	*Butea* sp.	Fabaceae	Cl,Cr	-
77	*Calamus palustris* Griff.	Arecaceae	ST	-
78	*Callicarpa* arborea Roxb.	Verbenaceae	T	-
79	*Callicarpa* sp.1	Verbenaceae	T	-

80	*Callicarpa* sp.2	Verbenaceae	T	-
81	*Callicarpa* sp.3	Verbenaceae	T	-
82	*Callicarpa* sp.4	Verbenaceae	T	-
83	*Callicarpa* sp.5	Verbenaceae	T	-
84	*Camellia* sp.	Theaceae	S	-
85	*Cananga* sp.1	Annonaceae	T	-
86	*Cananga* sp.2	Annonaceae	T	-
87	*Canthium* sp.1	Rubiaceae	S	-
88	*Canthium* sp.2	Rubiaceae	S	-
89	*Capparis* sp.	Capparaceae	Cl,Cr	-
90	*Carallia brachiata* (Lour.) Merr.	Rhisophoraceae	T	-
91	*Caryota gigas*Hahn ex hodel	Arecaceae	ST	-
92	*Caryota urens* L.	Arecaceae	ST	-
93	*Castanopsis acuminatissima*(Bl.) A. DC.	Fagaceae	T	-
94	*Castanopsis diversifolia* King	Fagaceae	T	-
95	*Castanopsis* sp.1	Fagaceae	T	-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
96	*Castanopsis* sp.3	Fagaceae	T	-
97	*Castanopsis tribuloides* A.DC.	Fagaceae	T	-
98	*Cautleya gracilis* (Sm.) Dandy	Zingiberaceae	H	-
99	*Celastrus* sp.	Celastraceae	Cl,Cr	-
100	*Celtis* sp.	Ulmaceae	T	-
101	*Centella* sp.1	Apiaceae	H	-
102	*Centella* sp.3	Apiaceae	H	-
103	*Cephalotaxus griffithii* Hook. f.	Cephalotaxaceae	T	-
104	*Cerastium glomeratum* Thuill	Caryophyllaceae	H	-
105	*Chaukrasia* sp.	Meliaceae	T	-
106	*Chromolaena* sp.	Asteraceae	H	-
107	*Cibotium baromrtz* (L.) J. Sm.	Dicksoniaceae	F	-
108	*Cinnamomum* sp.1	Lauraceae	T	-
109	*Cinnamomum* sp.2	Lauraceae	T	-
110	*Cinnamomum* sp.3	Lauraceae	T	-
111	*Cirsium* sp.	Asteraceae	H	-
112	*Clausena* sp.1	Rutaceae	ST	-
113	*Clausena* sp.2	Rutaceae	ST	-
114	*Cleidion spiciflorum* (Burm. F.) Merr	Euphorbiaceae	T	Taw-kanako
115	*Clerodendrum fragrans*Vent.	Verbenaceae	S	-
116	*Clerodendrum infortunatum* Gaertn.	Verbenaceae	S	-

117	*Clerodendrum* sp.1	Verbenaceae	S	-
118	*Clerodendrum* sp.2	Verbenaceae	S	-
119	*Clerodendrum* sp.3	Verbenaceae	S	-
120	*Clerodendrum* sp.4	Verbenaceae	S	-
121	*Clerodendrum* sp.5	Verbenaceae	S	-
122	*Cleyera* sp.	Theaceae	ST	-
123	*Coelogyne* sp.	Orchidaceae	E	-
124	*Colona floribunda* (Kz.) Craib.	Tiliaceae	ST	-
125	*Colysis* sp.1	Polypodiaceae	F	-
126	*Colysis* sp.2	Polypodiaceae	F	-
127	*Commelina* sp.1	Commelinaceae	H	-
128	*Commelina* sp.2	Commelinaceae	H	-
129	*Commelina* sp.3	Commelinaceae	H	-
130	*Connarus macrophylla* Wall.	Cornnaceae	S	-
131	*Connarus*sp.	Cornnaceae	S	-
132	*Corydalis purpurea* Hk.	Papaveraceae	H	-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
133	*Cotoneaster microphyllus* Wall.	Rosaceae	S	-
134	*Crotalaria* sp.	Fabaceae	S	-
135	*Croton* sp.	Euphorbiaceae	T	-
136	*Ctenitopsis* sp.	Dryopteridaceae	F	-
137	*Curpinus* sp.	Betulaceae	T	-
138	*Cyathula* sp.	Amaranthaceae	H	-
139	*Cymbidium* sp.	Orchidaceae	E	-
140	*Dalbergia rimosa* Roxb.	Fabaceae	ST	Daung-daloung
141	*Dalbergia* sp.1	Fabaceae	ST	-
142	*Dalbergia* sp.2	Fabaceae	ST	-
143	*Dalbergia* sp.3	Fabaceae	ST	-
144	*Dalbergia* sp.4	Fabaceae	ST	-
145	*Daphne - pseudo* sp.	Thymelaeaceae	ST	-
146	*Daphne* sp.	Thymelaeaceae	ST	-
147	*Datura suaveolens*Humb. & Bonpl. ex. Willd	Solanaceae	S	-
148	*Davaillia* sp.	Davalliaceae	F	-
149	*Debregeasia edulis* (Sieb. & Zucc.)Wedd.	Urticaceae	ST	-
150	*Debregeasia longifolia* Wedd.	Urticaceae	ST	-
151	*Debregeasia* sp.	Urticaceae	ST	-
152	*Dendranthema lavandulifolium* (Fischer ex Trautv.) Kitam.	Orchidaceae	E	-
153	*Dendrobium densiflorum* Lindl. ex Wall.	Orchidaceae	E	-

154	*Dendrobium falconeri* Hook.	Orchidaceae	E	Myet-thitkwa
155	*Dendrobium* sp.1	Orchidaceae	E	-
156	*Dendrobium* sp.2	Orchidaceae	E	-
157	*Desmodium* sp.	Fabaceae	H	-
158	*Dicentra* sp.	Papaveraceae	H	-
159	*Dichorisandra* sp.	Commelinaceae	H	-
160	*Dimocarpus* sp.	Sapindaceae	T	-
161	*Dioscorea bulbifera* L.	Dioscoreaceae	Cl,Cr	-
162	*Dioscorea pentaphylla* L.	Dioscoreaceae	Cl,Cr	-
163	*Dioscorea* sp.1	Dioscoreaceae	Cl,Cr	Myauk-u
164	*Dioscorea* sp.2	Dioscoreaceae	Cl,Cr	-
165	*Diospyros* sp.1	Ebenaceae	T	-
166	*Diospyros* sp.2	Ebenaceae	T	-
167	*Diplomorpha trichotoma* (Thunb.) Nakai	Thymelaeaceae	T	-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
168	*Dipterocarpus* sp.1	Dipterocarpaceae	T	Kanyin
169	*Dipterocarpus* sp.2	Dipterocarpaceae	T	Kanyin
170	*Dipterocarpus* sp.3	Dipterocarpaceae	T	Kanyin
171	*Dipterocarpus* sp.4	Dipterocarpaceae	T	Kanyin
172	*Dipterocarpus* sp.5	Dipterocarpaceae	T	Kanyin
173	*Dipterocarpus obtusifolius* Teysm.	Dipterocarpaceae	T	Inbo, Kanyin-gok
174	*Disporum* sp.1	Convallariaceae	H	-
175	*Disporum* sp.2	Convallariaceae	H	-
176	*Dolichandrone serrulata* Seem.	Bignoniaceae	T	Tha-khut
177	*Dracaena* sp.1	Dracaenaceae	H	-
178	*Dracaena* sp.2	Dracaenaceae	H	-
179	*Dryopteris stenolepis* (Bark.) C. Chr	Dryopteridaceae	F	-
180	*Duabanga grandiflora* (Roxb. ex DC.)Wall.	Lythraceae	T	-
181	*Duchesnea indica* (Andrews) Focke	Rosaceae	S	-
182	*Ehretia* sp.	Ehretiaceae	T	-
183	*Elaeagnus* sp.	Elaeagnaceae	T	-
184	*Elaeagnus*sp.	Elaeagnaceae	T	-
185	*Elatostema platyphyllum* Wedd.	Urticaceae	S	-
186	*Elatostema* sp.1	Urticaceae	S	-
187	*Elatostema* sp.2	Urticaceae	S	-
188	*Elsholtzia* sp.	Lamiaceae	S	-
189	*Embelia* sp.	Myrsinaceae	S	-

190	*Emblica officinalis* Gaertn.	Euphorbiaceae	ST	-
191	*Engelhardtia spicata* Blume.	Juglandaceae	T	-
192	*Entada phaseoloides* (L.) Merr.	Fabaceae	Cl,Cr	-
193	*Epipogium roseum* (D.Don.) Lindl.	Orchidaceae	E	-
194	*Equisetum* sp.	Equisetaceae	F	-
195	*Eria ornata* Bl. Lindl.	Orchidaceae	E	-
196	*Eria pannea* Lindl.	Orchidaceae	E	-
197	*Eria* sp.	Orchidaceae	E	-
198	*Erythrina* sp.	Fabaceae	T	-
199	*Eugenia* sp.	Myrtaceae	T	-
200	*Euonymus* sp.1	Celastraceae	ST	-
201	*Euonymus* sp.2	Celastraceae	ST	-
202	*Euonymus* sp.3	Celastraceae	ST	-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
203	*Eurya acuminata* DC.	Theaceae	ST	-
204	*Eurya* sp.	Theaceae	ST	-
205	*Exbucklandia populnea* (R. Br. ex Griff.) R.W. Br.	Hamamelidaceae	T	-
206	*Fagus* sp.1	Fagaceae	T	-
207	*Fagus* sp.2	Fagaceae	T	-
208	*Fagus* sp.3	Fagaceae	T	-
209	*Ficus auriculata* Lour.	Moraceae	T	Sin-thapan
210	*Ficus curtipes*Corner	Moraceae	T	-
211	*Ficus fistulosa* Reinw.	Moraceae	T	-
212	*Ficus hirta var. roxburghii* Miq.	Moraceae	T	-
213	*Ficus semicordata* Buch.- Ham ex. J. E. Sm.	Moraceae	T	-
214	*Ficus* sp.1	Moraceae	T	-
215	*Ficus* sp.10	Moraceae	T	-
216	*Ficus* sp.11	Moraceae	T	-
217	*Ficus* sp.12	Moraceae	T	-
218	*Ficus* sp.2	Moraceae	T	-
219	*Ficus* sp.3	Moraceae	T	-
220	*Ficus* sp.4	Moraceae	T	-
221	*Ficus* sp.5	Moraceae	T	-
222	*Ficus* sp.6	Moraceae	T	-
223	*Ficus* sp.7	Moraceae	T	-
224	*Ficus* sp.8	Moraceae	T	-
225	*Ficus* sp.9	Moraceae	T	-
226	*Flemingia* sp.1	Fabaceae	S	-

227	*Flemingia* sp.2	Fabaceae	S	-
228	*Fraxinus* sp.	Oleaceae	S	-
229	*Garcinia* sp.	Hypericaceae	ST	-
230	*Garuga* sp.	Burseraceae	T	-
231	*Gentiana* sp.	Gentianaceae	H	-
232	*Geum* sp.	Rosaceae	S	-
233	*Globba* sp.	Zingiberaceae	H	-
234	*Glochidion* sp.1	Euphorbiaceae	ST	-
235	*Glochidion* sp.2	Euphorbiaceae	ST	-
236	*Gnaphalium affine* D. Don	Asteraceae	H	-
237	*Gnetum gnemon* L.	Gnetaceae	S	Hyinbyin Tanyin-ywe
238	*Gnetum* sp.1	Gnetaceae	S	-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
239	*Gnetum* sp.2	Gnetaceae	Cl,Cr	-
240	*Goniothalamus* sp.	Annonaceae	ST	-
241	*Goodyera prolera* Hook.	Orchidaceae	H	-
242	*Grewia* sp.	Tiliaceae	S	-
243	*Harpullia* sp.	Sapindaceae	T	-
244	*Hedychium* sp.	Zingiberaceae	H	-
245	*Hibiscus* sp.1	Malvaceae	S	-
246	*Hibiscus* sp.2	Malvaceae	S	-
247	*Hodgsonia macrocarpa* (Bl.) Cogn.	Cucurbitaceae	Cl,Cr	-
248	*Homalomena rubescens* (Roxb.) Kunth	Araceae	H	-
249	*Houttuynia cordata* Thunb.	Saururaceae	Cl,Cr	-
250	*Hoya* sp.1	Asclepiadaceae	Cl,Cr	-
251	*Hoya* sp.2	Asclepiadaceae	Cl,Cr	-
252	*Hoya* sp.3	Asclepiadaceae	Cl,Cr	-
253	*Hydrangea* sp.	Hydrangeaceae	T	-
254	*Hydrocotyle* sp.	Apiaceae	H	-
255	*Hypericum japonicum* Thunb.	Hypericaceae	S	-
256	*Hypericum erectum* Thunb.	Clusiaceae	S	-
257	*Hyphear* sp.	Loranthaceae	Parasitic shrub	-
258	*Hypolepsis punctata* (Thunb.) Mett.	Hypolepidaceae	F	-
259	*Ilex liukiuensis* Loes.	Aquifoliaceae	T	-
260	*Ilex* sp.1	Aquifoliaceae	T	-
261	*Ilex* sp.2	Aquifoliaceae	T	-
262	*Ilex* sp.3	Aquifoliaceae	T	-

263	*Ilex* sp.5	Aquifoliaceae	T	-
264	*Ilex* sp.6	Aquifoliaceae	T	-
265	*Impatiens* sp.1	Balsaminaceae	H	-
266	*Impatiens* sp.2	Balsaminaceae	H	-
267	*Impatiens* sp.3	Balsaminaceae	H	-
268	*Impatiens* sp.4	Balsaminaceae	H	-
269	*Ipomea* sp.	Convolvulaceae	Cl,Cr	-
270	*Iris* sp.1	Iridaceae	H	-
271	*Iris* sp.2	Iridaceae	H	-
272	*Irvingia* sp.	Irvingiaceae	T	-
273	*Ixeris dentata* (Thunb.) Nakai	Asteraceae	H	-
274	*Ixeris* sp.	Asteraceae	H	-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
275	*Jasminum* sp.1	Oleaceae	Cl,Cr	-
276	*Jasminum* sp.2	Oleaceae	Cl,Cr	-
277	*Juncus inflexus* L.	Juncaceae	H	-
278	*Keiskea* sp.	Lamiaceae	H	-
279	*Knema furfuracea* (HK. F.et Th.) Warb.	Myristicaceae	T	-
280	*Kyllinga* sp.	Cyperaceae	H	-
281	*Lasiathus* sp.1	Rubiaceae	ST	-
282	*Lasiathus* sp.2	Rubiaceae	ST	-
283	*Lemmaphyllum cunosum* Presl.	Polypodiaceae	F	-
284	*Lepisanthes* sp.1	Sapindaceae	T	-
285	*Lepisanthes* sp.2	Sapindaceae	T	-
286	*Lepisorus contortus* (Christ) Ching	Polypodiaceae	F	-
287	*Lepisorus* sp.	Polypodiaceae	F	-
288	*Leucosceptrum canum* Sm.	Acanthaceae	S	-
289	*Lindera* sp.	Lauraceae	T	-
290	*Liparis viridiflora* (Blume) Lindl.	Orchidaceae	E	-
291	*Listea* sp.	Lauraceae	T	-
292	*Lithocarpus* sp.1	Fagaceae	T	-
293	*Lithocarpus* sp.2	Fagaceae	T	-
294	*Lithocarpus* sp.3	Fagaceae	T	-
295	*Litsea cubeba* (Lour.) Pers.	Lauraceae	T	-
296	*Litsea macrophylla* Kurz.	Lauraceae	T	-
297	*Litsea* sp.1	Lauraceae	T	-
298	*Litsea* sp.2	Lauraceae	T	-
299	*Litsea* sp.3	Lauraceae	T	-

300	*Litsea* sp.4	Lauraceae	T	-
301	*Litsea* sp.5	Lauraceae	T	-
302	*Lycopodium* sp.1	Lycopodiaceae	F	-
303	*Lycopodium* sp.2	Lycopodiaceae	F	-
304	*Lygodium* sp.	Schizaceae	F	-
305	*Lysionotus* sp.	Gesneriaceae	H	-
306	*Machilus* sp.1	Lauraceae	T	-
307	*Machilus* sp.2	Lauraceae	T	-
308	*Machilus odoratissima* Nees.	Lauraceae	T	-
309	*Maclura cochichinensis* (Lour.) Corner	Moraceae	T	-
310	*Maesa montana* A.DC.	Myrsinaceae	ST	-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
311	*Malaxis calophylla* (Rolbf.) Kuntz.	Orchidaceae	E	-
312	*Mallotus peltatus* Muell. Arg.	Euphorbiaceae	T	-
313	*Mallotus piniculatus* Muell. Arg.	Euphorbiaceae	T	-
314	*Mallotus* sp.1	Euphorbiaceae	T	-
315	*Mallotus* sp.2	Euphorbiaceae	T	-
316	*Mallotus* sp.3	Euphorbiaceae	T	-
317	*Mariscus* sp.	Cyperaceae	H	-
318	*Mariscus* sp.	Cyperaceae	H	-
319	*Mariscus sumatrensis* (Retz.) Raynal	Cyperaceae	H	-
320	*Melastoma* sp.1	Melastomataceae	S	-
321	*Melastoma* sp.2	Melastomataceae	S	-
322	*Melia* sp.	Meliaceae	T	-
323	*Meliosma simplicifolia* (Roxb.) Walp.	Meliosmaceae	T	-
324	*Meliosma* sp.	Meliosmaceae	T	-
325	*Microlepia* sp.	Lygodiaceae	F	-
326	*Micromelum minutum* Wight & Arn 92	Rutaceae	ST	-
327	*Micromelum* sp.	Rutaceae	ST	-
328	*Microsorium* sp.	Polypodiaceae	F	-
329	*Mikania micrantha* H.B.K	Asteraceae	Cl,Cr	-
330	*Miliusa* sp.	Annonaceae	T	-
331	*Millettia* sp.	Fabaceae	Cl,Cr	-
332	*Mitrephora* sp.	Annonaceae	ST	-
333	*Molineria capitulata* (Lour.) Herb	Hypoxidaceae	H	-
334	*Morus* sp.1	Moraceae	T	-

335	*Morus* sp.2	Moraceae	T	-
336	*Murraya* sp.	Rutaceae	ST	-
337	*Mussaenda* sp.1	Rubiaceae	S	-
338	*Mussaenda* sp.2	Rubiaceae	S	-
339	*Myrica* sp.	Myricaceae	ST	-
340	*Myriopteron* sp.	Asclepiadaceae	Cl,Cr	-
341	*Nasturtium officinale* R. Br.	Brassicaceae	H	-
342	*Neottopteris antrophyoides* (Christ) Ching	Polypodiaceae	F	-
343	*Oberonia* sp.1	Orchidaceae	E	-
344	*Oberonia* sp.2	Orchidaceae	E	-
345	*Olea* sp.	Oleaceae	T	-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
346	*Onychium* sp.	Sinopteridaceae	F	-
347	*Orecnide fruticosa* (Gaudich.) Hand.-Mazz.	Urticaceae	S	-
348	*Oroxylum indicum* (L.) Kurz	Bignoniaceae	ST	Kyaung-sha
349	*Ostodes* sp.	Euphorbiaceae	T	-
350	*Otochilusfurus* Lindl.	Orchidaceae	H	-
351	*Otochilus*sp.	Orchidaceae	H	-
352	*Oxalis corniculata* L.	Oxalidaceae	H	-
353	*Oxyspora* sp.1	Melastomataceae	S	-
354	*Oxyspora* sp.2	Melastomataceae	S	-
355	*Panax* sp.	Araliaceae	T	-
356	*Panicum* sp.	Poaceae	G	-
357	*Pavetta* sp.3	Rubiaceae	S	-
358	*Pergularia* sp.	Asclepiadaceae	S	-
359	*Phalaenopsis* sp.	Orchidaceae	E	-
360	*Philodendron* sp.	Araceae	Cl,Cr	-
361	*Phlogacanthus thyrsiformis* (Hardwicke) Mabberley	Acanthaceae	S	-
362	*Phoebe* sp.1	Lauraceae	T	-
363	*Phoebe* sp.2	Lauraceae	T	-
364	*Phoebe* sp.3	Lauraceae	T	-
365	*Phoebe* sp.4	Lauraceae	T	-
366	*Phoebe* sp.5	Lauraceae	T	-
367	*Phrynium capitatum* Willd.	Marantaceae	H	-
368	*Picrasms* sp.	Simaroubaceae	T	-
369	*Piper* sp.1	Piperaceae	H	-
370	*Piper* sp.2	Piperaceae	H	-
371	*Piper* sp.3	Piperaceae	H	-

372	*Piper* sp.4	Piperaceae	H	-
373	*Piper thwaitseii* C. DC.	Piperaceae	H	-
374	*Plantago major* L.	Plantaginaceae	H	-
375	*Platanus* sp.	Plantanaceae	ST	-
376	*Podocarpus neriifolius* Don.	Podocarpaceae	T	-
377	*Polyalthia* sp.1	Annonaceae	T	-
378	*Polyalthia* sp.2	Annonaceae	T	-
379	*Polyalthia* sp.3	Annonaceae	T	-
380	*Polyalthia* sp.4	Annonaceae	T	-
381	*Polyalthia* sp.5	Annonaceae	T	-
382	*Polygonum* sp.1	Polygonaceae	H	-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
383	*Polygonum* sp.2	Polygonaceae	H	-
384	*Polygonum* sp.3	Polygonaceae	H	-
385	*Polygonum* sp.4	Polygonaceae	H	-
386	*Polygonum viviparum* L.	Polygonaceae	H	-
387	*Polystichum* sp.	Dryopteridaceae	F	-
388	*Polystichum*sp.	Dryopteridaceae	F	-
389	*Pothos scandens* L.	Araceae	Cl,Cr	-
390	*Pratia begoniifolia* G.Don	Campanulaceae	S	-
391	*Prunus* sp.	Rosaceae	S	-
392	*Pseudodrynaria coronans* (Wall. Ex. Melt.) Ching	Drynariaceae	F	-
393	*Psidium guajava* L.	Myrtaceae	ST	Mai-mak-ka
394	*Psychotria* sp.	Rubiaceae	S	-
395	*Psychotria* sp.	Rubiaceae	S	-
396	*Pteris aspericarlis* var. *tricolor* Wall.ex Hieron	Pteridaceae	F	-
397	*Pteris biaurita* L.	Pteridaceae	F	-
398	*Pteris semipinnata* L.	Pteridaceae	F	-
399	*Pteris* sp.	Pteridaceae	F	-
400	*Pterospermum cinnamonemum* Kurz	Sterculiaceae	T	-
401	*Pterospermum* sp.	Sterculiaceae	T	-
402	*Pyrrosia lingue* (Thunb.) Farwell	Polypodiaceae	F	-
403	*Pyrrosia* sp.	Polypodiaceae	F	-
404	*Quercus* sp.1	Fagaceae	T	-
405	*Ranunculus hirtellus* Royle.	Ranunculaceae	H	-
406	*Rhus chinensis* Mill.	Anacardiaceae	ST	-
407	*Rhus* sp.	Anacardiaceae	ST	-
408	*Rosa* sp.	Rosaceae	S	-

409	*Rubia cordifolia* L.	Rubiaceae	Cl,Cr	Pe-seint-ni-pin
410	*Rubus minusculus* H. Lév. & Vaniot	Rosaceae	S	-
411	*Rubus sieboldii* Blume	Rosaceae	S	-
412	*Rubus* sp.1	Rosaceae	S	-
413	*Rubus* sp.2	Rosaceae	S	-
414	*Rubus* sp.3	Rosaceae	S	-
415	*Rubus* sp.4	Rosaceae	S	-
416	*Rubus* sp.5	Rosaceae	S	-
417	*Rubus* sp.6	Rosaceae	S	-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
418	*Rubus* sp.7	Rosaceae	S	-
419	*Rubus* sp.8	Rosaceae	S	-
420	*Rubus sumatranus* Miq.	Rosaceae	S	-
421	*Sabia* sp.	Sabiaceae	Cl,Cr	-
422	*Sambucus japonica*Blume	Caprifoliaceae	S	-
423	*Sapindus* sp.1	Sapindaceae	ST	-
424	*Sapindus* sp.2	Sapindaceae	ST	-
425	*Sapindus* sp.3	Sapindaceae	ST	-
426	*Saurauia griffithii* Dyer	Actinidiaceae	ST	-
427	*Saurauia napaulensis* DC.	Actinidiaceae	ST	-
428	*Saurauia* sp.1	Actinidiaceae	ST	-
429	*Saurauia* sp.2	Actinidiaceae	ST	-
430	*Saurauia* sp.3	Actinidiaceae	ST	-
431	*Sauropus* sp.	Euphorbiaceae	ST	-
432	*Saussurea* sp.	Asteraceae	H	-
433	*Saxifraga* sp.	Saxifragaceae	Cl,Cr	-
434	*Schefflera* sp.1	Araliaceae	T	-
435	*Schefflera* sp.2	Araliaceae	T	-
436	*Schefflera* sp.3	Araliaceae	T	-
437	*Schefflera* sp.4	Araliaceae	T	-
438	*Schefflera* sp.5	Araliaceae	Cl,Cr	-
439	*Schima* sp.	Theaceae	T	-
440	*Schisandra* sp.	Schisandraceae	T	-
441	*Scirpus* sp.	Cyperaceae	G	-
442	*Scleria* sp.	Cyperaceae	G	-
443	*Scoparia dulcis* L.	Linderniaceae	H	-
444	*Scurrula* sp.	Loranthaceae	Parasitic shrub	-
445	*Selaginella* sp.	Selaginellaceae	F	-
446	*Selaginella* sp.	Selaginellaceae	F	-

447	*Senecio* sp.	Asteraceae	H	-
448	*Sida* sp.	Malvaceae	ST	-
449	*Siegesbeckia pubescens* (Makino) Makino	Asteraceae	H	-
450	*Smitinandia micrantha* (Lindl.) Holtt.	Orchidaceae	E	-
451	*Solanum indicum* L.	Solanaceae	H	-
452	*Sonchus asper* (L.) Hill	Asteraceae	H	-
453	*Stenoloma chusanum*(L.) Ching	Lindsaeaceae	F	-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
454	*Stephania* sp.	Menispermaceae	Cl,Cr	-
455	*Stephania venosa* (Bl.) Spreng	Menispermaceae	Cl,Cr	-
456	*Sterculia* sp.1	Sterculiaceae	T	-
457	*Sterculia* sp.2	Sterculiaceae	T	-
458	*Sterculia* sp.3	Sterculiaceae	T	-
459	*Sterculia* sp.4	Sterculiaceae	T	-
460	*Streptolirion volubile* Edgew.	Commelinaceae	H	-
461	*Styrax benzoides* Craib	Styracaceae	ST	-
462	*Styrax* sp.	Styracaceae	ST	-
463	*Suripia* sp.	Orchidaceae	E	-
464	*Symplocos microphylla* Wight.	Symplocaceae	ST	-
465	*Symplocos* sp.	Symplocaceae	S	-
466	*Symplocos* sp. (1)	Symplocaceae	S	-
467	*Syzygium cinereum* (Kurz.) P. Chantaranothai & J. Parn.	Myrtaceae	T	-
468	*Syzygium megacarpum* (Craib) Rathakr. & N.C. Nair	Myrtaceae	T	-
469	*Syzygium*sp.1	Myrtaceae	T	-
470	*Syzygium*sp.2	Myrtaceae	T	-
471	*Syzygium*sp.3	Myrtaceae	T	-
472	*Tabernaemontana* sp.	Apocynaceae	S	-
473	*Tacca* sp.	Taccaceae	H	-
474	*Tainia* sp.	Orchidaceae	E	-
475	*Taiwania cryptomeriodes* Hayata	Taxodiaceae	T	Tayok-khaung-bin
476	*Tectaria* sp.	Dryopteridaceae	F	-
477	*Thunbergia* sp.	Acanthaceae	H	-
478	*Thysanolaena maxima* (Roxb.) Kuntze	Poaceae	G	-
479	*Toona ciliata* M. Roem.	Meliaceae	T	-
480	*Trachelospermum asiaticum* (Sieb. & Zucc.) Nakai	Apocynaceae	Cl,Cr	-
481	*Trema orientalis* (L.) Blume	Ulmaceae	T	Kywe-sa,

				Satsha
482	*Trevesia* sp.	Araliaceae	T	-
483	*Tupidanthus*sp.	Araliaceae	T	-
484	*Turpinia cochinensis* (Lour.) Merr.	Staphyleaceae	T	-
485	*Turpinia* sp.	Staphyleaceae	T	-
486	UN-1		S	-
487	UN-2			-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
488	UN-3			-
489	UN-4			-
490	UN-5			-
491	UN-6	Orchidaceae	E	-
492	UN-7	Orchidaceae	E	-
493	UN-8			-
494	UN-9			-
495	UN-10	Acanthaceae	S	-
496	UN-11			-
497	UN-12	Asteraceae	H	-
498	UN-13			-
499	UN-14	Rubiaceae	S	-
500	UN-15			-
501	UN-16			-
502	UN-17			-
503	UN-18			-
504	UN-19			-
505	UN-20			-
506	UN-21			-
507	UN-22			-
508	UN-23			-
509	UN-24			-
510	UN-25	Annonaceae	T	-
511	UN-26			-
512	UN-27	Acanthaceae	S	-
513	UN-28	Rubiaceae	S	-
514	UN-29			-
515	UN-30	Araliaceae	T	-
516	UN-31			-
517	UN-32			-
518	UN-33	Poaceae	B	-

519	UN-34	Annonaceae	T	-
520	UN-35			-
521	UN-36	Rutaceae	ST	-
522	UN-37	Poaceae	G	-
523	UN-38	Verbenaceae	S	-
524	UN-39	Euphorbiaceae	T	-
525	UN-40			-
No.	**Scientific Name**	**Family**	**Habit**	**Common Name**
526	UN-41			-
527	UN-42	Asteraceae	H	-
528	UN-43			-
529	UN-44		F	-
530	UN-45	Rosaceae	S	-
531	UN-46			-
532	*Urena lobata* L.	Malvaceae	S	-
533	*Urena* sp.	Malvaceae	S	-
534	*Vernonia scandens* DC.	Asteraceae	H	-
535	*Vernonia* sp. 1	Asteraceae	H	-
536	*Vernonia* sp. 2	Asteraceae	H	-
537	*Vernonia* sp. 3	Asteraceae	H	-
538	*Vernonia* sp. 4	Asteraceae	H	-
539	*Vernonia* sp. 5	Asteraceae	H	-
540	*Vernonia* sp. 6	Asteraceae	H	-
541	*Viburnum* sp.1	Sambucaceae	T	-
542	*Viburnum* sp.2	Vicciniaceae	Cl,Cr	-
543	*Vitex* sp.	Vitaceae	T	-
544	*Vitis* sp.1	Vitaceae	Cl,Cr	-
545	*Vitis* sp.2	Vitaceae	Cl,Cr	-
546	*Vitis* sp.3	Vitaceae	Cl,Cr	-
547	*Vittaria* sp.	Vittariaceae	F	-
548	*Wallichia* sp.	Arecaceae	ST	-
549	*Wendlandia* sp.	Rubiaceae	T	-
550	*Wisteria chinensis* Sweet	Fabaceae	Cl,Cr	-
551	*Xantolis* sp.	Sapotaceae	T	-
552	*Youngia japonica* (L.) DC.	Asteraceae	H	-
553	*Youngia* sp.	Asteraceae	H	-
554	*Ziziphus* sp.1	Rhamnaceae	ST	-
555	*Ziziphus* sp.2	Rhamnaceae	ST	-

B = Bamboo, Cl = Climber, Cr = Creeper, E = Epiphyte, F = Fern, G = Grass, H = Herb, S = Shrub, ST = Small Tree, T = Tree

Appendix – II Chibwe Vegetation Type

No.	Locality	Vegatation Type	Latitude	Longitude	Altitude	Notes
1	Hpala-Tsawlaw	Lowland Evergreen Forest	26˚ 06' 54.2"	98˚ 13' 02.5"	326 m	*Schima wallichii*, *Duabanga grandiflora*, & *Pterospermum cinnamonemum* assosiate with *Cinnamomum* sp., *Knema furfuracea*, *Chisocheton siamensis* & *Polyalthia* sp. are found in tree layer. Shrub layer is dominated by *Arenga triandra*, *Aglaia* sp., *Clausena* sp., *Calamus* sp., & *Phrynium capitatum*. Herb layer is dominated by *Begonia* sp., *Calanthe triplicata, Athyrium silvicola*, *Alphanamixis* sp., *Allantodia similis*, *Tectaria* sp.,
2	Hpala-Tsawlaw	Lowland Evergreen Forest	26˚ 06' 31.5"	98˚ 12' 75.1"	342 m	
3	Manton	Lowland Evergreen Forest	25˚ 56' 23.3"	98˚ 08' 27.4"	254 m	
4	Kancon	Lowland Evergreen Forest	26˚ 14' 44.2"	98˚ 16' 10.1"	343 m	
5	Pitzaw	Lowland Evergreen Forest	26˚ 18' 46.6"	98˚ 17' 05.8"	421 m	
6	Hpala-Chibwe	Lowland Evergreen Forest	25° 59′ 59.7″	98°10′ 17.4″	428 m	
7	Hpala-Chibwe	Lowland Evergreen Forest	26˚ 00' 26.9"	98˚ 10' 05.3"	277 m	
8	Hpala-Chibwe	Lowland Evergreen Forest	26˚ 01' 10.3"	98˚ 10' 34.3"	311 m	
9	Hpala-Tsawlaw	Lowland Evergreen Forest	26˚ 05' 28.1"	98˚ 12' 27.0"	293 m	
10	Hpala-Tsawlaw	Lowland Evergreen Forest	26˚ 07' 32.5"	98˚ 13' 19.0"	314 m	
11	Hpala-Tsawlaw	Lowland Evergreen Forest	26˚ 01' 42.1"	98˚ 10' 34.4"	301 m	
12	Hpala-Tsawlaw	Lowland Evergreen Forest	26˚ 03' 31.0"	98˚ 11' 21.5"	314 m	
13	Hpala-Tsawlaw	Oak Forest	26˚ 06' 30.2"	98˚ 12' 47.1"	329 m	Castanopsis acuminatissima, *Lithocarpus* sp., Castanopsis sp., Castanopsis diversifolia, Fagus sp. & Quercus sp. assosiate with Schima wallichii, & Pterospermum cinnamonemum are found in tree layer. Shrub layer is dominated by Arenga triandra,
14	Hpala-Tsawlaw	Oak Forest	26˚ 03' 20.7"	98˚ 11' 20.3"	304 m	

15	Hpala-Tsawlaw	Oak Forest	26˚ 04' 59.4"	98˚ 12' 13.4"	492 m	Aglaia sp.. Herb layer is dominated by Elatostema sp., Calanthe triplicata, Phrynium
16	Pitzaw	Oak Forest	26˚ 18' 38.6"	98˚ 17' 15.0"	668 m	
17	Kancon	Oak Forest	26˚ 16' 02.1"	98˚ 17' 12.5"	781 m	

No.	Locality	Vegatation Type	Latitude	Longitude	Altitude	Notes
18	Kyihtam	Lowland Secondary Forest	26˚ 16' 11.3"	98˚ 18' 43.0"	480 m	*Saurauia* sp., *Ilex* sp., *Alnus nepaulensis*, *Ficus fistulosa* are found in tree layer. Shrub layer is dominated by *Arenga triandra* & *Melastoma* sp.. Herb layer is dominated by *Alphanamixis silvicola*, *Begonia* sp. & *Neolepisorus* sp.
19	Hpala-Tsawlaw	Lowland Secondary Forest	26˚ 06' 50.2"	98˚ 13' 04.7"	337 m	
20	Kyihtam-Kancon	Lowland Secondary Forest	26˚ 15' 67.3"	98˚ 16' 85.7"	476 m	
21	Kancon	Lowland Secondary Forest	26˚ 15' 67.7"	98˚ 16' 69.5"	412 m	
22	Kancon	Lowland Secondary Forest	26˚ 15' 10.7"	98˚ 16' 29.7"	360 m	
23	Pitzaw	Lowland Secondary Forest	26˚ 18' 39.7"	98˚ 17' 02.7"	443 m	
24	Kancon	Lowland Secondary Forest	26˚ 15' 42.2"	98˚ 16' 46.7"	426 m	
25	Hpala-Tsawlaw	Bamboo Forest	26˚ 07' 30.2"	98˚ 13' 18.0"	318 m	D*endrocalamus hamiltonii* Ness (Wabo Myatsan), D. *giganteus* Munro (Wabowa)
26	Hpala-Tsawlaw	Bamboo Forest	26˚ 07' 25.9"	98˚ 13' 17.0"	314 m	
27	Hpala-Tsawlaw	Bamboo Forest	26˚ 07' 14.2"	98˚ 13' 09.2"	311 m	
28	Manton	Bamboo Forest	25˚ 57' 43.2"	98˚ 09' 01.9"	269 m	
29	Manton	Bamboo Forest	25˚ 57' 56.9"	98˚ 09' 10.9"	252 m	
30	Manton	Bamboo Forest	25˚ 58' 38.1"	98˚ 09' 39.1"	243 m	
31	Kyihtam-Kancon	Bamboo Forest	26˚ 15' 43.9"	98˚ 17' 05.0"	504 m	
32	Kancon	Bamboo Forest	26˚ 15' 63.4"	98˚ 16' 65.9"	389 m	
33	Kancon	Bamboo Forest	26˚ 15' 61.6"	98˚ 16' 61.1"	389 m	

34	Kancon	Bamboo Forest	26˚ 15' 46.3"	98˚ 16' 58.8"	526 m	
35	Pitzaw	Bamboo Forest	26˚ 18' 39.3"	98˚ 17' 09.7"	542 m	
36	Pitzaw	Bamboo Forest	26˚ 18' 39.7"	98˚ 17' 09.8"	437 m	
37	Kancon	Bamboo Forest	26˚ 15' 36.8"	98˚ 16' 36.7"	436 m	
No.	**Locality**	**Vegatation Type**	**Latitude**	**Longitude**	**Altitude**	**Notes**
38	Kancon	Bamboo Forest	26˚ 15' 24.7"	98˚ 16' 32.5"	405 m	
39	Kancon	Bamboo Forest	26˚ 14' 52.7"	98˚ 16' 19.3"	372 m	
40	Hpala-Tsawlaw	Bamboo Forest	26˚ 04' 59.1"	98˚ 12' 27.8"	571 m	
41	Hpala-Tsawlaw	Bamboo Forest	26˚ 04' 57.4"	98˚ 12' 25.4"	528 m	
42	Kancon	Shifting Cultivation	26˚ 15' 03.9"	98˚ 16' 25.3"	347 m	
43	Hpala-Tsawlaw	Shifting Cultivation	26˚ 04' 55.2"	98˚ 12' 15.7"	376 m	
44	Kancon	Shifting Cultivation	26˚ 15' 17.0"	98˚ 16' 30.9"	354 m	
45	Kancon	Shifting Cultivation	26˚ 15' 17.0"	98˚ 16' 30.9"	354 m	
46	Hpala-Manton	Degraded Forest (Shrub)	25˚ 06' 08.7"	98˚ 12' 42.9"	291 m	Musa sp. *Mikania micrantha* sp. *Chromolaena* sp., *Bauhinia Bauhinia sp.*
47	Manton	Degraded Forest (Shrub)	25˚ 57' 09.8"	98˚ 08' 55.9"	267 m	
48	Pitzaw	Degraded Forest (Shrub)	26˚ 18' 37.7"	98˚ 17' 11.5"	693 m	
49	Hpala	Degraded Forest (Shrub)	26˚ 03' 27.1"	98˚ 11' 38.9"	321 m	
50	Pitzaw	Degraded Forest (Shrub)	26˚ 18' 37.7"	98˚ 17' 10.1"	593 m	
51	Hpala	Degraded Forest (Shrub)	26˚ 01' 30.5"	98˚ 10' 29.4"	256 m	
52	Manton	Degraded Forest (Shrub)	25˚ 56' 29.6"	98˚ 08' 31.2"	251 m	
53	Tayoke	Settlement/ Village	25˚ 56' 58.4"	98˚ 08' 48.2"	270 m	
54	Myawmaw	Settlement/ Village	25˚ 56' 47.4"	98˚ 08' 34.2"	264 m	
55	Kancon	Settlement/ Village	26˚ 15' 59.1"	98˚ 17' 04.7"	699 m	
56	Hpala	Settlement/ Village	26˚ 01' 95.2"	98˚ 10' 70.9"	323 m	

57	Pitzaw	River side	26˚ 18' 53.3"	98˚ 17' 13.5"	354 m	
58	Hpala-Chibwe	River side	26˚ 00' 30.5"	98˚ 10' 04.8"	268 m	
59	Panandin	River side	27˚ 41' 15.2"	98˚ 01' 28.6"	917 m	
60	Hpala-Tsawlaw	Plantation (Leinmaw)	26˚ 04' 55.8"	98˚ 12' 14.9"	362 m	

Chapter V

5. Biodiversity Impact Assessment Report of Flora on Lasa Hydropower Dam

5.1. Introduction

Biodiversity impact assessment study especially on plant diversity and floristic composition in different habitat in inundated area and surrounding area of Lasa Dam on Malihka River which will be constructed near future had been carried out during April 2009.

The report will evaluate forest types and vegetation, floristic composition and dominant species, potential long term and short term impacts and also suggest the mitigation measure and effective determination of the project feasibility.

5.1.1. Location

The Lasa Hydropower Dam project area is located at 26º28´N and 97º 49´ E, in Sumprabum Township and 144.2 km distance to the confluence at Myitsone (The junction of Malihka and Mayhka). The catchment area is 15390 sq-km covering huge area of Malihka watershed. It lies on downstream confluence mouth of Malihka River and Hkrang hka Stream. The catchment area is 15390 sq-km and the total flooded area 24535 hectare and reaches about 80 kilometre upstream. Normal pool level is 370m and total storage capacity is 123Gm^3. There are five streams namely, Shang Hka (Nam-Tisang) Ntsi-hka (Macht-hka), Hkrang-Hka flows into Malihka in the upstream of the dam site and Tara-hka (Tara hka and Ching ma hka) flow into Malihka in the dawn-stream of the dam.

The watershed comprises intact forests along on both sides of Malihka River. There are three lowland plains which will be inundated and some of the vital habitat of wildlife will be lost forever. The motor car road from Myitkyina to Putao including some bridge closed to Malhka River will be inundated.

5.1.2. Topography

The bulk of Lasa Dam area falls 26º28´to 26º54´ N and 97º 37´to 98º 46´ E and it lies in the area 114.2 km distance to the confluence at Myitsone. Malihka start from the mountains of northern Myanmar near the boundaries of China. The total length is about 375km with catchment area of about 23100 km^2 and natural fall of 4470 m.

The lowest elevation in the study area is 242m near LotmaiYang Village and 947 m near Phananyan Village. Therefore some areas are below normal pool level of 370 m. There are three low land areas along the Malihka River which will become flooded area in future. The topography of dam area is low land area of less than 800m in elevation.

5.1.3. Climate

The climate of Lasa Dam area is the character of monsoon climate. The three distinct seasons; cool and dry season, warm and dry season and warm and wet season are apparent. In the rainy season, from June to October, the annual rain fall is rather uniform.

5.1.4. Forest in the context of Eco-region

From biodiversity point of view, the Lasa Dam area lies WWF Eco-regions of Mizoram-Manipur-Kachin moist evergreen forest and Northern Triangle Subtropical forest-Myanmar. The catchment area of Chibwe Dam area is located in and between Hukaung Valley W.S and its extension and Bumphabum W.S. So the area as a whole is the biodiversity hotspot and outstanding area of conservation. The forest types are oak forest, lowland evergreen forest, highland evergreen forest and bamboo forest.

5.1.5. Local people and their livelihood

The local people dwelling in this area include Kachin, Shan, Bama and Chinese. The majority is Kachin tribes. Most of them are farmers and their livelihood is very simple, cultivating of Taungyar rice and vegetables, breeding poultry, hunting and fishing. Shifting cultivation is common and terrace cultivation is also found. Both commercial logging and illegal logging are commonly found. The cease-fire group, special region II (KIA) is responsible for this logging and gold mining. The gold mining is the major impact of the area. Lack of law enforcement and strict regulation concerning with logging and waste disposal of gold mines is the main issue of the area. The environmental impacts assessment studies and mitigation measure may not be workable due to lack of law enforcement.

The village near the river banks such as Syumpyi Yang, In GiYang, Hpa wan Haung ing Yang, InHtan Sut and Jara Yang will be inundated when the Lasa Dam was completed. These villages are located in the flat plain and the elevation is less than 350m.

5.2. Aims and Objectives

1. To collect, identify and list the plant species in the area
2. To record the dominant tree species and evaluate the forest types
3. To study the impact of dam on the flora and to suggest the mitigation measure

5.3. Materials and Methods

5.3.1. Participants

Four Myanmar members of flora team Dr. Win Myint, Daw Khin Shwe Lwin, Daw Ei Ei Phyoe and U Nay Phyo Aung are included and cooperated with Chinese flora teams which are included four members.

5.3.2. Materials

Materials used for recording are strings for sample plotting, digital camera, maps compass, field press, data collection sheets, drying press, dryer, digging tools, heavy duty plastic bags, newspapers, alcohol, spray jug (for fixing specimens) 10 x lens, permanent markers and other field equipments.

5.3.3. Methods

One research team with four Myanmar scientists was organized and studies were conducted especially in the areas which may be inundated after the dam is constructed.

The plant specimens were collected both in inundated areas and habitats of representative areas.

The Global Positioning System was used to navigate and mark coordinates between sample plots in each habitat. In order to obtain essential ecological data for predicting forest value and forest type, quadrants of varying size were set up and observed. Plant collection (all trees, shrubs and herbs) was carried out in random and by Transit line whenever possible to get the representative checklists of the plants in the studied area and all specimens are identified and recorded. DBH and Height classes at tree species are calculated by based on the measurement of breast height diameters along with its height.

Field press and drying press were used to get voucher specimens and to store in herbarium. Habitat type's altitude, topography, forest type, canopy cover and structure, light intensity, wind velocity and sign of disturbance were recorded. To know the habit of the plant species and to ensure the vegetation, photographic records were also carried out.

Leaves, inflorescences, floral structures and other vegetative parts of each plant specimens were collected and photographed and recorded as field notes.

5.4. Results

5.4.1. Floristic Composition in the study area

The total number of species collected in the Lasa Dam site and expected flooded area is 682 species belonging to 464 genera of 124 families. (Appendix - I)

The forest types were determined according to their species composition. The dominant tree species, shrub species and herb species were also determined according to their species composition in sample plots. (Appendix - II)

5.4.2. The human impacts in the study area

Logging

It was learnt that the major impact due to logging started during past five years and it still exists in the study periods. Almost all primary forests had been degraded due to logging. Some low land forests are left in patches in the potential flooded area. The degraded forests are common everywhere. As a long term impact the deforestation will leads to the climatic change and decrease annual rainfall. It may also lead to erosion which in turn leads to sedimentation in the dam and reduces the life of dam.

Shifting cultivation

The shifting cultivation is inevitable because of the major livelihood of the local people. New land for Taungyar cultivation was made by slashing and burning the forests. The impact of shifting cultivation may lead to the loss of forests. The abandoned Taungyarr dominated by grasses like *Panicum* sp. and *Sorghum* sp. are found elsewhere. The Taungyars were found both in low land and on mountain areas.

Gold Mining

Gold mining is the major business in the study area. The mining sites were found both in the middle of the river and bank. Land sliding was induced by pumping the banks with water as a mining technique. The result is the formation of wide sand bank and stone barriers in the riverine area. The other technique was digging the floor of the river using grittier machine. The result is the formation of stone ridges in the river which changes the navigation and blocks the natural water flow of the river. The water quality becomes silty. The river water becomes very turbid and impure due to landslide.

Involuntary Displacement

There are nine large villages which may be inundated after the dam is constructed. So the involuntary displacement may be the main adverse social impact. The main mitigation measure, with agreement of both resettle and host population will be the best solution.

The loss of infrastructure

Some areas of motor car road from Myitkyina to Putao including some bridge will be inundated. New access road must be substituted. The sitting of new road should be environmentally and socially least damaging. Road engineering should ensure proper drainage to protect water ways and minimize erosion.

Endangered species: According to the IUCN Red list (2000), the following species are recorded;

4. *Aquilaria malaccensis* Lam. VU
5. *Dipterocarpus turbinatus* Gaertn. f. CR
6. *Shorea assamia* Dyer CR

5.5. Discussion and Conclusion

Among 682 species collected in the area 77 species are tree species. *Dipterocarpus* sp., *Litsea* sp., *Mallotus paniculatus*, *Castanopsis* sp., *Lithocarpus* sp., *Quercus* sp., *Fagus* sp., *Myristica* sp., and *Garcinia* sp., are found to be dominant. It was found that 50% of them are more than 10 m in height and 60 cm in girth and majority of species are small trees. The timber value is moderate.

All the forests are subject to various kinds of disturbances such as logging, mining and shifting cultivation. The area as a whole has an insufficient protection of natural resources. Three is no laws and legislation for waste disposal produced by mining and timber extraction from the forest. The immediate impacts are the deforestation and change in water quality. The long term impact will be the climate change due to deforestation and change in navigation and natural flow system in the river due to gold mining.

The vegetation pattern is dependent on the moisture content in the atmosphere, topography and disturbance. The vegetation pattern in the study area consists of oak forest, low land evergreen forest, low land secondary forest, high land secondary forest and bamboo forest. The primary forests are found in small patches in the area of steep valley and steep river bank. By comparing the composition of tree species in so called primary forest and disturbed area, the previous forest type had been assessed.

Fagus sp., *Lithocarpus* sp., *Quercus* sp., *Castanopsis* sp., are found mixed with *Dipterocarpus* sp., *Litsea* sp., *Mallotus* sp., *Myristica* sp., and *Chisocheton* sp., in tree layer. The shrub layer is dominated by *Achanthus* sp., *Melastoma* sp., *Gnetum* sp., *Begonia* sp., *Ziziphus* sp., and *Dracaena* sp. The herb layer is dominated by Urea sp., *Selaginella* sp., *Commelina* sp., *Smilax* sp., *Clerodendrum* sp, and *Piper* sp.

To prevent the climate change in the study area the restoration of previous vegetation pattern by preventive and reforestation measures should be planned and carried out no matter whether the dam is constructed or not.

5.6. Recommendation

1. One or more compensatory protected area such as national park or wildlife sanctuary should be established in the area between Malihka and Mayhka Rivers under project expenditure.
2. Reforestation should be carried out to restore the previous vegetation pattern no matter whether the dam is constructed or not.
3. Law and legislation concerning with logging and mining technique and waste disposal should be immediately adopted and enforced.
4. The resettlement of displaced population including new housing, compensation, and creation of new jobs for the loss of livelihood of resettled population should be planned and worked out.
5. New access road from Miytkyina to Putao should be planned and the siting of road should be environmentally and socially least damaging corridor.
6. Terrace cultivation and long term plantation such as tea leaves (lahpet), coffee, orange and lemon plantation should be encouraged to reduce shifting cultivation.

The socio-economic development and community development of local community development accommodating with conservation practice should be planned and practised under project expenditure.

Table - 1 Tree species in DBH class intervals in Lasar

DBH Classes	No. of species	Total number of individual	% of total species
< 30 cm	22	71	16.54
30 - 60 cm	44	92	33.08
60 - 90 cm	37	88	27.82
90 - 120 cm	14	26	10.53
120 - 150 cm	5	7	3.76
150 - 180 cm	6	12	4.51
180 - 210 cm	4	10	3.01
210 -240 cm	1	2	0.75
240 - 270 cm	-	-	0.00
270 - 300 cm	-	-	0.00
300 - 330 cm	-	-	0.00
330 - 360 cm	-	-	0.00
360 - 390 cm	-	-	0.00

390 - 420 cm	-	-	0.00
420 - 450 cm	-	-	0.00
450 - 480 cm	-	-	0.00
480 - 510 cm	-	-	0.00
510 - 540 cm	-	-	0.00
540 - 570 cm	-	-	0.00
> 570 cm	-	-	0.00
Total	77	308	100

Table - 2 Tree species in Height class intervals in Lasar

Height Classes	No. of species	Total number of individual	% of total species
< 3m	1	2	0.85
3 - 10 m	55	158	47.01
10 - 17 m	38	89	32.48
17 - 24 m	18	52	15.38
24 - 31 m	5	7	4.27
31 - 38	-	-	0.00
> 38 m	-	-	0.00
Total	77	308	100.00

Appendix -I Lasa Plant Lists

No.	Scientific Name	Family	Habit	Common-Name
1	*Abroma angusta* (L.) L. f.	Sterculiaceae	S,ST	Mway-seik-phay-pin
2	*Acacia pennata* (L.) Willd.	Mimosaceae	Cl	Suboke-gyi
3	Acampe rigida (Buch.-Ham. ex J.E. Sm.) P.F. Hunt.	Orchidaceae	E	-
4	Acampe sp.	Orchidaceae	E	-
5	*Acanthus leucostachyus* Wall.	Acanthaceae	Cl,Cr	-
6	*Acanthus* sp.	Acanthaceae	S	-
7	*Achyranthes* sp.	Amaranthaceae	H	-

No.	Scientific Name	Family	Habit	Common-Name
8	*Acmella calva* (DC.) R.K. Jansen	Asteraceae	H	Hingala
9	*Acmella* sp.	Asteraceae	H	-
10	*Acorus* sp.	Acoraceae	H	-
11	*Acrocephalus* sp.	Lamiaceae	H	-
12	Actinodaphne sp.	Lauraceae	T	-
13	*Adenostemma lavenia* (L.) Kuntze	Asteraceae	H	Sin-bizat-gyi
14	*Aeschynanthus* sp.	Gesneriaceae	H	-
15	*Aesculus* sp.	Sapindaceae	ST	-
No.	**Scientific Name**	**Family**	**Habit**	**Common-Name**
16	*Afzelia*sp.	Caesalpiniaceae	Cl	-
17	*Agapetes macrantha* Hook. f.	Ericaceae	Cl	-
18	*Agastache* sp.	Lamiaceae	H	-
19	*Ageratum conyzoides* L.	Asteraceae	H	Kadu-hpo
20	*Aglaonema* sp.	Araceae	H	-
21	*Alangium* sp.1	Alangiaceae	T	-
22	*Alangium* sp.2	Alangiaceae	T	-
23	*Albizia chinensis* (Osbeck.) Merr.	Mimosaceae	T	Bonmeza
24	*Alocasia* sp.1	Araceae	H	-
25	*Alocasia* sp.2	Araceae	H	-
26	*Alpinia* sp.1	Zingiberaceae	H	-
27	*Alpinia* sp.2	Zingiberaceae	H	-
28	Alstonia sp.	Apocynaceae	S	-
29	*Alternanthera sessilis* (L.) R. Br.	Amaranthaceae	S	-
30	*Alternanthera* sp.	Amaranthaceae	H	-
31	*Amaranthus gracilis* Desf.	Amaranthaceae	H	-
32	*Amaranthus spinosus* L.	Amaranthaceae	H	-
33	*Amomum corynostachyum* Wall.	Zingiberaceae	H	-
34	*Amorphophallus paeoniifolius* (Dennst.) Nicolson	Araceae	H	Wa-u-bin,Wa-u-pin
35	*Ampelopsis* sp.	Vitaceae	Cl	-
36	*Angelica* sp.	Apiaceae	H	-

37	*Angiopteris* sp.	Marattiaceae	F	-
38	Antidesmasp.	Euphorbiaceae	T	-
39	*Aporusa* sp.1	Euphorbiaceae	ST	-
40	*Aporusa*sp.2	Euphorbiaceae	S	-
41	*Aquilaria malaccensis* Lam.	Thymelaeaceae	T	Thit-hmwe
42	*Araiostegia* sp.	Davalliaceae	F	-
43	Archidendron sp.	Mimosaceae	T	-
No.	**Scientific Name**	**Family**	**Habit**	**Common-Name**
44	*Ardisia* sp.2	Myrsinaceae	S	-
45	*Ardisia* sp.3	Myrsinaceae	ST	-
46	*Ardisia* sp.4	Myrsinaceae	S	-
47	*Ardisia* sp.5	Myrsinaceae	S	-
48	*Ardisia* sp.6	Myrsinaceae	H	-
49	*Ardisia*sp.1	Myrsinaceae	S	-
50	*Areca triandra* Roxb.	Arecaceae	ST	Taw-kun-thi
51	Artemisia vulgaris L.	Asteraceae	H	Me-di-dok
52	*Asclepias curassavica* L.	Asclepiadaceae	S	Pandein-ngo
53	*Asplenium nidus* L.	Aspleniaceae	F	-
54	*Atalantia roxburghiana* Hk.f.	Rutaceae	ST	-
55	*Atractylodes* sp.	Asteraceae	H	-
56	*Averrhoa*sp.	Oxalidaceae	ST	-
57	Baccaurea ramiflora Lour.	Euphorbiaceae	T	-
58	*Barleria* sp.	Acanthaceae	S	-
59	*Bauhinia* sp.1	Caesalpiniaceae	Cl	-
60	*Bauhinia* sp.2	Caesalpiniaceae	Cl	-
61	*Bauhinia* sp.3	Caesalpiniaceae	Cl	-
62	*Begonia roxburghii* A. DC.	Begoniaceae	H	-
63	*Begonia* sp.1	Begoniaceae	H	-
64	*Begonia* sp.2	Begoniaceae	H	-
65	*Begonia* sp.3	Begoniaceae	H	-
66	*Begonia* sp.4	Begoniaceae	H	-

67	*Begonia* sp.5	Begoniaceae	H	-
68	*Berchemia* sp.	Rhamnaceae	S	-
69	*Bischofia javanica* Blume	Euphorbiaceae	T	-
70	Bischofia sp.	Euphorbiaceae	T	-
71	*Blumea* sp.1	Asteraceae	S	-
72	*Blumea* sp.2	Asteraceae	S	-
73	*Boehmeria* sp.	Urticaceae	ST	-
No.	**Scientific Name**	**Family**	**Habit**	**Common-Name**
74	*Borassus* sp.	Arecaceae	T	-
75	*Borreria* sp.	Rubiaceae	H	-
76	*Brassaiopsis* sp.	Araliaceae	T	-
77	*Brassica nigra* (L.) Koch	Brassicaceae	S	Monnyin-net
78	*Brassica* sp.	Brassicaceae	H	-
79	*Bredelia* sp.	Euphorbiaceae	T	-
80	*Breynia officinalis* Hemsl.	Euphorbiaceae	S	-
81	Broussonetia sp.	Moraceae	ST	-
82	Broussonetia sp.	Moraceae	T	-
83	*Buddleja asiatica* Lour.	Buddlejaceae	S	Kyaung-migo
84	*Bulbophyllum* sp.	Orchidaceae	E	-
85	*Butea* sp.	Fabaceae	Cl	-
86	*Caesalpinia nuga* Ait.	Caesalpiniaceae	S	-
87	*Calamus floribundus* Griff.	Arecaceae	Cl	Ye-kyein
88	*Calamus palustris* Griff.	Arecaceae	ST	-
89	*Calamus* sp.	Arecaceae	Cl	-
90	*Callicarpa* sp.1	Verbenaceae	T	-
91	*Callicarpa* sp.2	Verbenaceae	T	-
92	*Camellia* sp.1	Theaceae	ST	-
93	*Camellia* sp.2	Theaceae	S	-
94	*Canna* sp.	Cannaceae	S	Budatharana,Pan-u-pin
95	*Carallia*sp.	Rhizophoraceae	ST	-
96	*Carex* sp.1	Cyperaceae	H	-
97	*Carex* sp.2	Cyperaceae	H	-

98	*Carex* sp.3	Cyperaceae	G	-
99	*Carex* sp.4	Cyperaceae	H	-
100	*Carya* sp.	Juglandaceae	T	-
101	*Caryota gigas* Hahn ex hodel	Arecaceae	T	minbaw
102	*Cassia* sp.1	Caesalpiniaceae	ST	-
No.	**Scientific Name**	**Family**	**Habit**	**Common-Name**
103	*Cassia* sp.2	Caesalpiniaceae	S	-
104	*Castanopsis argyrophylla* King.	Fagaceae	T	-
105	*Castanopsis* sp.1	Fagaceae	T	-
106	*Castanopsis* sp.2	Fagaceae	T	-
107	*Castanopsis* sp.3	Fagaceae	T	-
108	Cedrela sinensis A.Juss.	Meliaceae	T	-
109	*Ceiba pentandra* (L.) Gaertn.	Bombacaceae	T	Le-moh-pin
110	*Celosia argentea* L.	Amaranthaceae	H	-
111	Celtis sp.	Ulmaceae	T	-
112	*Centella* sp.1	Apiaceae	H	-
113	*Centella* sp.2	Apiaceae	H	-
114	*Centipeda minima* (L.) A. Br. & Asch.	Asteraceae	H	Sat-cahy
115	*Chisocheton siamensis* Crab.	Meliaceae	T	-
116	Chromolaena odorata (L.) R.M. King & H. Robinson	Asteraceae	H	Bezat
117	*Chrysopogon acicularis* (Retz.) Trin.	Poaceae	H	Naukpo-myet
118	*Cinnamomum* sp.1	Lauraceae	T	-
119	*Cinnamomum* sp.2	Lauraceae	T	-
120	*Citrus* sp.1	Rutaceae	T	-
121	*Citrus* sp.2	Rutaceae	ST	-
122	*Clausena*sp.	Rutaceae	ST	-
123	Cleisostomasp.	Orchidaceae	E	-
124	*Clematis*sp.	Ranunculaceae	Cl	-
125	*Cleome* sp.	Capparaceae	H	-
126	*Clerodendrum* sp.1	Verbenaceae	S	-

127	*Clerodendrum* sp.2	Verbenaceae	S	-
128	*Clerodendrum* sp.3	Verbenaceae	S	-
129	*Clerodendrum fragrans* Vent.	Verbenaceae	S	-
130	*Coccinia*sp.	Cucurbitaceae	Cl	-
No.	**Scientific Name**	**Family**	**Habit**	**Common-Name**
131	*Coix lacryma-jobi* L.	Poaceae	G	Kyeik
132	*Colocasia esculenta* (L.) Schott	Araceae	H	Mahuya-pein
133	*Colocasia* sp.	Araceae	H	Pein-pin
134	*Colysis elliptica* (Thunb.) Ching	Polypodiaceae	F	-
135	*Commelina nudiflora* L.	Commelinaceae	H	Wetkyok
136	*Commelina* sp.1	Commelinaceae	H	-
137	*Commelina* sp.2	Commelinaceae	Cl	-
138	*Commelina* sp.3	Commelinaceae	H	-
139	*Commelina* sp.4	Commelinaceae	H	-
140	*Corchorus* sp.	Tiliaceae	S	-
141	*Cordia myxa* L.	Boraginaceae	T	Taung-thanut
142	*Cordia* sp.	Boraginaceae	T	-
143	*Corydalis bungeana* Turcz.	Papaveraceae	H	-
144	*Crassocephalum crepidioides* (Benth.) S. Moore	Asteraceae	H	-
145	*Crisium setosum*	Asteraceae	H	-
146	*Crotalaria* sp.1	Fabaceae	H	-
147	*Crotalaria* sp.2	Fabaceae	S	-
148	*Cuphea hyssopifolia* Kunth	Lythraceae	H	-
149	*Cuphea* sp.	Lythraceae	H	-
150	*Curcuma* sp.	Zingiberaceae	H	-
151	*Cyanotis* sp.	Commelinaceae	H	-
152	*Cymbidium* sp.	Orchidaceae	H	-
153	*Cynodon dactylon* (L.) Pers.	Poaceae	G	Myin-sar-myet
154	*Cyperus* sp.1	Cyperaceae	G	-
155	*Cyperus* sp.2	Cyperaceae	H	-

156	*Cyperus* sp.3	Cyperaceae	G	-
157	*Cyperus* sp.4	Cyperaceae	G	-
158	*Cyrtandra*sp.	Gesneriaceae	S	-
No.	**Scientific Name**	**Family**	**Habit**	**Common-Name**
159	Cyrtococcum sp.1	Poaceae	G	-
160	Cyrtococcum sp.2	Poaceae	G	-
161	Cyrtomium sp.	Dryopteridacea e	F	-
162	*Dalbergia* sp.1	Fabaceae	Cl	-
163	*Dalbergia* sp.2	Fabaceae	T	-
164	*Debregeasia longifolia* Wedd.	Urticaceae	ST	-
165	Dendrobium moschatum (Buch.-Ham.) Sw.	Orchidaceae	E	Lettan-she
166	*Dendrobium* sp.1	Orchidaceae	E	-
167	*Dendrobium* sp.2	Orchidaceae	E	-
168	*Desmodium* sp.1	Fabaceae	H	-
169	*Desmodium* sp.2	Fabaceae	H	-
170	*Desmodium* sp.3	Fabaceae	S	-
171	*Desmodium* sp.4	Fabaceae	Cl	-
172	*Desmodium* sp.5	Fabaceae	H	-
173	*Desmodium* sp.6	Fabaceae	S	-
174	*Desmodium triangulare* (Retz.) Merr.	Fabaceae	S	-
175	*Dicentra* sp.	Papaveraceae	H	-
176	*Digitaria* sp.	Poaceae	G	-
177	*Dioscorea* sp.1	Dioscoreaceae	Cl	-
178	*Dioscorea* sp.2	Dioscoreaceae	Cl	-
179	*Dioscorea* sp.3	Dioscoreaceae	Cl	-
180	*Diospyros ehretioides* Wall.	Ebenaceae	T	Aukchinsa
181	*Dipteris chinensis* Christ	Dipteridaceae	F	-
182	*Dipterocarpus turbinatus* Gaertn. f.	Dipterocarpaceae	T	Kanyin-ni
183	*Dipterocarpus obtusifolius* Teysm.	Dipterocarpaceae	T	Inbo, Kanyin-gok
184	*Dracaena*sp.1	Dracaenaceae	S	-
185	*Dryopteris* sp.	Dryopteridaceae	F	-

186	*Duabanga grandiflora* (Roxb. ex DC.) Walp.	Lythraceae	T	Myaukngo
No.	**Scientific Name**	**Family**	**Habit**	**Common-Name**
187	*Duchesnea* sp.1	Rosaceae	H	-
188	*Duchesnea* sp.2	Rosaceae	H	-
189	*Eclipta alba* (L.) Hassk.	Asteraceae	H	Kyeik-hman
190	*Elatostema* sp.1	Urticaceae	S	-
191	*Elatostema* sp.2	Urticaceae	H	-
192	*Elatostema* sp.3	Urticaceae	S	-
193	*Elatostema* sp.4	Urticaceae	S	-
194	*Elatostema* sp.5	Urticaceae	S	-
195	*Elatostema* sp.6	Urticaceae	H	-
196	*Elatostema* sp.7	Urticaceae	Cl	-
197	*Elatostema* sp.8	Urticaceae	H	-
198	*Eleocharis acicularis* (L.) Roem. & Schult.	Cyperaceae	H	Myet
199	*Eleocharis* sp.	Cyperaceae	H	-
200	*Eleusine indica* (L.) Gaertn.	Poaceae	G	Sinngo-myet
201	*Elsholtzia* sp.	Lamiaceae	S	-
202	*Engelhardtia spicata* Blume	Juglandaceae	T	Pan-swelwe
203	*Entada phaseoloides* (L.) Merr.	Mimosaceae	Cl	-
204	Epigeneium rosem (D.Don) Lindl	Orchidaceae	E	-
205	*Epipremmum* sp.	Araceae	H	Ceriman
206	*Equisetum* sp.	Equisetaceae	H	-
207	*Eragrostis gangetica* (Roxb.) Steud.	Poaceae	G	Gyo-gya-myet
208	*Eragrostis tef* (Zucc.) Trotter	Poaceae	G	-
209	Eria acervata Lindl.	Orchidaceae	E	-
210	Ervatamia recurva Roxb.	Apocynaceae	S	Taw-zalat
211	*Erymgium foetidum*L.	Apiaceae	H	-
212	*Erythrina*sp.	Fabaceae	T	-
213	Eurya sp.	Theaceae	ST	-
214	Fatsia sp.	Araliaceae	T	-

No.	Scientific Name	Family	Habit	Common-Name
215	*Ficus auriculata* Lour.	Moraceae	T	Sin-thapan
216	*Ficus elastica* Roxb.	Moraceae	T	Nyaung-kyetpaung
217	*Ficus hirta* Vahl.	Moraceae	ST	Kyasha-tha-phan
218	*Ficus roxburghii* Wall.	Moraceae	T	-
219	*Ficus* sp.1	Moraceae	T	-
220	*Ficus* sp.2	Moraceae	T	-
221	*Ficus* sp.3	Moraceae	ST	-
222	*Ficus* sp.4	Moraceae	T	-
223	*Ficus* sp.5	Moraceae	Cl	-
224	*Ficus* sp.6	Moraceae	F	-
225	*Ficus* sp.7	Moraceae	T	-
226	*Ficus* sp.8	Moraceae	T	-
227	*Fimbristylis aestivalis* Vahl.	Cyperceae	H	-
228	*Fimbristylis* sp.	Cyperaceae	H	-
229	*Fimbristylis*sp.	Cyperaceae	H	-
230	*Firmiana* sp.	Sterculiaceae	T	-
231	*Fittonia* sp.	Acanthaceae	H	-
232	*Floscopa scandens* Lour.	Commelinaceae	H	-
233	*Gardenia*sp.	Rubiaceae	ST	-
234	*Gelsemium* sp.	Loganiaceae	Cl	-
235	*Gentiana*sp.	Gentianaceae	H	-
236	*Gladiolus* sp.	Iridaceae	H	-
237	*Gleichenia flexuosa* Smith	Hymenophyllaceae	F	-
238	*Globba* sp.1	Zingiberaceae	H	-
239	*Globba* sp.2	Zingiberaceae	H	-
240	*Glochidion* sp.1	Euphorbiaceae	S	-
241	*Glochidion* sp.2	Euphorbiaceae	S	-
242	*Glochidion* sp.3	Euphorbiaceae	T	-
243	*Glochidion* sp.4	Euphorbiaceae	S	-
244	*Gnaphalium affine* D. Don	Asteraceae	H	-
No.	**Scientific Name**	**Family**	**Habit**	**Common-Name**

245	*Gnetum gnemon* L.	Gnetaceae	Cl	-
246	*Gnetum* sp.	Gnetaceae	S	Hyinbyin Tanyin-ywe
247	*Goleola nudifolia* Lour.	Orchidaceae	E	-
248	*Goodyera procera* Hook.	Orchidaceae	H	-
249	*Gordonia* sp.	Theaceae	T	-
250	*Gossypium* sp.	Malvaceae	ST	-
251	*Grangea* sp.	Asteraceae	H	-
252	*Hedyotis* sp.1	Rubiaceae	H	-
253	*Hedyotis* sp.2	Rubiaceae	H	-
254	*Hedyotis verticillata* (L.) Lam.	Rubiaceae	H	-
255	*Heteropanax fragrans* (Roxb. ex DC.) Seem.	Araliaceae	ST	Kyaungdauk
256	*Hippeastrum* sp.	Amaryllidaceae	H	-
257	*Hippeastrum* sp.	Amaryllidaceae	H	-
258	*Homonoia riparia* Lour.	Euphorbiaceae	S	Ye-chanya
259	*Houttuynia cordata* Thunb.	Saururaceae	H	-
260	*Hoya* sp.1	Asclepiadaceae	E	-
261	*Hoya* sp.2	Asclepiadaceae	Cl	-
262	*Humata platylepis* (Bak.)Ching	Davalliaceae	F	-
263	*Humata* sp.	Davalliaceae	F	-
264	*Hydrangea heteromalla* D.Don Prodr.	Hydrangeaceae	T	-
265	Hypericum kamtschaticum Ledeb	Hypericeceae	H	-
266	*Hypericum* sp.	Hypericaceae	H	-
267	*Impatiens racemosa* DC.Prodr.	Balsaminaceae	H	-
268	*Impatiens stenantha* Darjeeling	Balsaminaceae	H	-
269	*Ipomoea* sp.1	Convolvulaceae	Cl	-
270	*Ipomoea* sp.2	Convolvulaceae	Cl	-
271	*Ipomoea* sp.3	Convolvulaceae	Cl	-
272	*Ipomoea* sp.4	Convolvulaceae	Cl	-
No.	**Scientific Name**	**Family**	**Habit**	**Common-Name**
273	*Itea macrophylla* Wall.	Escalloniaceae	T	Yekun

274	Itea sp.	Escalloniaceae	ST	-
275	*Ixeridium chinense* (Thunb.) Tzvelev	Asteraceae	H	-
276	*Ixora grandifolia* Zoll. & Moritzi	Rubiaceae	S	-
277	*Ixora* sp.1	Rubiaceae	S	-
278	*Ixora* sp.2	Rubiaceae	S	-
279	*Ixora* sp.3	Rubiaceae	S	-
280	*Ixora* sp.4	Rubiaceae	S	-
281	*Ixora* sp.5	Rubiaceae	S	-
282	*Ixora* sp.6	Rubiaceae	S	-
283	*Ixora* sp.7	Rubiaceae	S	-
284	*Ixora* sp.8	Rubiaceae	S	-
285	*Juncus* sp.	Juncaceae	H	-
286	*Justica simplex* D. Don	Acanthaceae	S	-
287	*Justicia* sp.1	Acanthaceae	S	-
288	*Justicia* sp.2	Acanthaceae	S	-
289	*Kaempferia rotunda* L.	Zingiberaceae	H	-
290	*Kyllinga* sp.	Cyperaceae	H	-
291	Kyllinga tenuifolia Steud.	Cyperaceae	H	Thon-daunt-myet
292	*Lasia spinosa* (L.) Thwaites	Araceae	H	Zayit
293	*Lasianthus*sp.	Rubiaceae	S	-
294	*Lepidagathis* sp.	Acanthaceae	S	-
295	*Lepidagathis* sp.2	Acanthaceae	S	-
296	*Leucosceptrum* sp.	Lamiaceae	H	-
297	*Limonia* sp.	Rutaceae	ST	-
298	*Lindernia* sp.1	Linderniaceae	H	-
299	*Lindernia* sp.2	Linderniaceae	H	-
300	*Lindernia* sp.3	Linderniaceae	H	-
301	Liparissp.	Orchidaceae	H	-
No.	**Scientific Name**	**Family**	**Habit**	**Common-Name**
302	*Lithocarpus* sp.1	Fagaceae	T	-
303	*Lithocarpus* sp.2	Fagaceae	T	-

304	*Lithocarpus* sp.3	Fagaceae	T	-
305	*Lithocarpus* sp.4	Fagaceae	T	-
306	Litsea macrophylla Bl.	Lauraceae	T	-
307	*Litsea salicifolia* (Nees.) Hook.f.	Lauraceae	ST	-
308	*Litsea* sp.1	Lauraceae	ST	-
309	*Litsea* sp.2	Lauraceae	ST	-
310	*Litsea* sp.3	Lauraceae	ST	-
311	*Litsea* sp.4	Lauraceae	S	-
312	*Livistona jenkinsiana* Griff.	Arecaceae	ST	Taung-htan
313	*Loranthus pentandius*L.	Loranthaceae	E	-
314	*Loranthus* sp.	Loranthaceae	Paraside Herb	-
315	*Loxogramma* sp.	Loxogrammaceae	F	-
316	*Ludwigia octovalvis* (Jacq.) Raven	Onagraceae	H	Lay-nyin-gyi
317	*Ludwigia* sp.1	Onagraceae	H	-
318	*Ludwigia* sp.2	Onagraceae	H	-
319	*Luffa aegyptiaca* Mill.	Cucurbitaceae	Cl	Tha-but-nwe
320	*Luvunga* sp.	Rutaceae	Cl	-
321	Lycopersicon esculentum Mill.	Solanaceae	H	-
322	*Lycopodium* sp.	Lycopodiaceae	F	-
323	*Lygodium* sp.	Schizaeaceae	F	-
324	*Macaranga denticulata* Muell.Arg.	Euphorbiaceae	T	Pet-waing
325	*Macaranga gigantea* (Rchb.f.&Zoll.)	Euphorbiaceae	T	-
326	*Macaranga kurzii* (O.k.) Pax & Hoffm.	Euphorbiaceae	T	-
327	*Machilus* sp.	Lauraceae	T	-
328	*Maesa montana* A.DC.	Myrsinaceae	S	-
329	*Magnolia liliifera* (L.) Baill.	Magnoliaceae	T	Lai-makhan-phang
No.	**Scientific Name**	**Family**	**Habit**	**Common-Name**
330	*Malaxis*sp.	Orchidaceae	E	-
331	*Mallotus paniculatus*Muell. Arg.	Euphorbiaceae	T	-
332	*Mallotus* sp.	Euphorbiaceae	S	-

333	Mariscus sumatrensis(Retz.) Raynal	Cyperaceae	H	-
334	*Mazus surculosus* C.Nepal.	Phrymaceae	H	-
335	*Melastoma* sp.1	Melastomataceae	S	-
336	*Melastoma* sp.2	Melastomataceae	S	-
337	*Melochia corchorifolia* L.	Sterculiaceae	ST	Pilaw, Pilaw-akyi
338	*Melothria heterophylla* (Lour.) Cogn.	Cucurbitaceae	Cl	Kyet-sha
339	*Melothria* sp.1	Cucurbitaceae	H	-
340	*Melothria* sp.2	Cucurbitaceae	Cl	-
341	*Merremia vitifolia* (Burm. f.) Hallier f.	Convolvulaceae	Cl	-
342	*Micromelum minutum* (Forst. f.)Wight & Arn	Rutaceae	T	-
343	*Microsorus* sp.	Polypodiaceae	F	-
344	*Mikania micrantha* H.B.K.	Asteraceae	Cl	-
345	*Millettia*sp.	Fabaceae	Cl	-
346	*Mimosa pudica* L.	Mimosaceae	H	Tikayon
347	*Molineria capitulata* (Lour.) Herb.	Hypoxidaceae	H	Kywet-malut
348	*Monochoria hastaefolia* Presl	Pontenteriaceae	H	-
349	*Monochoria* sp.	Pontederiaceae	H	
350	*Morinda angustifolia* Roxb.	Rubiaceae	ST	Nibase-gyi
351	*Morus* sp.	Moraceae	S	-
352	*Mucuna* sp.2	Fabaceae	Cl	-
353	*Mucuna*sp.	Fabaceae	Cl	-
354	*Musa* sp.	Musaceae	H	-
355	*Musa* sp.	Musaceae	S	-
356	*Mussaenda*sp.	Rubiaceae	T	-
357	*Mycetia* sp.	Rubiaceae	S	-
No.	**Scientific Name**	**Family**	**Habit**	**Common-Name**
358	*Myosotis* sp.	Boraginaceae	H	-
359	Naringi sp.	Rutaceae	ST	-
360	*Neillia rubiflora* Malechin C.Nepal	Rosaceae	Cl	-

361	*Nephrolepis auriculata* (L.)Trimen	Davalliaceae	F	-
362	*Nephrolepis*sp.	Davalliaceae	F	-
363	*Odontonema* sp.	Acanthaceae	S	-
364	*Oldenlandia diffusa* (Willd.) Roxb.	Rubiaceae	H	-
365	*Oldenlandia* sp.1	Rubiaceae	H	-
366	*Oldenlandia* sp.2	Rubiaceae	H	-
367	*Oldenlandia* sp.3	Rubiaceae	H	-
368	*Ophiorrhiza* sp.	Rubiaceae	H	-
369	*Oroxylum* sp.	Bignoniaceae	ST	-
370	*Oxalis corniculata* L.	Oxalidaceae	H	Hmo-chin
371	*Oxyspora paniculata* (D.Don.)DC.Prodr.	Melastomataceae	ST	-
372	*Paederia lanuginosa* Wall.	Rubiaceae	Cl	-
373	*Paederia* sp.	Rubiaceae	Cl	-
374	*Pandanus* sp.1	Pandanaceae	ST	-
375	*Pandanus* sp.2	Pandanaceae	ST	-
376	*Panicum psilopodium* Trin.	Poaceae	G	-
377	*Paris tetraphylla* A. Gray	Liliaceae	H	-
378	*Paspalum scrobiculatum* L.	Poaceae	G	Myet-khayan
379	*Pennisetum* sp.	Poaceae	G	-
380	*Peperomia*sp.	Piperaceae	H	-
381	*Perilla*sp.	Lamiaceae	H	-
382	*Peristylus* sp.	Orchidaceae	H	-
383	*Phlogacanthus curviflorus* Nees.	Acanthaceae	S	-
384	*Phlogacanthus pubinervius* T. Anders.	Acanthaceae	ST	-
385	*Phoebe*sp.	Lauraceae	ST	-
No.	**Scientific Name**	**Family**	**Habit**	**Common-Name**
386	Pholidota articulata Lindl.	Orchidaceae	E	-
387	*Photinia*sp.	Rosaceae	ST	-
388	*Phrynium capitatum* Willd.	Marantaceae	H	Taungsin-phet
389	Phyllanthus sp.	Euphorbiaceae	S	-

390	*Phyllanthus urinaria* L.	Euphorbiaceae	H	Mye-shit-sha
391	*Phyllanthus*sp.	Euphorbiaceae	S	-
392	*Physalis minima* L.	Solanaceae	H	-
393	*Pilea scripta* U	Urticaceae	S	-
394	*Piper attenuatum* Ham.	Piperceae	H	-
395	*Piper cubebe* L.f.	Piperceae	Cl	Peik-chin
396	*Piper thwaitseii* C. DC.	Piperaceae	H	-
397	*Piper* sp.	Piperaceae	Cl	-
398	Plantago major L.	Plantaginaceae	H	Ah-gyaw-paung-ta-htaung
399	*Plectranthus*sp.	Lamiaceae	H	-
400	*Polygala* sp.	Polygalaceae	H	-
401	*Polygonatum* sp.	Convallariaceae	H	-
402	*Polygonum chinense*L.	Polygonaceae	H	-
403	*Polygonum pubescens* Blume	Polygonaceae	H	-
404	*Polygonum* sp.1	Polyganaceae	H	-
405	*Polygonum* sp.2	Polygonaceae	H	-
406	*Polygonum* sp.3	Polyganaceae	H	-
407	*Polygonum* sp.4	Polygonaceae	H	-
408	*Polygonum* sp.5	Polygonaceae	H	-
409	*Polygonum* sp.6	Polygonaceae	H	-
410	*Potentilla chinensis* Ser.	Rosaceae	H	-
411	*Pothos* sp.1	Araceae	Cl	-
412	*Pothos* sp.2	Araceae	Cl	-
413	*Pothos* sp.3	Araceae	Cl	-
414	*Pouzolzia* sp.	Urticaceae	S	-
No.	**Scientific Name**	**Family**	**Habit**	**Common-Name**
415	*Pronephrium* sp.	Thelypteridaceae	F	-
416	*Prumus persica* Benth.& Hook.f.	Rosaceae	ST	-
417	*Pseuderanthemum* sp.1	Acanthaceae	S.	-
418	*Pseuderanthermum* sp.2	Acanthaceae	S	-
419	*Pseudostachyum polymorphum* Munro	Poaceae	B	Bauk-wa

420	*Pteris* sp.1	Pteridaceae	F	-
421	*Pteris* sp.2	Pteridaceae	F	-
422	Pterospermum sp.	Sterculiaceae	T	-
423	*Pyrrosia lingua* (Thunb.) Farw.	Polypodiaceae	F	-
424	*Pyrrosia* sp.	Polipodiaceae	H	-
425	*Quercus brandisiana* Kurz	Fagaceae	T	-
426	*Quercus semiserrata* Roxb.	Fagaceae	T	Wet-thitcha
427	*Ranunculus* sp.	Ranunculaceae	H	-
428	*Rhinacanthus*sp.	Acanthaceae	S	-
429	*Rhododendron*sp.	Ericaceae	S,ST	-
430	Rhynchostylis retusa Blume	Orchidaceae	E	Kyaung-mi-tu
431	*Rhynchotechum* sp.	Gesneriaceae	H	-
432	*Rinorea griffithii* (Hook.f & Thonson) Kuntze	Violaceae	ST	-
433	*Rosa* sp.	Rosaceae	Cl	-
434	*Rubus* sp.	Rosaceae	Cl	-
435	*Sabia* sp.	Sabiaceae	Cl	-
436	*Sambucus javanica* Blume	Caprifoliaceae	ST	-
437	*Sapium baccatum* Roxb.	Euphorbiaceae	T	Ye-badon
438	*Saurauia* sp.1	Actinidiaceae	ST,T	-
439	*Saurauia* sp.2	Actinidiaceae	ST,T	-
440	*Saurauia* sp.3	Actinidiaceae	ST,T	-
441	*Saurauia* sp.4	Actinidiaceae	ST,T	-
442	*Saurauia* sp.5	Actinidiaceae	ST,T	-
443	*Saurauia* sp.6	Actinidiaceae	ST,T	-
No.	**Scientific Name**	**Family**	**Habit**	**Common-Name**
444	*Saurauia* sp.7	Actinidiaceae	S	-
445	*Schefflera* sp.1	Araliaceae	T	-
446	*Schefflera* sp.2	Araliaceae	Cl	-
447	*Schefflera* sp.3	Araliaceae	S	-
448	*Schefflera* sp.4	Araliaceae	ST	-
449	*Schefflera* sp.5	Araliaceae	T	-

450	*Schima wallichii* Choisy.	Theaceae	T	Laukya
451	*Schoenoplectus* sp.1	Cyperaceae	H	-
452	*Schoenoplectus* sp.2	Cyperaceae	H	-
453	*Scindapsus* sp.1	Araceae	H	-
454	*Scindapsus* sp.2	Araceae	Cl	-
455	*Scindapsus* sp.3	Araceae	Cl	Sin-peik-chin
456	Scleria sp.1	Cyperaceae	G	-
457	Scleria sp.2	Cyperaceae	H	-
458	Scleria sp.3	Cyperaceae	G	-
459	Scoparia dulcis L.	Plantaginaceae	H	-
460	*Scurrula* sp.	Loranthaceae	Paraside Shrub	-
461	*Scutellaria*sp.	Lamiaceae	H	-
462	*Selaginella* sp.1	Selaginellaceae	H	-
463	*Selaginella* sp.2	Selaginellaceae	H	-
464	*Selaginella* sp.3	Sellagineaceae	F	-
465	Senna alata(L.) Roxb.	Caesalpiniaceae	S	Mezali-gyi
466	*Senna* sp.1	Caesalpiniaceae	S	-
467	*Senna* sp.2	Caesalpiniaceae	S	-
468	*Setaria pumila* (Poir.) Roem. & Schult.	Poaceae	G	Khwemi-pok
469	*Setaria* sp.	Poaceae	G	-
470	*Shorea assamica* Dyer	Dipterocarpaceae	T	-
471	*Sida acuta* Burm.f.	Malvaceae	S	-
472	*Sida* sp.	Malvaceae	H	-
473	*Sloanea*sp.	Elaeocarpaceae	T	-
No.	**Scientific Name**	**Family**	**Habit**	**Common-Name**
474	*Smilax macrophylla* Roxb.	Smilaceae	Cl	-
475	*Solanum nigrum* L.	Solanaceae	S	Baung-laung-nyo
476	*Solanum* sp.1	Solanaceae	S	-
477	*Solanum* sp.2	Solanaceae	H	-
478	*Solanum* sp.3	Solanaceae	S	-
479	*Solanum* sp.4	Solanaceae	S	-
480	*Solanum* sp.5	Solanaceae	S	-

481	*Solanum torvum* Swartz.	Solanaceae	S	-
482	*Sonchus* sp.	Asteraceae	H	-
483	Spermacoce sp.	Rubiaceae	H	-
484	Stellaria sp.1	Caryophyllaceae	H	-
485	Stellaria sp.2	Caryophyllaceae	H	-
486	*Stephania discolor* Spreng.	Menispermaceae	Cl	-
487	*Stephania* sp.	Menispermaceae	Cl	-
488	*Sterculia* sp.1	Sterculiaceae	ST	-
489	*Sterculia* sp.2	Sterculiaceae	S	-
490	*Sterculia* sp.3	Sterculiaceae	T	-
491	*Sterculia* sp.4	Sterculiaceae	ST	-
492	*Strobilanthes* sp.4	Acanthaceae	S	-
493	*Strobilanthes* sp.5	Acanthaceae	H	-
494	*Strobilanthes longipes* C.B. Clarke	Acanthaceae	S	-
495	*Strobilanthes* sp.1	Acanthaceae	S	-
496	*Strobilanthes* sp.2	Acanthaceae	S	-
497	*Strobilanthes* sp.3	Acanthaceae	H	-
498	*Symplocos* sp.1	Symplocaceae	S	-
499	*Symplocos* sp.2	Symplocaceae	ST	-
500	*Symplocos* sp.3	Symplocaceae	T	-
501	*Symplocos* sp.4	Symplocaceae	ST	-
502	*Symplocos* sp.5	Symplocaceae	ST	-
503	*Syzygium jambos.* L. Alston	Myrticeae	T	-
No.	**Scientific Name**	**Family**	**Habit**	**Common-Name**
504	*Syzygium* sp.1	Myrtaceae	T	-
505	*Syzygium* sp.2	Myrtaceae	ST	-
506	*Syzygium* sp.3	Myrtaceae	T	-
507	*Syzygium* sp.4	Myrticeae	ST	-
508	*Tamarindus indica* L.	Caesalpiniaceae	T	Magyi
509	Tectaria cicutaria (L.) Copel.	Dryopteridaceae	F	-
510	*Tectaria* sp.1	Dryopteridaceae	F	-

511	*Tectaria* sp.2	Dryopteridaceae	F	-
512	*Terminalia* sp.1	Combretaceae	T	-
513	*Terminalia*sp.2	Combretaceae	T	-
514	*Tetrastigma* sp.1	Vitaceae	Cl	-
515	*Tetrastigma* sp.2	Vitaceae	Cl	-
516	*Thladiantha dubia* Bunge	Cucurbitaceae	Cl	-
517	*Thladiantha* sp.	Cucurbitaceae	Cl	-
518	Thrixspermum centipeda Lour.	Orchidaceae	E	Thitkwa-ni-gale
519	*Thunbergia* sp.	Acanthaceae	Cl,Cr	-
520	*Thysanolaena maxima* (Roxb.) Kuntze	Poaceae	G	Tabyetsi
521	*Tithonia* sp.	Asteraceae	S	-
522	*Torenia* sp.	Linderniaceae	H	-
523	*Trachyspermum* sp.	Apiaceae	H	-
524	*Trema* sp.	Ulmaceae	ST	-
525	*Trichosanthes* sp.2	Cucurbitaceae	Cl	-
526	*Trichosanthes*sp.	Cucurbitaceae	Cl	-
527	*Tridax* sp.	Asteraceae	H	-
528	*Triumfetta bartramia* L.	Tiliaceae	S	-
529	*Triumfetta* sp.	Tiliaceae	S	-
530	UN-1	Caryophylaceae	S	-
531	UN-2		H	-
532	UN-3	Anacardiaceae	T	-
No.	**Scientific Name**	**Family**	**Habit**	**Common-Name**
533	UN-4	Melastomataceae	S	-
534	UN-5	Menispermaceae	Cl	-
535	UN-6	Urticaceae	H	-
536	UN-7	Asteraceae	H	-
537	UN-8	Fabaceae	Cl	-
538	UN-9	Rubiaceae	H	-
539	UN-10	Brassicaceae	H	-
540	UN-11	Cucurbitaceae	Cl	-
541	UN-12		S	-

542	UN-13	Menispermaceae	Cl	-
543	UN-14	Lauraceae	T	-
544	UN-15	Euphorbiaceae	Cl	-
545	UN-16	Brassicaceae	H	-
546	UN-17	Anacardiaceae	T	-
547	UN-18	Lamiaceae	S	-
548	UN-19	Rubiaceae	S	-
549	UN-20		F	-
550	UN-21	Anacardiaceae	T	-
551	UN-22	Urticaceae	ST	-
552	UN-23		T	-
553	UN-24		H	-
554	UN-25	Lamiaceae	H	-
555	UN-26		ST	-
556	UN-27		T	-
557	UN-28		ST	-
558	UN-29		S	-
559	UN-30	Moraceae	T	-
560	UN-31	Fabaceae	H	-
561	UN-32		S	-
562	UN-33	Scrophulariaceae	H	-
No.	**Scientific Name**	**Family**	**Habit**	**Common-Name**
563	UN-34		ST	-
564	UN-35	Annonaceae	S	-
565	UN-36		T	-
566	UN-37	Asteraceae	H	-
567	UN-38	Apocynaceae	T	-
568	UN-39		H	-
569	UN-40	Lamiaceae	H	-
570	UN-41	Urticaceae	H	-
571	UN-42	Mysinaceae	T	-
572	UN-43		S	-

573	UN-44	Iridaceae	H	-
574	UN-45	Urticaceae	ST	-
575	UN-46		ST	-
576	UN-47		S	-
577	UN-48	Menispermaceae	Cl	-
578	UN-49		T	-
579	UN-50		ST	-
580	UN-51	Acanthaceae	H	-
581	UN-52	Cucurbitaceae	Cl	-
582	UN-53		T	-
583	UN-54		T	-
584	UN-55		ST	-
585	UN-56		S	-
586	UN-57	Theaceae	ST	-
587	UN-58	Elaeocarpaceae	ST	-
588	UN-59	Euphorbiaceae	S	-
589	UN-60	Lamiaceae	H	-
590	UN-61		S	-
591	UN-62	Rubiaceae	S	-
592	UN-63	Rubiaceae	ST	-
No.	**Scientific Name**	**Family**	**Habit**	**Common-Name**
593	UN-64		S	-
594	UN-65		H	-
595	UN-66	Amaryllidaceae	H	-
596	UN-67	Menispermaceae	Cl	-
597	UN-68	Cucurbitaceae	Cl	-
598	UN-69	Anacardiaceae	T	-
599	UN-70		T	-
600	UN-71	Cucurbitaceae	Cl	-
601	UN-72	Cucurbitaceae	Cl	-
602	UN-73	Cucurbitaceae	Cl	-
603	UN-74		Cl	-

604	UN-75		S	-
605	UN-76	Moraceae	T	-
606	UN-77		T	-
607	UN-78	Asclepiadaceae	Parasi de Shrub	-
608	UN-79	Amaranthaceae	S	-
609	UN-80	Poaceae	G	-
610	UN-81	Asteraceae	H	-
611	UN-82		ST	-
612	UN-83	Cucurbitaceae	Cl	-
613	UN-84		T	-
614	UN-85		ST	-
615	UN-86		ST	-
616	UN-87	Anacardiaceae	T	-
617	UN-88		ST	-
618	UN-89	Zingiberaceae	H	-
619	UN-90	Tiliaceae	T	-
620	UN-91		T	-
621	UN-92		T	-
No.	**Scientific Name**	**Family**	**Habit**	**Common-Name**
622	UN-93	Rubiaceae	S	-
623	UN-94		H	-
624	UN-95	Urticaceae	S	-
625	UN-96	Meliaceae	T	-
626	UN-97		ST	-
627	UN-98	Sapiaceae	ST	-
628	UN-99		S	-
629	UN-100		F	-
630	UN-101	Rubiaceae	S	-
631	UN-102	Apocynaceae	Cl	-
632	UN-103		ST	-
633	UN-104	Rutaceae	S	-

634	UN-105	Anacardiaceae	T	-
635	UN-106	Acanthaceae	S	-
636	UN-107		T	-
637	UN-108	Mimosaceae	ST	-
638	UN-109		Cl	-
639	UN-110		ST	-
640	UN-111	Fagaceae	ST	-
641	UN-112		Cl	-
642	UN-113	Urticaceae	S	-
643	UN-114		ST	-
644	UN-115		H	-
645	UN-116		S	-
646	UN-117	Menispermaceae	Cl	-
647	UN-118	Simaroubaceae	ST	-
648	UN-119	Rubiaceae	S	-
649	UN-120	Meliaceae	S	-
650	UN-121	Annonaceae	T	-
651	UN-122		T	-
No.	**Scientific Name**	**Family**	**Habit**	**Common-Name**
652	UN-123	Rubiaceae	S	-
653	UN-124		H	-
654	UN-125	Lamiaceae	H	-
655	UN-126		S	-
656	UN-127	Meliaceae	ST	-
657	UN-128	Chenopodiaceae	H	-
658	UN-129	Fabaceae	Cl	-
659	UN-130	Euphorbiaceae	S	-
660	UN-131	Annonaceae	S	-
661	UN-132		F	-
662	UN-133		F	-
663	UN-134	Thelypteridaceae	F	-
664	UN-135	Acanthaceae	S	-
665	*Uncaria* sp.	Rubiaceae	Cl	-

666	*Ureceola* sp.	Apocynaceae	Cl	-
667	Urena lobata L.	Malvaceae	S	Kat-sine
668	*Urena lobata L.*	Malvaceae	S	-
669	*Urtica* sp.	Urticaceae	H	-
670	*Verbena officinalis* L.	Verbenaceae	H	-
671	*Vernonia arborea* Buch-Ham.	Asteraceae	T	-
672	Vernonia sp.	Asteraceae	S	-
673	*Viola* sp.	Violaceae	H	-
674	*Vitis japonica* Thumb.	Vitaceae	Cl	-
675	*Vitis* sp.	Vitaceae	Cl	-
676	*Vitis* sp.	Vitaceae	Cl	-
677	*Vittaria* sp.	Vittariaceae	F	-
678	*Wendlandia* sp.	Rubiaceae	T	-
679	*Wendlandia tinctoria* DC.	Rubiaceae	T	Thitni
680	*Zanthoxylum* sp.	Rutaceae	ST	-
681	*Zingiber rubens* Roxb.	Zingiberaceae	H	-
682	*Ziziphus* sp.	Rhamnaceae	S	-

B = Bamboo, Cl = Climber, Cr = Creeper, E = Epiphyte, F = Fern, G = Grass, H = Herb, S = Shrub, ST = Small Tree, T = Tree

Appendix – II Lasa Vegetation type

No.	Locality	Vegatation Type	Latitude	Longitude	Altitude	Notes
1	East side of Malihka River, around the Indamzut village	Low land evergreen forest	26˚ 36′ 16.3″	97˚ 45′ 16.0″	344m	Itea macrophyll., *Dipterocarpus* sp., *Litsea* sp., *Mallotus paniculatus, Spondias* sp. are mainly found in tree layer. Ground layer is dominated by *Urena* sp., *Commelina* sp. *Gnetum* sp., *Molineria capitulata*, *Begonia* sp.,*Phrynium capitatum*
2	Around the Hpaw wang Daru village	Low land evergreen forest	26˚ 53′ 41.4″	97˚ 43′ 27.7″	362m	
3	Around the Hpaw wang Daru village	Low land evergreen forest	26˚ 52′ 38.3″	97˚ 42′ 28.5″	370m	
4	Around the Phonanyan village, on the side of stream	Low land evergreen forest	26˚ 44′ 35.4″	97˚ 37′ 43.0″	372m	

5	East side of Malihka River, around the Indamzut village	Low land evergreen forest	26° 35′ 37.5″	97° 43′ 55.8″	375m	
6	Around the Hpaw wang Daru village, Taungyar cultivation	Low land evergreen forest	26° 52′ 40.3″	97° 40′ 29.0″	382m	
7	East side of Malihka River, around the Indamzut village	Low land evergreen forest	26° 36′ 39.7″	97° 44′ 45.1″	394m	
8	Around the Hpaw wang Daru village	Low land Secondary Forest	26° 54′ 06.2″	97° 44′ 01.6″	402m	*Cinnamomum* sp., *Myristica angustifolia, Chisocheton siamensis and Macaranga kurzii, Mallotus* sp.are mainly found in tree layer. Ground layer is dominated by *Dracaena* sp.,*Wallichia siamensis* , *Clerodendron* sp.*Piper* sp., and *Commelina* sp..
9	Around the Phonan yan village along the another bank of Phonanyan stream	Low land Secondary Forest	26° 44′ 31.3″	97° 38′ 54.0″	420m	
10	East side of Malihka River, around the Indamzut village	Low land Secondary Forest	26° 36′ 41.7″	97° 44′ 51.2″	426m	
11	West side of Malihka river around the Hpaw wang Daru village	Low land Secondary Forest	26° 51′ 53.7″	97° 40′ 37.2″	433m	
12	Around the village track to Sikhaung	Low land Secondary Forest	26° 42′ 35.4″	98° 46′ 40.5″	439m	
No.	**Locality**	**Vegatation Type**	**Latitude**	**Longitude**	**Altitude**	**Notes**
13	Around the village track to Sikhaung	Low land Secondary Forest	26° 39′ 36.4″	98° 46′ 45.7″	443m	
14	Around the village track to Sikhaung	Low land Secondary Forest	26° 38′ 37.3″	98° 46′ 39.6″	457m	
15	East side of Malihka River, around the Indamzut village	Low land Secondary Forest	26° 36′ 38.0″	97° 42′ 54.1″	460m	
16	Around the village track to Sikhaung	Oak Forest	26° 40′ 30.6″	98° 45′ 41.7″	543m	*Lithocarpus* sp., *Quercus* sp., *Castanopsis* sp., *associate with Garcinia* sp., *Chisocheton siamensis are found in tree layer. Ground layer is*
17	Around the Hpaw wang Daru village	Oak Forest	26° 52′ 54.8″	97° 42′ 48.6″	589m	

18	Around the Hpaw wang Daru village	Oak Forest	26˚ 52′ 53.7″	97° 42′ 50.4″	590m	*dominated by Melastoma* sp., *Smilax* sp.,
19	Around the Hpaw wang Daru village	Oak Forest	26˚ 52′ 45.6″	97° 42′ 46.5″	604m	
20	East side of Malihka River, around the Indamzut village	Oak Forest	26˚ 40′ 33.5″	98° 44′ 45.6″	643m	
21	East side of Malihka River, around the Indamzut village	Oak Forest	26˚ 40′ 36.7″	98° 44′ 46.7″	658m	
22	Around the village track to Sikhaung	Oak Forest	26˚ 40′ 32.5″	98° 45′ 38.5″	687m	
23	Around the Phonan yan village along the another bank of Phonanyan stream	Oak Forest	26˚ 44′ 33.4″	97° 38′ 59.8″	688m	
24	Around the village track to Sikhaung	Oak Forest	26˚ 41′ 35.4″	98° 35′ 39.6″	694m	
25	Around the village track to Sikhaung	High land Secondary Forest	26˚ 40′ 35.5″	98° 45′ 39.7″	724m	*Chisocheton siamensis., Macaraga gigantea., Acer* sp. *& Macaraga kurzii are found in tree layer. Shrub layer is dominated by Acanthaceae, Marantaceae. & Melastoma* sp. *Herb layer is dominated by Selaginella* sp., *Adiantum* sp., *Alocasia* sp., *Commelina* sp.,
26	East side of Malihka River, around the Indamzut village	High land Secondary Forest	26˚ 36′ 22.6″	97° 45′ 14.9″	753m	
27	East side of Malihka River, around the Indamzut village	High land Secondary Forest	26˚ 36′ 39.7″	97° 45′ 65.8″	758m	
28	Around the Hpaw wang Daru village	High land Secondary Forest	26˚ 53′ 43.3″	97° 43′ 20.7″	767m	
No.	**Locality**	**Vegatation Type**	**Latitude**	**Longitude**	**Altitude**	**Notes**
29	Around the Phonanyan village, on the side of stream	High land Secondary Forest	26˚ 44′ 32.0″	97° 38′ 43.9″	778m	
30	Around the Hpaw wang Daru village	High land Secondary Forest	26˚ 53′ 48.2″	97° 43′ 30.6″	784m	
31	Around the Phonanyan village, on the side of stream	High land Secondary Forest	26˚ 44′ 30.5″	97° 38′ 63.0″	804m	
32	Around the Phonanyan village, on the side of stream	High land Secondary Forest	26˚ 44′ 33.9″	97° 38′ 58.2″	834m	
33	Around the Hpaw wang Daru village	High land Secondary Forest	26˚ 53′ 04.8″	97° 42′ 52.1″	947m	

34	Around the Hpaw wang Daru village	Bamboo forest	26° 52′ 40.2″	97° 43′ 26.5″	343m	*Dendrocalamus hamiltonii Ness., D. giganteus ,Cephalostachyum* sp*, Bambusa* sp.
35	Around the Phonan yan village along the another bank of Phonanyan stream	Bamboo forest	26° 44′ 41.5″	97° 38′ 66.9″	353m	
36	Around the Hpaw wang Daru village	Bamboo forest	26° 50′ 36.6″	97° 33′ 25.7″	475m	
37	East side of Malihka River, around the Indamzut village	Bamboo forest	26° 36′ 22.6″	97° 45′ 15.5″	467m	
38	Around the village track to Sikhaung	Bamboo forest	26° 39′ 38.5″	98° 43′ 39.6″	478m	
39	Around the Phonan yan village along the another bank of Phonanyan stream	Bamboo forest	26° 44′ 35.4″	97° 38′ 44.3″	534m	
40	Around the village track to Sikhaung	Bamboo forest	26° 38′ 28.4″	98° 35′ 40.5″	545m	
41	Around the Hpaw wang Daru village,west side of Malihka river	Bamboo forest	26° 51′ 00.7″	97° 40′ 50.9″	567m	
42	Phaw wun	Shifting Cultivation	26° 54′ 00.5″	97° 44′ 06.2″	328m	
43	Phonanyan	Shifting Cultivation	26° 44′ 30.3″	97° 34′ 54.8″	428m	*Brassica* sp., *Panicum* sp., *Sorghum* sp.
44	Maliyan	Shifting Cultivation	26° 36′ 40.6″	97° 44′ 50.3″	443m	
45	Phaw wun	Paddy field	26° 52′ 53.4″	97° 42′ 44.6″	428m	Paddy
46	Maliyan	Paddy field	26° 36′ 39.5″	97° 44′ 49.4″	345m	

Chapter VI

6. Biodiversity Impact Assessment Report of Flora on Myitsone Hydropower Dam

6.1. Introduction

The purpose of this report is to assess the potential impacts on biodiversity especially the flora in inundated area of Myitsone dam on Ayeyarwaddy River above Myitkyina, which will be constructed in the near future.

The report will represent on account of how biodiversity impact assessment procedure and practices have been effective for determining the project feasibility. It will also recommend the mitigation of the impacts.

6.1.1. Location

The Myitsone Hydropower Dam project area is located between 25º40´ N, 97º 20´E and 26º50´ N, 98º 47´E and dam site is about 26 kilometre away from Myitkyina Township, Kachin State. The catchment area is approximately 11680 sq-km covering the huge area of Mayhka and Malihka watersheds. The average annual rainfall at Myitsone (Tanphaye ´village) is 100 inches and the annual flow of water into the dam is expected to be about 4540 m^3/s. The watersheds comprise intact forests, along on both sides of the Mayhka and Malihka Rivers. Some low land area along Mayhka and Malihka rivers will be inundated and some of the vital habitat of diverse wildlife will be lost forever. The motor car road from Myitkyina to Putao including some bridges and the road from and Myitkyina to Chibwe closed to the Mayhka and Malihka will be inundated.

6.1.2. Topography

The bulk of Myitsone dam area falls 25º24´ to 25º39´ latitude and 97º 30´ to 97º 53´ longitude and reaches between Taphaye´ village in Myitkyina Township and catchment area along Mayhka and Malihka River up to 70 kilometres upstream. These are six main streams namely Taron-wang, Ah-chan-hka, Mekhram, Ngaw-chan-hka, Chi-bwe-hka and Tumpana-kha which drain into Mayhka river and five streams namely Namlang, Shang-hka (Nam-Tisang), Ntsihka (Macht-hka), Hkrang-kha and tara-hka (Tanahka + Chingma-hka) drain into Malihka River. Mayhka and Malihka Rivers flow along narrow valleys with opening to east and west regions as valleys along the streams. There are three low land areas along Mayhka River and two low land areas along Malihka River which will later become the flooded area (map-1). The topography of dam area is low land area of below 800m in elevation.

6.1.3. Climate

The climate of Myitsone Dam area is strongly seasonal and it is mostly the character of Monsoon climate. There are three distinct seasons, a cool and dry season from November to February, warm and dry season from March to May, warm wet season from June to October. The annual rainfall during the rainy season is rather uniform there is usually no rain in December and January.

6.1.4. Forest in the context of Eco-region

From biodiversity point of view, the project area lies in WWF Eco-regions of Mizoram-Manipur-Kachin moist evergreen forest. The whole Kachin state lies in four WWF Eco-regions namely East Hamalayan alpine shrub/meadow, Mizoram-Manipur-Kachin moist evergreen forests, and Northern Triangle temperate forest. The Kachin State is also located within two priority corridor, namely Northern Mountain Forest Complex and Upper Chindwin lowlands for conservation investment in Myanmar (Tordoff *et al*. 2005). This large conservation area including Pidaung W.S, Hkakaborazi N.P, Indawgyi W.S, Hukaung Valley W.S, Hukaung Valley W.S (Extension), Hponganrazi W.S and Bumphabum W.S, is one of the biodiversity hotspots and is nationally essential, regionally significant and globally outstanding (Uga,2002). There, as a whole comprises a large natural habitat in the upper catchment of Mayhka and Malihka Rivers which are the main tributaries of Ayeyarwaddy which in turn is the lifeblood of Myanmar. The project areas include low land evergreen forest, low land secondary forest, Oak forest, Bamboo forest and Banana forest.

6.1.5. Local people and their livelihood

People dwelling in this area include Kachin, Shan, Bamar and Chinese. The majority is Kachin tribes. Except Chinese, Kachin, Shan and Bamar are earning as farmers cultivating Taungyarr rice and vegetable. Some Kachin tribes are earning as hunters. Most gold miners are Chinese and Lesu tribes. The roles of cease-fire groups: special region I (NDAK), special region II (KIA) and special region II (KIA separate group) in the studied area are important issue. They are responsible for the commercial logging and gold mining in the area. Their livelihood is concerning with environmental impacts in the area.

There are many villages in the studied area. The villages along the bank of Mayhka and Malihka Rivers would be inundated in future.

6.2. Aims and Objectives

1. To collect, identify and list the plant species in the area
2. To record the dominant tree species and evaluate the forest type
3. To study the impact of dam on the flora and to suggest the mitigation measure

6.3. Materials and Methods

6.3.1. Participants

The Myanmar flora team comprises 9 members, U Nyo Maung flora group leader, Dr Myint Aung co-leader, Dr Win Myint co-leader, Dr Kalyalu, Daw Thin Thin Su, Daw Khin Swe Lwin, Daw Khin Khin Soe, U Tazar Aung and U Nay Phyo Aung and Chinese flora team.

6.3.2. Materials

Materials used for recording are strings for sample plotting, digital camera, maps compass, field press, data collection sheets, drying press, dryer, digging tools, heavy duty plastic bags, newspapers, alcohol, spray jug (for fixing specimens) 10 x lens, permanent markers and other field equipments.

6.3.3. Methods

Two research teams with five scientists were organized and studies were conducted especially in the areas which may be inundated after the dam is constructed. The plant specimens were collected both in inundated areas and habitats of representative areas.

A Global Positioning System was used to navigate and mark coordinates between sample plots in each habitat. In order to obtain essential ecological data for predicting forest value and forest type, quadrants of varying size were set up and observed. Plant collection (all trees, shrubs and herbs) was carried out in random and by Transit line whenever possible to get the representative checklists of the plants in the studied area and all specimens are identified and recorded. DBH and Height classes at tree species are calculated based on the measurement of breast height diameters along with its height.

Field press and drying press were used to get voucher specimens and to store in herbarium. Habitat type, altitude, topography, forest type, canopy cover and structure, light intensity, wind velocity and sign of disturbance were recorded. To know the habit of the plant species and to ensure the vegetation, photographic records were also carried out.

Leaves, inflorescences, floral structures and other vegetative parts of each plant specimens were collected and photographed and recorded as field notes.

6.4. Results

6.4.1. Floristic Composition in the study area

The total number of species collected in the Myitsone dam site and intended flooded area are 818 species belonging to 582 genera of 136 families (Appendix- I).The forest types were determined according to their species composition. The dominant tree species, shrub species and herb species were also determined according to their species composition in sample plots (Appendix- II)

6.4.2. The human impact in the study area

Logging

The major impact due to logging started during past ten to five years and it still exists until study period. Almost all the primary forests have been destroyed. But some remain in patches due to deep slope which is difficult to extract and transport. The lost of forest will leads to the climate change and decrease rain fall as long time impact. It may also lead to soil erosion and sedimentation in the dam which will be constructed near future.

Shifting cultivation

The shifting cultivation was the major livelihood of the local people. Taungyar is the main source of their earning and Taungyar is found both in lowland area and high mountain area. The impact of shifting cultivation also leads to the loss of forest and formation degraded forest and secondary forest.

Gold Mining

Gold mining in both Mayhka and Malihka Rivers became major business in the study area. Due to gold mining the riverine forest were totally destroyed. The result is the new formation of sand and stone barriers and the water quality becomes silty. The river water becomes very turbid and impure.

Involuntary Displacement

There are many large villages which may be inundated after the dam is constructed. So the involuntary displacement may be the main adverse social impact. The main mitigation measure, with agreement of both resettle and host population will be the best solution.

The Loss of infrastructure

Some areas of motor car road from Myitkyina to Putao and Myitkyina to Chibwe including some bridges will be inundated. New access road must be substituted. The new road should be environmentally and socially least damaging. Road engineering should ensure proper drainage to protect waterway and minimize erosion.

Endangered species

According to the IUCN Red list (2000), the following species are recorded;

10. *Aquilaria malaccensis* Lam., VU
11. *Dipterocarpus turbinatus* Gaertn. f. CR
12. *Holarrhena pubescens* Wall. ex G.Don EX

13. *Shorea assamica* Dyer,	CR
14. *Caesalpinia sappan* L.	LR/LC
15. *Dipterocarpus boudii* Koth.	CR
16. *Taiwania cryptomeriodes* Hyata	VU
17. *Elaeocarpus prunifolius* Wall. ex C. Muell.	VU

6.5. Discussion and Conclusion

Among 818 species collected in the study area 231 species are tree species. The tree species are the value of the forest. *Dracontomelon* sp., *Fagus crenata*, *Dipterocarpus obtusifolius*, *Chisocheton siamensis* and *Castanopsis indica* are found to be dominant. But it was noted that in the study area most members of the species are less than 3 m to 15 m in height and are 5 cm to 40 cm in girth. The timber value is more or less poor at present time. This result is due to over exploitation.

All the forests are subjected to various form of disturbance such as logging and shifting cultivation. Insufficient protection status of the Myitsone area and its surroundings enhances the exploitation of natural resources such as logging, shifting cultivation, orchid hunting and gold mining. Lack of law enforcement and strict regulation for waste disposal produced by gold mining is the major issue. The immediate impact of gold mining is the change in water quality and long term impact is the change in navigation in the rivers and natural flow system which will affect the aquatic life in the rivers.

The vegetation pattern is the result of the seasonal climate of the study area with same topography. It consists of the same lowland evergreen forest with degraded forest and bamboo forest due to logging, expansion of cultivated land and gold mining. The evergreen plant species and deciduous plant species are found mixed in the study area. The distribution of forest type and species depend on the three main factors; moisture, altitude and disturbance.

The moisture of the forest is determined by the role of water input and rate of water loss. In high land area light showers are frequent throughout the year but in low land area the water input in dry season is ground water flow which is correlated with topography and geology. In valleys and concave slope, the period of ground water retention time is longer than in the ridge and convex slope. So the species composition in the respective areas is different. So, also the sleep north facing slope are in shade for longer period of time than south facing one and tend to be more moist.

The study area has lower temperature in winter and intermediate temperature in summer which is only short periods of time. Longer period of time is rainy season which takes nearly six months a year. The altitude of study area is low land area between 131 metre and 600 metre. The difference in topography is due to the low land river bank and exposed ridge and shady valleys.

The forest in the study area is subject to various form of disturbance mainly by human induced impact. The vast majority of disturbance to the forest in the study area at current time are results of human activities such as logging, gold mining and shifting cultivation. 80% of the river bank forest shows the sign of recent erosion due to gold mining, burning forests due to shifting cultivation and degraded secondary composition due to commercial logging.

Almost all the primary forests are found in small patches in the steep valley and steep river bank. By comparing the composition of tree species in so called primary forest and the disturbed area, the previous forest types have been assessed.

The valuable forest trees, like *Tectona grandis*, *Pterocarpus macrocarpus*, *Xylia xylocarpa*, *Michelia champaca* and *Dalbergia* sp. have almost disappeared. *Dipterocarpus* species are also rarely found. *Fagus* sp., *Lithocarpus* sp., *Quercus* sp., *Castanopsis* sp., *Dipterocarpus* sp., *Litsea* sp. are found mainly in tree layer. Ground layer is dominated by *Gnetum* sp., *Dracaena* sp., *Clerodendrum* sp., *Selaginella* sp., *Commelina* sp.. The shrub layer is dominated by *Homonia* sp., *Rhododendron* sp., *Euphorbia* sp., and *Ziziphus* sp. and herb layer is dominated by *Stenoloma* sp., *Viola* sp., and *Youngia* sp.

To restore the previous vegetation pattern, the preventive and reforestation measure should be carried out as soon as possible no matter whether the dam is constructed or not so that the climatic change in the area can be prevented.

The most long term impact of dam on large river like Ayeyarwaddy may cause the downriver hydrological changes which can destroy riparian ecosystem dependent on periodic natural flooding (formation of fertile soil deposition so called Mayenukyun), exacerbate water pollution during low flow period and increase salt water intrusion near river mouth (destroy the delta ecosystem). The results may lead to the damage of the biological and economic productivity of the river and its estuaries.

6.6. Recommendation

1. One or more compensatory new protected area should be established and managed under the project expenditure, to offset the loss of natural habitat to flooding.
2. Special attention should be paid on the threaten species listed in the paper.
3. Reforestation should be carried out to restore the previous vegetation pattern no matter whether the dam is constructed or not.
4. Laws and regulation concerning with waste disposal and mining technique should be immediately adapted and enforced.
5. The construction of dam on the large river Ayeyarwaddy should be avoided due to the changes in downriver hydrology which may affect the navigation, riverine ecosystem and delta ecosystem and will lead to negative impacts on the economy of people dwelling in riparian along Ayeyarwaddy River.
6. Before construction access road and power transmission line, environmental impact assessment should be carried out.
7. Terrace cultivation should be encouraged and practised in the study area to prevent further deforestation under project expenditure.

Table - 1 Tree species in DBH class intervals in Myitsone

DBH Classes	No. of species	Total number of individual	% of total species
< 30 cm	177	823	35.4
30 - 60 cm	105	279	21
60 - 90 cm	80	173	16

90 - 120 cm	48	83	9.6
120 - 150 cm	30	48	6
150 - 180 cm	15	25	3
180 - 210 cm	15	19	3
210 -240 cm	12	17	2.4
240 - 270 cm	3	3	0.6
270 - 300 cm	7	7	1.4
300 - 330 cm	4	5	0.8
330 - 360 cm	-	-	0
360 - 390 cm	1	1	0.2
390 - 420 cm	1	1	0.2
420 - 450 cm	1	1	0.2
450 - 480 cm	1	1	0.2
480 - 510 cm	-	-	0
510 - 540 cm	-	-	0
540 - 570 cm	-	-	0
> 570 cm	-	-	0
Total	231	1486	100

Table - 2 Tree species in Height class intervals in Myitsone

Height Classes	No. of species	Total number of individual	% of total species
< 3m	7	8	1.58
3 - 10 m	168	656	37.92
10 - 17 m	138	494	31.15
17 - 24 m	88	225	19.86
24 - 31 m	36	96	8.13
31 - 38 m	6	7	1.35
> 38 m	-	-	0.00
Total	231	1486	100.00

Appendix-I Myitsone Plant Lists

No.	Scientific Name	Family Name	Habit	Common Name
1	*Acanthopanax* sp.	Araliaceae	T	-
2	*Acanthus* sp.	Acanthaceae	H	-
3	*Acmella calva* (D.C) R.K.Jansen	Asteraceae	H	Pelay-lyin
4	*Acronychia* sp.	Rutaceae	S,ST	-
5	*Actinodaphne* sp.1	Lauraceae	T	-

6	*Actinodaphne* sp.2	Lauraceae	T	-
7	*Actinodaphne* sp.3	Lauraceae	T	-
8	*Adhatoda vasica* Nees.	Acanthaceae	S	Maya-gyi
9	*Adiantum* sp.	Pteridaceae	F	-
10	*Ageratum conyzoides* L.	Asteraceae	H	Ka-du-pho
11	*Ageratum* sp.	Asteraceae	H	Ka-du-pho
12	*Aglaia lawii* (Wight) Sald.& Rama.	Meliaceae	T	-
13	*Aglaia* sp.	Meliaceae	T	-
14	*Aglaonema commutatum* Schott	Araceae	H	Si-pwa-gamon
15	*Alangium chinense* (Lour.) Harms	Alangiaceae	T	-
16	*Alangium* sp.	Allangiaceae	T	-
17	*Alangium* sp.	Allangiaceae	T	-
18	*Albizia lebbek* (L.) Benth.	Mimosaceae	T	Ko-kko-phyu
19	*Albizia lucidior* (Steud.) Nielsen	Mimosaceae	T	Than-that
20	*Alchornea* sp.	Euphorbiaceae	T	-
21	*Allamanda* sp.	Apocynaceae	Cl	Shwe-wa
22	*Allophylus*sp.1	Sapindaceae	H	-
23	*Allophylus*sp.2	Sapindaceae	H	-
24	*Alocacia* sp.	Araceae	H	-
25	*Alocacia* sp.	Araceae	H	Pein
26	*Alphonsea* sp.	Annonaceae	ST	-
27	*Alpinia allughas* Rose	Zingiberaceae	H	Gone-min
28	*Alpinia* sp.	Zingiberaceae	H	-
29	*Alseodaphne* sp.	Lauraceae	T	Ohn-don-ywet-chun
30	*Alstonia scholaris* (L.) R.Br.	Apocynaceae	T	Taung-mayo
31	*Amaranthus* sp.	Amaranthaceae	H	Hnin-nu-new
32	*Amaranthus* sp.	Amaranthaceae	H	Kyet-mauk-pan
33	*Amorphophallus* sp.	Araceae	H	Wa-u
34	*Anacolosa* sp.	Olacaceae	ST	-
35	*Anacolosa* sp.	Olacaceae	ST	-
No.	**Scientific Name**	**Family Name**	**Habit**	**Common Name**
36	*Angiopteris* sp.	Marattiaceae	F	-
37	*Antidesma* sp.	Euphorbiaceae	S,ST	-
38	*Antidesma* sp.	Euphorbiaceae	S,ST	-
39	*Antidestma* sp.	Euphorbiaceae	S,ST	-
40	*Apousa* sp.1	Euphorbiaceae	ST	-
41	*Apousa* sp.2	Euphorbiaceae	ST	-
42	*Aquilaria malaccensis* Lam.	Thymeliaceae	S,ST	Thit-hmwe
43	*Aralia* sp.1	Araliaceae	T	-
44	*Aralia* sp.2	Araliaceae	T	-

45	*Archidendron jiringa* (Jack) Nielsen	Mimosaceae	T	-
46	*Archidendron* sp.	Mimosaceae	T	-
47	*Ardisia polycephala* Wall.	Myrsinaceae	T	Kyet-ma-oak
48	*Ardisia* sp.1	Myrsinaceae	T	-
49	*Ardisia* sp.2	Myrsinaceae	T	-
50	*Ardisia* sp.3	Myrsinaceae	T	-
51	*Arenga nana* (Griff.) H.E.Moore	Arecaceae	T	-
52	*Arenga* sp.	Arecaceae	ST	-
53	*Arenga triandra* Roxb.	Arecaceae	ST	Taw-kun-thi
54	*Aristolochia* sp.	Aristolochiaceae	Cl	-
55	*Artemisia* sp.1	Asteraceae	H	-
56	*Artemisia* sp.2	Asteraceae	H	-
57	*Artemisia* sp.3	Asteraceae	H	-
58	*Artocarpus heterophyllus* Lam.	Moraceae	T	-
59	*Artocarpus lakoocha* Roxb.	Moraceae	T	-
60	*Arundina graminifolia* (D.Don) Hochr.	Orchidaceae	E	-
61	*Asplenium* sp.	Aspleniaceae	E	-
62	*Atalantia roxburghiana* Hk.f.	Rutaceae	ST	-
63	*Averrhoa*sp.	Oxalidaceae	H	-
64	*Baccaurea sapida* Muell.Arg.	Euphorbiaceae	T	Ka-na-soe
65	*Balakara baccata* (Roxb.) Esser	Euphorbiaceae	T	-
66	*Bambusa polymorpha* Munro	Poaceae	B	Kyathaung-wa
67	*Barleria cristata* L.	Acanthaceae	H	-
68	*Bauhinia* sp.	Caesalpiniaceae	Cl	-
69	*Bauhinia* sp.	Caesalpiniaceae	Cl	-
70	*Bauhinia* sp. (Cl)	Caesalpiniaceae	Cl	Swe-daw
71	*Begonia roxburghii* A. DC.	Begoniaceae	H	-
72	*Begonia* sp.	Begoniaceae	H	Kyway-pan
No.	**Scientific Name**	**Family Name**	**Habit**	**Common Name**
73	*Benthamidia capitata* (Wall.) Hara	Cornaceae	ST	
74	*Betula* sp.	Betulaceae	T	-
75	*Bichofia tritiflorus* HK	Euphorbiaceae	T	-
76	*Bidens pilosa* L.	Asteraceae	H	-
77	*Bischofia* sp.	Euphorbiaceae	T	-
78	*Blumea densiflora* DC.	Asteraceae	S	Phon-ma-thein
79	*Boehmeria cledemioides* Miq.	Urticaceae	T	Phet-yar
80	*Boehmeria* sp.	Urticaceae	ST	Phet-yar
81	*Bombax insigne* Wall.	Bombacaceae	T	Didu
82	*Bougainvillea* sp.	Nyctaginaceae	Cl	Setkukan
83	*Brachiaria* sp.1	Poaceae	G	-

84	*Brachiaria* sp.2	Poaceae	G	-
85	*Brassica* sp.	Brassicaceae	H	Monyin
86	*Bridelia* sp.	Euphorbiaceae	T	-
87	*Broussonetia* sp.	Moraceae	T	-
88	*Brucea sumatrana* Roxb.	Simaroubaceae	T	-
89	*Buddleja asiatica* Lour.	Lamiaceae	T	-
90	*Byttneria* sp.	Sterculiaceae	Cl, Cr	-
91	*Caesalpinia sappan* L.	Caesalpiniaceae	T	-
92	*Caesalpinia* sp.1	Caesalpiniaceae	T	-
93	*Caesalpinia* sp.2	Caesalpiniaceae	S	-
94	*Calamus platyspathus* Mart.ex Kunth	Arecaceae	ST	Kyet-u-kyein
95	*Calamus viminalis* Willd.	Arecaceae	ST	Kyein-kha
96	*Callicarpa arborea* Roxb.	Verbenaceae	T	-
97	*Callicarpa* sp.1	Verbenaceae	T	Kyun-na-lein
98	*Callicarpa* sp.2	Verbenaceae	T	-
99	*Calotropis gigantea* (L.) Dryand. ex W.T. Aiton	Asclepiadaceae	S	Mayo-gyi
100	*Capparis* sp.1	Capparaceae	Cl	-
101	*Capparis* sp.2	Capparaceae	Cl	-
102	*Capparis* sp.3	Capparaceae	Cl	-
103	*Capsella brusa-pastoris* (L.) Medicus	Brassicaceae	H	-
104	*Capsicum* sp.	Lamiaceae	H	-
105	*Carex* sp.1	Cyperaceae	H	-
106	*Carex* sp.2	Cyperaceae	H	-
107	*Carica papaya* L.	Caricaceae	S	Thin-baw
108	*Caryota urens* L.	Arecaceae	T	Min-baw
109	*Casearia* sp.	Flacourtiaceae	T	-
No.	**Scientific Name**	**Family Name**	**Habit**	**Common Name**
110	*Cassia fistula* L.	Caesalpiniaceae	ST	Ngu
111	*Cassia* sp.	Caesalpiniaceae	ST	Taw-ma-zali
112	*Castanopsis diversifolia* (Kurz) King	Fagaceae	T	-
113	*Castanopsis indica* A. DC.	Fagaceae	T	-
114	*Castanopsis* sp.1	Fagaceae	T	-
115	*Castanopsis* sp.2	Fagaceae	T	-
116	*Castanopsis tribuloides* A.DC.	Fagaceae	T	Wet-thit-cha
117	*Cedrela toona* Roxb.	Meliaceae	T	Taung-tama
118	*Centratherum punctatum* Cass.	Asteraceae	H	-
119	*Cephalostachyum pergracile* Munro	Poaceae	B	Tin wa
120	*Cheomolaena* sp.	Asteraceae	H	-
121	*Cheopodium* sp.	Lamiaceae	H	-

122	*Chisocheton siamensis* Craib	Meliaceae	T	-
123	*Chloranthus* sp.	Chloranthaceae	S	-
124	*Chromolaena odorata* (L.) R.M.King & H.Robinson	Asteraceae	S	Bisat
125	*Chrysophyllum cainito* L. DC.	Sapotaceae	T	Tha-gar-thi
126	*Chukrasia tabularis* A. Juss.	Meliaceae	T	
127	*Cinnamomum* sp.1	Lauraceae	T	Na-lin-kyaw
128	*Cinnamomum* sp.2	Lauraceae	T	-
129	*Cissampelos* sp.	Menispermaceae	T	Thi-lin-katha
130	*Cissus* sp.	Vitaceae	Cl	-
131	*Citrus* sp.	Rutaceae	S,ST	Shauk
132	*Clausena* sp.	Rutaceae	S,ST	-
133	*Cleidion spiciflorum* Merr.	Euphorbiaceae	T	Taw-kanako
134	*Cleisostoma* sp.	Orchidaceae	E	-
135	*Clerodendrum infortunatum* Gaertn.	Verbenaceae	S,ST	Tha-gyan-pan
136	*Clerodendrum* sp.1	Verbenaceae	S,ST	-
137	*Clerodendrum* sp.2	Verbenaceae	S,ST	-
138	*Clerodendrum* sp.3	Verbenaceae	S,ST	-
139	*Cnidium monnieri* (L.) Cuss.	Apiaceae	H	-
140	*Codonacanthus pauciflorus* Nees (Herb)	Acanthaceae	H	-
141	*Coffea* sp.1	Rubiaceae	ST	-
142	*Coffea* sp.2	Rubiaceae	ST	-
143	*Combretum pilosum* Roxb.	Combretaceae	Cl	-
144	*Commelina* sp.	Commelinaceae	H	Wet-kyet
145	*Congea tomentosa* Roxb.	Verbenaceae	Cl, Cr	Tha-ma-ga-hmwe-soke
146	*Coniogaramme* sp.	Hemionitidaceae	F	-
No.	**Scientific Name**	**Family Name**	**Habit**	**Common Name**
147	*Convolvulus* sp.	Convolvulaceae	Cl, Cr	-
148	*Corranus* sp.	Connaraceae	S	-
149	*Crassocephalum crepidioides* (Benth.) S. Moore	Asteraceae	H	-
150	*Crotalaria* sp.1	Fabaceae	S	-
151	*Crotalaria* sp.2	Fabaceae	S	-
152	*Croton joufra* Roxb.	Euphorbiaceae	T	Thet-yin-gyi
153	*Cudrania* sp.	Moraceae	T	-
154	*Curcuma* sp.	Zingiberaceae	H	-
155	*Cyathula* sp.	Amaranthaceae	H	Se-kyet-mauk
156	*Cyclosorus* sp.	Thelypteridaceae	F	-
157	*Cymbidium* sp.2	Orchidaceae	E	-
158	*Cynometra* sp.	Caesalpiniaceae	T	-
159	*Cyperus alternifolius* L.	Cyperaceae	H	-

No.	Scientific Name	Family Name	Habit	Common Name
160	*Cyperus distans* L. f.	Cyperaceae	H	-
161	*Cyperus* sp.1	Cyperaceae	H	-
162	*Cyperus* sp.2	Cyperaceae	H	-
163	*Cyperus* sp.3	Cyperaceae	H	-
164	*Cyperus* sp.4	Cyperaceae	H	-
165	*Cyrtococcum* sp.1	Poaceae	G	-
166	*Cyrtococcum* sp.2	Poaceae	G	-
167	*Dalbergia* sp.1	Fabaceae	T	-
168	*Dalbergia* sp.2	Fabaceae	T	-
169	*Dalbergia* sp.3	Fabaceae	T	Daung-ta-laung
170	*Dalbergia* sp.4	Fabaceae	T	-
171	*Damnacanthus* sp.1	Rubiaceae	S,ST	-
172	*Damnacanthus* sp.2	Rubiaceae	S,ST	-
173	*Decaspermum* sp.1	Myrtaceae	T	-
174	*Decaspermum* sp.2	Myrtaceae	T	-
175	*Dedrocalamus* sp.1	Poaceae	B	-
176	*Dedrocalamus* sp.2	Poaceae	B	-
177	*Dendranthema lavandulifolium* (Fischer ex Trautv.) Kitam.	Orchidaceae	E	-
178	Dendrobium anceps Sw.	Orchidaceae	E	-
179	*Dendroclamus hamitonii* Nees	Poaceae	B	Wa-bo-myat-san-kywe
180	*Desmodium polycarpum* (Poir.) DC.	Fabaceae	H	Myay-pe-htwe
181	*Dianella* sp.	Phormiaceae	H	-
182	*Dillenia sermentosa* L.	Dilleniaceae	T	Zin-byun-new
No.	**Scientific Name**	**Family Name**	**Habit**	**Common Name**
183	*Dioscorea* sp.1	Dioscoraceae	Cl, Cr	-
184	*Dioscorea* sp.2	Dioscoreaceae	Cl, Cr	-
185	*Diospyros packmannia* C.B. Clarke.	Ebenaceae	ST	-
186	*Diospyros* sp.	Ebenaceae	ST	Tae
187	*Dipterocarpus obtusifolius Teysm.*	Dipterocarpaceae	T	Inbo, Kanyin-gok
188	*Dipterocarpus* sp.1	Dipterocarpaceae	T	Kanyin
189	*Dipterocarpus* sp.2	Dipterocarpaceae	T	Kanyin
190	*Dipterocarpus* sp.3	Dipterocarpaceae	T	Kanyin
191	*Dipterocarpus turbinatus* Gaertn. f.	Dipterocarpaceae	T	Kanyin-ni
192	*Dracaena* sp.1	Dracaenaceae	H	-
193	*Dracaena* sp.2	Dracaenaceae	H	Pyilone-chantha
194	*Drynaria* sp.1	Drynariaceae	F	-
195	*Drynaria* sp.2	Drynariaceae	F	-
196	*Drynaria* sp.2	Drynariaceae	F	-
197	*Duabnga grandiflora* (Roxb. ex DC.)Wall.	Lythraceae	T	Myauk ngo

198	*Duchesnea indica* (Andr.) Foke	Rosaceae	S	-
199	*Duranta repens* L.	Verbenaceae	S	Bo-kadaw-myet-hkon
200	*Dysoxylum cochinchinense* Pierrre	Meliaceae	T	Zin-nyin
201	*Eclipta alba (*L.) Hassk.	Asteraceae	H	Kyik-hman
202	*Elaeaganus* sp.	Elaeaginaceae	T	-
203	*Elaeagnus* sp.	Elaeaginaceae	T	-
204	*Elaeocarpus prunifolius* Wall. ex c. Muell.	Elaeocarpaceae	T	
205	*Elaeocarpus* sp.	Elaeocarpaceae	T	-
206	*Elatostema* sp.	Urticaceae	S,ST	-
207	*Elatostema* sp.2	Urticaceae	S,ST	-
208	*Eleocarpus sphaericus* (Gaertn.) K. Schum.	Elaeocarpaceae	T	-
209	*Eleusine* sp.	Poaceae	G	-
210	*Eleutherococcus trifoliatus* (L.)S.Y.Hu	Araliaceae	T	-
211	*Elsholtzia* sp.1	Almiaceae	H	-
212	*Elsholtzia* sp.2	Almiaceae	H	-
213	*Elsholtzia* sp.3	Lamiaceae	H	-
214	*Embelia ribes* Burm. f.	Myrsinaceae	Cl, Cr	-
215	*Engelhardtia spicata* Blume.	Juglandaceae	T	-
216	*Equisetum* sp.	Equisetaceae	F	-
217	*Eragrostis* sp.	Poaceae	G	-
218	*Eranthenum* sp.	Acanthaceae	H	-
No.	**Scientific Name**	**Family Name**	**Habit**	**Common Name**
219	*Erigeron* sp.	Asteraceae	H	-
220	*Erythrina* sp.	Fabaceae	T	-
221	*Erythropalum* sp.	Olacaceae	ST	-
222	*Euonymus* sp.	Celastraceae	S	-
223	*Euphorbia hypericifolia* L.	Euphorbiaceae	T	Hmin-that-pin
224	*Euphorbia pilulirfera* L.	Euphorbiaceae	T	-
225	*Eurya* sp.	Theaceae	ST	-
226	Eurya sp.	Theaceae	ST	-
227	*Fagopyrum* sp.	Polygonaceae	H	Pan-gyon
228	*Fagus crenata* Blume	Fagaceae	T	Wet-thit-cha
229	*Fagus* sp.	Fagaceae	T	-
230	*Fatsia* sp.	Araliaceae	T	-
231	*Ficus auriculata* Lour.	Moraceae	T	Sen-Tha-phen
232	*Ficus benjamina* L.	Moraceae	T	Nyaung-thabye
233	*Ficus fistulosa* Reinw.	Moraceae	T	Taung-tha-phen
234	*Ficus nervosa* Heyne ex Roth	Moraceae	T	Nyaung-peinne

235	*Ficus semicordata* Buch-Ham.ex J.E.Sm.	Moraceae	T	Tha-phen
236	*Ficus* sp.1	Moraceae	T	-
237	*Ficus* sp.2	Moraceae	T	Taungsalat
238	*Ficus* sp.3	Moraceae	T	Tha-phen
239	*Ficus* sp.4	Moraceae	T	Tha-phen
240	*Ficus* sp.5	Moraceae	T	-
241	*Ficus* sp.6	Moraceae	T	-
242	*Ficus* sp.7	Moraceae	T	-
243	*Fimbristylis dichotoma* (L.) Vahl	Cyperaceae	H	Sin-monnyin-myet
244	*Flemengia* sp.	Fabaceae	S	Kyay-mee
245	*Flemingia stricta* Roxb.	Fabaceae	S	Kyay-mee
246	*Floscopa* sp.1	Commelinaceae	H	-
247	*Floscopa* sp.2	Commelinaceae	H	-
248	*Fluggea stricta*	Euphorbiaceae	ST	Chin-ya
249	*Fordia* sp.	Fabaceae		-
250	*Frimbrestylis* sp.	Cyperaceae	H	-
251	*Galeola* sp.	Orchidaceae	E	-
252	*Garcinia dulcis* (Roxb.) Kurz	Hypericaceae	T	Madaw
253	*Garcinia merguensis* Wight	Hypericaceae	T	-
254	*Garcinia* sp.1	Hypericaceae	T	-
255	*Garcinia* sp.2	Hypericaceae	T	-
No.	**Scientific Name**	**Family Name**	**Habit**	**Common Name**
256	*Garcinia* sp.3	Hypericaceae	T	-
257	*Garcinia* sp.4	Hypericaceae	T	-
258	*Garcinia speciosa* Wall.	Hypericaceae	T	Taung-thale, Palawa, Parawa
259	*Getonia floribunda* Roxb.	Combretaceae	Cl, Cr	Kywet-new
260	*Gigantochloa macrostachya* Kurz	Poaceae	B	Tabindaing-wa
261	*Girardina suborbiculata*	Urticaceae	S	-
262	*Gironniera* sp.	Ulmaceae	T	-
263	*Gleichenia flexuosa* Smith	Hymenophyllaceae	F	-
264	*Globba* sp.	Zingiberaceae	H	-
265	*Glochidion* sp.1	Euphorbiaceae	S,ST	Hti-ma-soke
266	*Glochidion* sp.2	Euphorbiaceae	S,ST	-
267	*Glochidion* sp.3	Euphorpiaceae	S,ST	Htaik-ma-soke
268	*Glyptopetalum sclerocarpus* (Kurz) Prain	Celastraceae	ST	-
269	*Glyscomis* sp.	Rutaceae	S,ST	Taw-shauk
270	*Gmelina arborea* Roxb.	Verbenaceae	T	-
271	*Gnetum* sp.1	Gnetaceae	S	-

272	*Gnetum* sp.2	Gnetaceae	S	Hyinbyin Tanyin-ywe
273	*Gnetum* sp.3	Gnetaceae	S	-
274	*Gnetum* sp.4	Gnetaceae	S	-
275	*Goniothalamus* sp.1	Annonaceae	T	-
276	*Goniothalamus* sp.2	Annonaceae	T	-
277	Goodyera procera (Kes Cawls) Hooh	Orchidaceae	E	-
278	*Gouania microcarpa* DC.	Rhamnaceae	S,ST	Saungtawgu
279	*Grewia* sp.	Tiliaceae	S	Kyet-tayaw
280	*Gymadenia* sp.	Orchidaceae	E	-
281	*Heptapleurum* sp.	Araliaceae	T	-
282	*Heteropanax* sp.	Araliaceae	T	-
283	*Hibiscus macrophyllus* Roxb.	Malvaceae	T	-
284	*Hibiscus rosa - sinensis* L.	Malvaceae	S	Khaung-yan-pan
285	*Hibiscus* sp.	Malvaceae	S	Kaung-yan
286	*Holarrhena pubescens* Wall. ex G.Don =msjubilie	Apocynaceae	ST	Tha-put-hein
287	*Holcus* sp.	Poaceae	G	-
288	*Homalium* sp.	Flacourliaceae	ST	-
289	*Homonoia riparia* Lour.	Euphorbiaceae	T	Ye-ne
290	*Hoya* sp.	Asclepiadaceae	Cl, Cr	-
291	*Hydrocotyle*sp.	Apiaceae	H	Myin-khwa
No.	**Scientific Name**	**Family Name**	**Habit**	**Common Name**
292	*Hypericum* sp.2	Hypericaceae	T	-
293	*Hypolepis* sp.	Hypolepidaceae	F	-
294	*Hypolytrum nemorum* (M. Vahl) Spreng.	Cyperaceae	G	-
295	*Hypolytrum* sp.	Poaceae	G	-
296	*Ilex* sp.1	Aquifoliaceae	T	-
297	*Ilex* sp.2	Aqulifoliaceae	T	-
298	*Illigera* sp.	Hernandiaceae	Cl, Cr	-
299	*Ixeris chinensis* (Thunb.) Nakai	Asteraceae	H	-
300	*Ixora myikyinensis* Bremek.	Rubiaceae	S	-
301	*Ixora* sp.	Rubiaceae	S	Taw-sagwe
302	*Jatropha* sp.	Euphorbiaceae	ST	-
303	*Juncus* sp.	Juncaceae	H	-
304	*Jusminum* sp.1	Oleaceae	S	-
305	*Jusminum* sp.2	Oleaceae	S	-
306	*Jusminum* sp.3	Oleaceae	Cl, Cr	-
307	*Justicia adhatoda* L.	Acanthaceae	H	-
308	*Justicia* sp.1	Acanthaceae	H	-
309	*Justicia* sp.2	Acanthaceae	H	-

310	*Justicia* sp.3	Acanthaceae	H	-
311	*Justicia* sp.4	Acanthaceae	H	-
312	*Justicia* sp.5	Acanthaceae	H	-
313	*Knema furfuracea* (HK. F.et Th.) Warb.	Myristicaceae	T	-
314	*Kyllinga* sp.	Cyperaceae	G	-
315	*Lagerstroemia parviflora* Roxb.	Lythraceae	T	-
316	*Lagerstroemia* sp.1	Lythraceae	T	Pyin-ma
317	*Lagerstroemia* sp.2	Lythraceae	T	-
318	*Lantana* sp.	Lamiaceae	S	Sein-na-gat
319	*Lasia heterophylla* Schott L.	Araceae	S	Zayit
320	*Lasianthus cyanocarpus* Jack	Rubiaceae	S	-
321	*Lasianthus obliquinervis* Merr.	Rubiaceae	S	-
322	*Lasianthus* sp.1	Rubiaceae	S	-
323	*Lasianthus* sp.2	Rubiaceae	S	-
324	*Lasianthus wallichii* Wight	Rubiaceae	S	-
325	*Leea* sp.	Leeaceae	S	Na-ga-mouk
326	*Lepchilus decurrens* Bl.	Polypodiaceae	F	-
327	*Lepidagathis hyalina* Nees.	Acanthaceae	H	-
328	*Lepidagathis incurva* Buch.-Ham. ex D. Don	Rubiaceae	S	-
No.	**Scientific Name**	**Family Name**	**Habit**	**Common Name**
329	*Lepisanthes rubiginosa* (Roxb.) Leenh.	Sapidaceae	S,ST	-
330	*Lepisanthes* sp.	Sapindaceae	S,ST	-
331	*Leucas lavandulaefolia* Rees	Lamiaceae	H	-
332	*Limnophila sessiliflora* (Vahl) Blume	Scrophulariaceae	H	-
333	*Listea monopetala* (Roxb.) Pers.	Lauraceae	T	-
334	*Listea* sp.1	Lauraceae	T	-
335	*Lithocarpus* sp.1	Fagaceae	T	-
336	*Lithocarpus* sp.2	Fagaceae	T	Wet-thit-cha
337	*Lithocarpus* sp.3	Fagaceae	T	Wet-thit-cha
338	*Litsea cubeba* (Lour.) Pers.	Lauraceae	T	Ohn-dohn
339	*Litsea glutinosa* (Lour.) C.B.Rob.	Lauraceae	T	Ohn-dohn
340	*Litsea* sp.1	Lauraceae	T	-
341	*Litsea* sp.2	Lauraceae	T	-
342	*Litsea* sp.3	Lauraceae	T	-
343	*Litsea* sp.4	Lauraceae	T	-
344	*Lobellia* sp.	Campanulaceae	H	-
345	*Loranthus coccineus* Jack.	Loranthaceae	Parasitic shrub	-
346	*Lycopodium* sp.1	Lycopodiaceae	F	-
347	*Lycopodium* sp.2	Lycopodiaceae	F	-

348	*Lygodium* sp.1	Lygodiaceae	F	-
349	*Lygodium* sp.2	Lygodiaceae	F	-
350	*Lygodium* sp.3	Lygodiaceae	F	-
351	*Lygodium* sp.4	Lygodiaceae	F	-
352	*Macaranga denticulata* Muell.Arg.	Euphorbiaceae	T	Hpet-wun
353	*Macaranga* sp.	Euphorbiaceae	T	-
354	*Maesa ramentacea* A.DC	Myristicaceae	S,ST	-
355	*Maesa* sp.	Myrsinaceae	S,ST	-
356	*Magnolia lilifera* Druce	Berberidaceae	ST	-
357	*Magnolia* sp.1	Magnoliaceae	T	-
358	*Magnolia* sp.2	Magnoliaceae	T	-
359	*Mahonia thunberghii* DC.	Berberidaceae	ST	-
360	*Mallotus barbatus* muell. Arg.	Euphorbiaceae	T	Shaw
361	*Mallotus philippinensis* (Lam.) Muell.Arg.	Euphorbiaceae	T	-
362	*Mallotus piniculatus* Muell. Arg.	Euphorbiaceae	T	Phet-wun
363	*Mallotus* sp.1	Euphorbiaceae	T	-
364	*Mallotus* sp.2	Euphorbiaceae	T	-
365	*Mangifera indica*L.	Anacardiaceae	T	-
No.	**Scientific Name**	**Family Name**	**Habit**	**Common Name**
366	*Mariscus compactus* Retz	Cyperaceae	G	-
367	*Mazus japonica* Thunb.	Scrophulariaceae	H	-
368	*Melastoma* sp.1	Melastomalaceae	S	-
369	*Meliosma pinnata* Roxb.	Meliosmaceae	T	-
370	*Meliosma* sp.	Meliosmaceae	T	-
371	*Meliosma* sp.	Meliosmaceae	T	-
372	*Memecylon* sp.	Melastomataceae	H	-
373	*Meniscium* sp.	Thelypteridaceae	F	-
374	*Merremia vitifolia* (Burm.f.) Hallier f.	Convolvulaceae	Cl, Cr	Kyet-hingale-new
375	*Mesua ferrea* L.	Hypericaceae	T	Gangaw
376	*Mesua nervosa* Planch.&Triana	Hypericaceae	T	Taung-gan-gaw
377	*Microlepia* sp.	Lygodiaceae	F	-
378	*Microlepia* sp.	Lygodiaceae	F	-
379	*Micromelum minutum* Wight & Arn	Rutaceae	S,ST	-
380	*Microtoena insuavis*(Hance) Prain ex Dunn	Lamiaceae	H	-
381	*Mikarnia macrantha* HBK	Asteraceae	Cl, Cr	Bizat-new
382	*Miliusa* sp.	Annonaceae	ST	-
383	*Mimosa pudica* L.	Mimosaceae	H	Htaik-kayon
384	*Mitragyna* sp.	Rubiaceae	T	-
385	*Molineria caputulata* (Lour.) Herb	Hypoxidaceae	H	-

386	*Momordica dioica* Roxb.ex Willd.	Cucurbitaceae	Cl, Cr	Kyet-hin-kha
387	*Morinda angustifolia* Roxb.	Rubiaceae	ST	-
388	*Morus laevigata* Wall.	Moraceae	T	Taw-poza
389	*Murraya paniculata* L. Jack	Rutaceae	S,ST	-
390	*Musa* sp.1	Musaceae	H	-
391	*Musa* sp.2	Musaceae	H	Nget-pyaw
392	*Mussaenda* sp.	Rubiaceae	S	-
393	*Mycetia* sp.	Rubiaceae	H	-
394	*Myosoton* sp.	Caryophyllaceae	H	-
395	*Myriopteron extensum* (Wight) K.Schum.	Asclepiadaceae	Cl, Cr	Daunk-salat
396	*Myristica angustifolia* Roxb.	Myristicaceae	T	Myauk-ma-kun-thwe
397	*Nasturtium officinale* R.Br.	Brassicaceae	H	Taung-kya-gale
398	*Neolitsea* sp.	Lauraceae	T	-
399	*Neottopteris* sp.1	Davalliaceae	F	-
400	*Neottopteris* sp.2	Davalliaceae	F	-
401	*Nephelium lappaceum* L.	Sapindaceae	ST	Kyet-mauk
No.	**Scientific Name**	**Family Name**	**Habit**	**Common Name**
402	*Nephelium litchi* Cambess.	Sapidaceae	ST	litchi
403	*Nephelium* sp.	Sapindaceae	T	-
404	*Nothaphoebe umbelliflora* (Bl.) Bl.	Lauraceae	T	-
405	*Oblismenus* sp.	Poaceae	G	-
406	*Oldenlandia unicinella* HK & Arn	Rubiaceae	H	-
407	*Ophioglossum* sp.	Ophioglossaceae	F	-
408	*Ophiorrhiza* sp.1	Rubiaceae	H	-
409	*Ophiorrhiza* sp.2	Rubiaceae	H	-
410	*Osmanthus* sp.	Oleaceae	S	-
411	*Ostrya* sp.1	Betulaceae	T	Tha-puthein
412	*Ostrya* sp.2	Betulaceae	T	-
413	*Oxalis corniculata* L.	Oxalidaceae	H	Hmo-chin
414	*Oxalis corymbosa* DC.	Oxalidaceae	H	Hmo-chin
415	*Oxyspara* sp.	Melastomalaceae	S	-
416	*Pandanas* sp.	Pandanaceae	ST	-
417	*Panicum* sp.	Cyperaceae	G	-
418	*Parvatia brunoniana* Decne	Lardizabalaceae	Cl, Cr	-
419	*Pavetta* sp.	Rubiaceae	H	Za-gwe-pan
420	*Phalaenopsis lowii* Rchb.f.	Orchidaceae	E	-
421	*Phaulopsis paviflora* Willd.	Acanthaceae	H	-
422	*Phellodendron* sp.	Rutaceae	S,ST	-
423	*Phlogacanthus* sp.	Acanthaceae	S	-

424	*Phlogacanthus thyrsiflorus* Nees	Acanthaceae	S	-
425	*Phoebe* sp.	Lauraceae	T	-
426	*Phoenix* sp.	Arecaceae	T	-
427	Pholidota imbricata Lindl.	Orchidaceae	E	-
428	*Phragmite* sp.	Poaceae	G	Kyu
429	*Phymatopteris* sp.	Polypodiaceae	F	-
430	*Phynium* sp.	Marantaceae	H	-
431	*Physalis minima* L.	Solanaceae	H	Bauk-thi
432	*Piper attenuatum* Ham.	Piperaceae	H	Sayo
433	*Piper nigrum* L.	Piperaceae	Cl, Cr	Sen-paik-chin
434	*Piper* sp.1	Piperaceae	H	-
435	*Piper* sp.2	Piperaceae	Cl, Cr	Sen-paik-chin
436	*Piper* sp.3	Piperaceae	Cl, Cr	Sen-paik-chin
437	*Piper* sp.4	Piperaceae	Cl, Cr	-
438	*Pittostoropsis kerii* Craib	Icacinaceae	ST	-
No.	**Scientific Name**	**Family Name**	**Habit**	**Common Name**
439	*Pityogramma calamelanos* (Klf.) Link	Pteridaceae	F	-
440	*Podocarpus* sp.	Podocarpaceae	T	-
441	*Pollia* sp.	Commelinaceae	H	-
442	*Polygonatum*sp.	Convallariaceae	H	-
443	*Polygonum capitatum* Ham.	Polygonaceae	H	Wet-kyut-gyi
444	*Polygonum pubescens* Blume	Polygonaceae	H	Wet-kyut-gyi
445	*Polygonum* sp.1	Polygonaceae	H	Wet-kyut-gyi
446	*Polygonum* sp.2	Polygonaceae	H	Wet-kyut-gyi
447	*Polygonum* sp.3	Polygonaceae	H	Wet-kyut-gyi
448	*Portulaca* sp.	Portulacaceae	H	-
449	*Pothos scandens*L.	Araceae	Cl, Cr	Kin-that-nwe
450	*Pouzolzia* sp.	Urticaceae	H	-
451	Pronephrium lakhimpurense (Ros.) Holtt.	Thelypteridaceae	F	-
452	*Pronephrium triphyllum* (Sw.) Hollt.	Thelypteridaceae	F	-
453	*Pseuderanthemum* sp.1	Acanthaceae	S	-
454	*Pseuderanthemum* sp.2	Acanthaceae	S	-
455	*Pseudodrynaria coronans* (Wall. Ex. Melt.) Ching	Drynariaceae	F	-
456	*Pseudostachyum* sp.	Poaceae	B	Bauk-wa
457	*Psidium guajava* L.	Myrtaceae	ST	Malaka
458	*Psychotria elongata* Benth.	Rubiaceae	S	-
459	*Psychotria* sp.	Rubiaceae	S	-
460	*Psychotria* sp.	Rubiaceae	S	-
461	*Pteris longifolia* L.	Pteridaceae	F	-

462	*Pteris* sp.	Pteridaceae	F	-
463	*Pteris* sp.	Pteridaceae	F	-
464	*Pterocarpus* sp.	Fabaceae	T	-
465	*Pterospermum acerifolium* (L.) Willd.	Sterculiaceae	T	Shaw
466	*Pterospermum cinnamonemum* Kurz	Sterculiaceae	T	Nagye
467	*Pueraria tuberasa* DC.	Fabaceae	Cl, Cr	Kyway-byu
468	*Pycreus* sp.	Cyperaceae	G	-
469	*Quercus aliena* Blume	Fagaceae	T	Wet-thit-cha
470	*Quercus semiserrata* Roxb.	Fagaceae	T	-
471	*Quercus* sp.	Fagaceae	T	-
472	*Randia dumetorum* Lam	Rubiaceae	H	-
473	*Ranunculus* sp.	Ranunculaceae	H	-
474	*Rapanea* sp.	Myrsinaceae	T	-
475	*Rhododendron simsii* Planch.	Ericaceae	ST	Taung-zalat
No.	**Scientific Name**	**Family Name**	**Habit**	**Common Name**
476	*Rhododendron* sp.1	Ericaceae	ST	Taung-zalat
477	*Rhus succedanea* L.	Anacardiaceae	T	-
478	*Rhyrcostylis* sp.	Orchidaceae	E	-
479	*Ricinus communis* L.	Euphorbiaceae	ST	Kyet-su
480	*Rosa involucrata* Roxb.	Rosaceae	S	-
481	*Rostellularia procumbens* Nees	Acanthaceae	H	-
482	*Rubia cordifolia* L.	Rubiaceae	Cl, Cr	Peseint-ni-pin
483	*Rubus* sp.1	Rosaceae	S	-
484	*Rubus* sp.2	Rosaceae	S	-
485	*Rumex* sp.	Polygonaceae	H	-
486	*Rungia* sp.	Acanthaceae	H	-
487	*Sabia* sp.	Sabiaceae	Cl, Cr	-
488	*Salix*sp.	Salicaceae	S	Poza
489	*Saussurea* sp.	Asteraceae	H	-
490	*Saurauia* sp.1	Actinidiaceae	ST	-
491	*Saurauia* sp.2	Actinidiaceae	ST	-
492	*Saurauia* sp.3	Actinidiaceae	ST	-
493	*Saurauia* sp.4	Actinidiaceae	ST	-
494	*Schefflera* sp.1	Araliaceae	Cl	-
495	*Schefflera* sp.2	Araliaceae	T	-
496	*Schefflera* sp.3	Araliaceae	T	-
497	*Schoenoplectus* sp.1	Cyperaceae	H	-
498	*Schoenoplectus* sp.2	Cyperaceae	H	-
499	*Schoenoplectus* sp.3	Cyperaceae	H	-
500	*Scleria* sp.	Cyperaceae	H	-

501	*Scleria* sp.	Poaceae	G	-
502	*Scleria* sp.	Cyperaceae	H	-
503	*Scoparia dulis* L.	Linderniaceae	H	Dan-ta-thu-kha
504	*Scripus* sp.	Cyperaceae	G	-
505	*Selaginella delicaluta* (Derv.) Alston.	Selaginellaceae	F	-
506	*Selaginella* sp.1	Selaginellaceae	F	-
507	*Selaginella* sp.2	Selaginellaceae	F	-
508	*Selaginella* sp.3	Sellagineaceae	F	-
509	*Semecarpus* sp.	Anacardiaceae	T	Chee
510	*Setaria* sp.	Poaceae	G	-
511	*Shorea assamica* Dyer	Dipterocarpaceae	T	-
512	*Sida acuta* Burm.f.	Malvaceae	S	Wet-chay-pane
No.	**Scientific Name**	**Family Name**	**Habit**	**Common Name**
513	*Sida rhombifolia* L.,s.l	Malvaceae	S	Katsi-ne
514	*Smilax macrophylla* Roxb.	Smilacaceae	Cl, Cr	Sein-na-baw
515	*Smilax* sp.1	Smilacaceae	Cl, Cr	Sein-na-baw
516	*Smilax* sp.2	Smilacaceae	Cl, Cr	Sein-na-baw
517	*Smilax* sp.3	Smilacaceae	Cl, Cr	-
518	*Smilax* sp.4	Smilacaceae	Cl, Cr	-
519	*Solanum erianthum* D. Don	Solanaceae	H	Daunk-sat-pya
520	*Solanum indicum* L.	Solanaceae	H	Kha-yan-kazaw
521	*Solanum melongena* L.	Solanaceae	H	Kha-yan
522	*Solanum nigrum* L.	Solanaceae	H	Khan-yan
523	*Solanum* sp.1	Solanaceae	H	Kha-yan
524	*Solanum* sp.2	Solanaceae	H	Kha-yan
525	*Spathodea campanulata* P.Beauv.	Bignoniaceae	T	Ar-fri-ka-kyu-lit-pin
526	*Sphaeropteris* sp.	Cytheaceae	F	Tree-fern
527	*Stachyphrynium* sp.	Marantaceae	S	-
528	*Stenoloma chusanum* (L.) Ching	Lindsaeaceae	F	-
529	*Sterculia lanceolata* Buch-Ham.	Sterculiaceae	T	Ohn-dohn
530	*Sterculia* sp.1	Sterculiaceae	T	-
531	*Sterculia* sp.2	Sterculiaceae	T	-
532	*Sterculia* sp.3	Sterculiaceae	T	-
533	*Sterculia* sp.4	Sterculiaceae	T	-
534	*Sterculia* sp.5	Sterculiaceae	T	-
535	*Sterculia urena* Roxb.	Sterculiaceae	T	Shaw
536	*Stereospermum* sp.	Bignoniaceae	T	-
537	*Streblus asper* Lour.	Moraceae	T	Ohn-hne
538	*Strobilanthes* sp.	Acanthaceae	S	-

539	*Strychnos* sp.	Loganiaceae	T	-
540	*Suregada multiflora* (A.Juss.) Baill.	Euphorbiaceae	T	Awle
541	*Suregada* sp.	Euphorbiaceae	T	-
542	*Swintonia floribunda* Griff.	Anacardiaceae	T	Taung-tha-yet
543	*Symplocos macrophylla* Wight	Symplocaceae	S,ST	-
544	*Symplocos* sp.1	Symplocaceae	S	-
545	*Symplocos* sp.2	Symplocaceae	S	Sarthunge
546	*Symplocos* sp.3	Symplocaceae	S	-
547	*Symplocos* sp.4	Symplocaceae	S	-
548	*Symplocos* sp.5	Symplocaceae	S	-
549	*Syzigium* sp.1	Myrtaceae	T	Thabye
No.	**Scientific Name**	**Family Name**	**Habit**	**Common Name**
550	*Syzigium* sp.2	Myrtaceae	T	-
551	*Syzigium* sp.3	Myrtaceae	T	Thabye
552	*Syzigium* sp.4	Myrtaceae	T	-
553	*Syzigium* sp.5	Myrtaceae	T	-
554	*Tabernaemontana* sp.	Apocynaceae	S	-
555	*Tadehagi triquetrum* (L.) H. Ohashi	Fabaceae	S	Lauk-thay
556	*Tarennoidea* sp.	Rubiaceae	ST	-
557	*Tectaria* sp.1	Dryopteridaceae	F	-
558	*Tectaria* sp.2	Dryopteridaceae	F	-
559	*Tectaria* sp.3	Dryopteridaceae	F	-
560	*Tectaria* sp.4	Dryopteridaceae	F	-
561	*Tectaria* sp.5	Dryopteridaceae	F	-
562	*Terminelia chebula* Retz.	Verbenaceae	T	Phun-gya
563	*Thevetia peruviana* (Pers.) Schum.	Apocynaceae	ST	-
564	*Thunbergia coccinea* Wall.	Acanthaceae	Cl, Cr	Kyi-ni-nwe
565	*Thunbergia erecta* T.Anderson	Acanthaceae	Cl, Cr	Khaung-laung-pyar
566	*Thunbergia grandiflora* Roxb.	Acanthaceae	Cl, Cr	-
567	*Thunbergia* sp.	Acanthaceae	Cl, Cr	-
568	*Thysanolaena maxima* (Roxb.) Kuntze	Poaceae	G	Tha-ma-zaing
569	*Toisusu urbaniana* Seem.	Salicaceae	T	-
570	*Toona ciliata* M. Roemer	Meliaceae	T	
571	*Trema Orientalis* (L.) Blume	Ulmaceae	T	Khwesha
572	*Tricalysia dubia* (Lindl.) Ohwi	Rubiaceae	H	-
573	*Tropidia angulosa* (Lindl.) Blume	Orchidaceae	E	-
574	*Turpinia* sp.	Staphyleaceae	T	-
575	UN-1		S	Taw-thanut-kha
576	UN-10		T	-
577	UN-100	Liliaceae	H	-

578	UN-101	Sabiaceae	T	-
579	UN-102	Loranthaceae	Parasitic shrub	-
580	UN-103	Meliaceae	T	-
581	UN-104	Meliaceae		-
582	UN-105	Meliaceae		-
583	UN-106	Meliaceae		-
584	UN-107	Menispermaceae	T	-
585	UN-108	Anacardiaceae		-
586	UN-109	Moraceae		-
No.	**Scientific Name**	**Family Name**	**Habit**	**Common Name**
587	UN-11			-
588	UN-110	Moraceae		-
589	UN-111	Myristicaceae		-
590	UN-112	Annonaceae		-
591	UN-113	Sapindaceae	ST	-
592	UN-114	Myrtaceae	T	-
593	UN-115	Myrtaceae	T	-
594	UN-116	Orchidaceae	E	-
595	UN-117	Orchidaceae	E	-
596	UN-118	Orchidaceae	E	-
597	UN-119	Annonaceae		-
598	UN-12		T	-
599	UN-120	Orchidaceae	E	-
600	UN-121	Orchidaceae	E	-
601	UN-122	Orchidaceae	E	-
602	UN-123	Orchidaceae	E	-
603	UN-124	Sapindaceae	ST	-
604	UN-125	Piperaceae	Cl	-
605	UN-126	Poaceae	B	Wa-net
606	UN-127	Poaceae	B	Paung-tin-wa
607	UN-128	Poaceae	B	Wa-ni-bar
608	UN-129	Sapindaceae	ST	-
609	UN-13			-
610	UN-130	Scrophulariaceae	H	-
611	UN-131	Annonaceae		-
612	UN-132	Sterculiaceae	T	-
613	UN-133	Sterculiaceae	T	-
614	UN-134	Urticaceae	S	-
615	UN-135	Vitaceae	Cl	-

616	UN-136	Vitaceae	Cl	-
617	UN-137	Poaceae	B	Bauk-wa
618	UN-138	Zingiberaceae	H	-
619	UN-139	Zingiberaceae	H	-
620	UN-14	Rubiaceae	S	-
621	UN-140			-
622	UN-141			-
623	UN-142			-
No.	**Scientific Name**	**Family Name**	**Habit**	**Common Name**
624	UN-143	Apocynaceae		-
625	UN-144			-
626	UN-145			-
627	UN-146		T	-
628	UN-147		T	-
629	UN-148	Poaceae	G	-
630	UN-149			-
631	UN-15			-
632	UN-150			-
633	UN-151			-
634	UN-152			-
635	UN-153			-
636	UN-154		T	-
637	UN-155	Apocynaceae		-
638	UN-156		T	-
639	UN-157			-
640	UN-158		S	-
641	UN-159	Poaceae	G	-
642	UN-16			-
643	UN-160		T	-
644	UN-161			-
645	UN-162		T	-
646	UN-163		Cl	-
647	UN-164		H	-
648	UN-165			-
649	UN-166			-
650	UN-167	Apocynaceae		-
651	UN-168		T	-
652	UN-169		T	-
653	UN-17	Acanthaceae		-
654	UN-170	Poaceae	G	-

655	UN-171		T	-
656	UN-172		T	-
657	UN-173			-
658	UN-174			-
659	UN-175			-
660	UN-176			-
No.	**Scientific Name**	**Family Name**	**Habit**	**Common Name**
661	UN-177			-
662	UN-178			-
663	UN-179	Apocynaceae		-
664	UN-18	Araliaceae		-
665	UN-180			-
666	UN-181	Poaceae	G	-
667	UN-182		S	-
668	UN-183		T	-
669	UN-184			-
670	UN-185			-
671	UN-186		T	-
672	UN-187		S	-
673	UN-188			-
674	UN-189			-
675	UN-19			-
676	UN-190		T	-
677	UN-191	Apocynaceae		-
678	UN-192	Polypodiaceae	F	-
679	UN-193			-
680	UN-194		S	-
681	UN-195		S	-
682	UN-196		T	-
683	UN-197			-
684	UN-198			-
685	UN-199			-
686	UN-2	Rubiaceae	S	-
687	UN-20		F	-
688	UN-200			-
689	UN-201			-
690	UN-202		B	-
691	UN-203	Rubiaceae	S	-
692	UN-204	Apocynaceae	T	-
693	UN-205			-

694	UN-206		H	-
695	UN-207		T	-
696	UN-208			-
697	UN-209			-
No.	**Scientific Name**	**Family Name**	**Habit**	**Common Name**
698	UN-21		S	-
699	UN-210			-
700	UN-211			-
701	UN-212		S	-
702	UN-213		S	-
703	UN-22			-
704	UN-23			-
705	UN-24		S	-
706	UN-25	Rubiaceae	S	-
707	UN-26			-
708	UN-27		T	-
709	UN-28		T	-
710	UN-29			-
711	UN-3	Rubiaceae	S	-
712	UN-30	Arecaceae		-
713	UN-31		T	-
714	UN-32		T	-
715	UN-33			-
716	UN-34		T	-
717	UN-35			-
718	UN-36	Annonaceae		-
719	UN-37		T	-
720	UN-38		S	-
721	UN-39			-
722	UN-4			-
723	UN-40	Arecaceae	S	-
724	UN-41	Asclepidiaceae		-
725	UN-42	Asclepidiaceae		-
726	UN-43	Asclepidiaceae		-
727	UN-44	Asclepidiaceae		-
728	UN-45	Asclepidiaceae		-
729	UN-46	Asclepidiaceae		-
730	UN-47	Rubiaceae	S	-
731	UN-48	Asclepidiaceae	T	-
732	UN-49	Acanthaceae		-

733	UN-5	Araceae		-
734	UN-50	Asteraceae	Cl	-
No.	**Scientific Name**	**Family Name**	**Habit**	**Common Name**
735	UN-51	Asteraceae		-
736	UN-52	Asteraceae		-
737	UN-53	Asteraceae	H	-
738	UN-54	Asteraceae		-
739	UN-55	Asteraceae		-
740	UN-56	Asteraceae		-
741	UN-57	Rubiaceae	S	-
742	UN-58	Bignoniaceae	T	-
743	UN-59	Bignoniaceae		-
744	UN-6			-
745	UN-60	Acanthaceae		-
746	UN-61	Boraginaceae		-
747	UN-62	Brassicaceae	H	-
748	UN-63	Combretaceae		-
749	UN-64	Commelinaceae	S	-
750	UN-65	Comvolvulaceae		-
751	UN-66	Cucurbitaceae		-
752	UN-67	Euphorbiaceae		-
753	UN-68	Rutaceae	S,ST	-
754	UN-69	Euphorbiaceae	Cl	-
755	UN-7			-
756	UN-70	Euphorbiaceae		-
757	UN-71	Euphorbiaceae		-
758	UN-72	Acanthaceae	S	-
759	UN-73	Euphorbiaceae		-
760	UN-74	Euphorbiaceae		-
761	UN-75	Euphorbiaceae		-
762	UN-76	Euphorbiaceae	S	-
763	UN-77	Fabaceae		-
764	UN-78	Fabaceae		-
765	UN-79	Rutaceae	S,ST	-
766	UN-8			-
767	UN-80	Fabaceae	Cl	-
768	UN-81	Fabaceae		-
769	UN-82	Fabaceae	Cl	-
770	UN-83	Fabaceae	T	-
771	UN-84	Acanthaceae		-

No.	Scientific Name	Family Name	Habit	Common Name
772	UN-85		F	-
773	UN-86	Hypericaceae		-
774	UN-87	Icacinaceae		-
775	UN-88	Icacinaceae		-
776	UN-89	Lamiaceae		-
777	UN-9			-
778	UN-90	Rutaceae	S,ST	-
779	UN-91	Lamiaceae		-
780	UN-92	Lamiaceae	H	-
781	UN-93	Lauraceae		-
782	UN-94	Lauraceae	T	-
783	UN-95	Lauraceae		-
784	UN-96	Amarayllidaceae	H	-
785	UN-97	Lauraceae	T	-
786	UN-98	Lauraceae		-
787	UN-99	Liliaceae	H	-
788	*Uncaria ovalifolia* Roxb.	Rubiaceae	S	-
789	*Urena lobata* L.	Malvaceae	S	Kat-sine-gyi
790	*Urtica* sp.	Urticaceae	*S*	-
791	*Urtica* sp.	Urticaceae	S	Phet-yar
792	*Uvaria* sp.	Annonaceae	T	-
793	*Vernonia cinerea* Less.	Asteraceae	H	Kadu-pyan
794	*Viola* sp.	Violaceae	H	-
795	*Vitex* sp.	Verbenaceae	T	-
796	*Vitex* sp.1	Verbenaceae	T	-
797	*Vitex* sp.2	Verbenaceae	T	Kyet-yo
798	*Vitex* sp.2	Verbenaceae	T	-
799	Vitis sp.	Vitaceae	Cl	-
800	*Vitis* sp.	Vitaceae	Cl	-
801	*Vitis* sp.1	Vitaceae	Cl	Men-ngu-khaw
802	*Vitis* sp.2	Vitaceae	Cl	-
803	*Wallichia siamensis* Becc.	Arecaceae		-
804	*Wedelia trilobata* (L.) Hitche.	Asteraceae	H	-
805	*Wendlandia* sp.	Rubiaceae	T	Thitni
806	*Wendlandia* sp.	Rubiaceae	T	-
807	*Wendlandia tinctoria* DC.	Rubiaceae	T	-
808	*Woodfordia fruticosa* (L.) Kz.	Lythraceae	T	-
No.	**Scientific Name**	**Family Name**	**Habit**	**Common Name**
809	*Xanthium* sp.	Asteraceae	H	-

810	*Xantolis tomentosa* Raf.	Sapotaceae	T	-
811	*Youngia japonica* (L.) DC.	Asteraceae	H	-
812	*Zanthoxylum* sp.	Rutaceae	ST	Maya-hnin
813	*Zingiber* sp.1	Zingiberaceae	H	-
814	*Zingiber* sp.2	Zingiberaceae	H	-
815	*Ziziphus jujuba* Lam.	Rhamnaceae	S	Zee
816	*Ziziphus* sp.1	Rhamnaceae	S	Zee
817	*Ziziphus* sp.2	Rhamnaceae	S	Zee
818	*Ziziphus* sp.3	Rhamnaceae	Cl	-

B = Bamboo, Cl = Climber, Cr = Creeper, E = Epiphyte, F = Fern, G = Grass, H = Herb, S = Shrub, ST = Small Tree, T = Tree

Appendix – II Myitsone Vegetation Type

No.	Locality	Vegatation Type	Latitude	Longitude	Altitude	Notes
1	Bentbane	Low land Evergreen Forest	25° 34′ 49.9″	97° 47′ 41.6″	231 m	*Dracontomelon* sp., *Chisocheton siamensis*, *Dipterocarpus* sp., *Litsea* sp., *Baccaurea sapida*, *Arenga* sp. are mainly found in tree layer. Ground layer is dominated by *Dracaena* sp. 6/8, *Litsea* sp. , *Selaginella* sp. 2/8, *Commelina* sp. 2/8, *Arenga triandra* 6/8, G*netum* sp. 6/8, *Scleria* sp. 1/8, *Calamus* sp. 3/8, *Saurauia* sp. 2/8, *Spathoglattis* sp., *Dipterocarpus* sp., P*ronephrium triphyllum 3/8*, *Begonia roxburghii* 1/8, *Phrynium capitatum* 4/8, S*tachyphrynium* sp. 1/8, *Myrisitca angustifolia* 2/8 & *Leea* sp. 6/8.
2	Bentbane	Low land Evergreen Forest	25° 33′ 56.7″	97° 47′ 11.3″	393 m	
3	Mada-Taung, Bentbane near Mayhka River	Low land Evergreen Forest	25° 40′ 44.3″	97° 41′ 16.9″	214 m	
4	Beside Malihka River	Low land Evergreen Forest	25° 51′ 45.9″	97° 30′ 33.6″	244 m	
5	59 miles	Low land Evergreen Forest	25° 42′ 35.6″	97° 50′ 43.2″	262 m	
6	59 miles	Low land Evergreen Forest	25° 42′ 51.8"	97° 50′ 29.1″	266 m	
7	Thewaing	Low land Evergreen Forest	25°40′ 51.8″	97° 37′ 31.6″	452 m	
8	Mada-Taung, Bentbane, near Mayhka River	Low land Evergreen Forest	25° 40′ 50.0″	97° 41′ 20.0″	224 m	
9	Myitsone	Low land Evergreen Forest	25° 41′ 58.3"	97° 27′ 59.2″	565 m	
10	Mada-Taung, Bentbane, Chang sone, near Mayhka River	Low land Evergreen Forest	25° 40′ 49.5″	97° 36′ 57.9″	327 m	
No.	Locality	Vegatation Type	Latitude	Longitude	Altitude	Notes
11	Mada-Taung, Bentbane, Chang	Low land Evergreen	25° 41′ 03.1″	97° 36′ 50.4″	204 m	

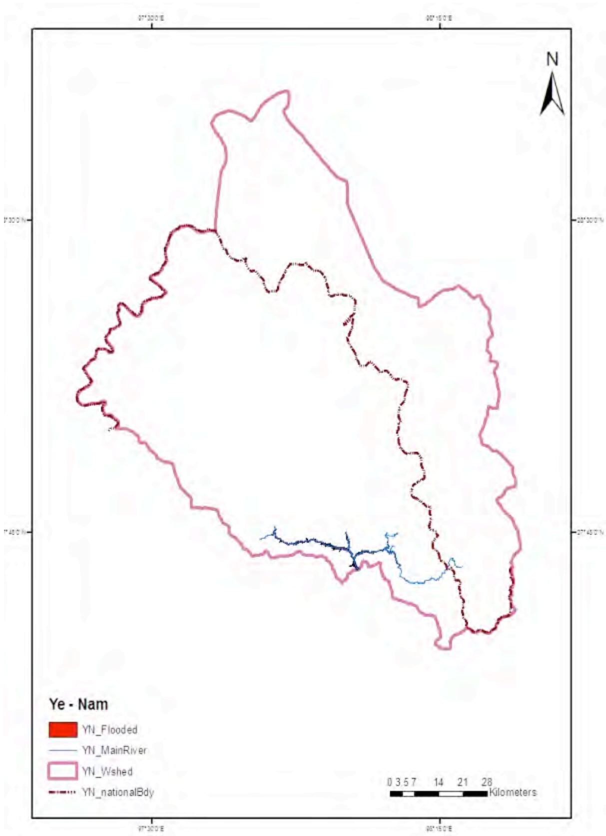
	sone, near Mayhka River	Forest				
12	Mada-Taung, Bentbane, Chang sone, near Mayhka River	Low land Evergreen Forest	25° 41′15.3″	97° 36′ 41.8″	164 m	
13	Mada Taung, Bentbane, Chang sone, near Mayhka River	Low land Evergreen Forest	25° 40′ 45.7″	97° 41′ 10.7″	185 m	
14	59 miles, Along the Mayhka River	Low land Evergreen Forest	25° 33′ 55.8″	97° 46′ 52.2″	206 m	
15	Bentbane,beside Mayhka River	Low land Evergreen Forest	25° 34′ 48.1″	97° 47′ 34.9″	285 m	
16	Bentbane,beside Mayhka River	Low land Evergreen Forest	25° 34′ 47.6″	97° 47′ 29.7″	314 m	
17	Lwengu,Bentbane, beside Mayhka River	Low land Evergreen Forest	25° 33′ 56.9″	97° 47′ 11.3″	393 m	
18	Mada-Taung, Bentbane- near Mayhka River	Low land Evergreen Forest	25° 40′ 51.8″	97° 37′ 35.1″	452 m	
19	Myitsone, Junction of Mayhka River and Malihka River	Low land Evergreen Forest	25° 41′ 58.3″	97° 27′ 59.2″	565 m	
20	Asia World Camp Area, Beside Ayewaddy River	Low Land Secondary Forest	25° 04′ 40.7″	97° 29′ 20.9″	190 m	
21	Bentbane,beside Mayhka River	Low Land Secondary Forest	25°34 ′45.3 ″	97°47 ′17.7 ″	347 m	
22	Beside Malihka River	Low Land Secondary Forest	25° 52′ 05.7″	97° 31′ 05.8″	193 m	
23	Myit sone, Junction of Mayhka River and Malihka River	Low Land Secondary Forest	25° 42′ 18.8″	97° 28′ 30.3″	245 m	*Ostrya* sp., *Garcinia* sp., *Myristica angustifolia*, *Chisocheton siamensis* & *Symplocos sp.* assosiate with *Castanopsis indica* are mainly found in tree layer. Ground layer is dominated by *Gnetum* sp. 7/8, *Dracaena* sp. 4/8, *Spathoglattis* sp. 1/8, *Arenga triandra* 6/8, *Wallichia siamensis* 1/8*, Clerodendron* sp. 1/8, *Ziziphus oenoplia* 2/8*, Calamus* sp. 3/8, *Piper* sp. 5/8, *Selaginella* sp. 4/8 & *Commelina* sp. 1/8.
24	59 miles	Low Land Secondary Forest	25° 42' 00.5"	97° 52' 18.0″	210 m	
25	BesideMalihka River	Low Land Secondary Forest	25° 50′ 56.6″	97° 29′ 51.3″	210 m	
26	Bentbane,beside Mayhka River	Low Land Secondary Forest	25° 34′ 49.9″	97° 47′ 41.6″	231m	
27	Mada-Taung,Bentbane- near Mayhka River	Low Land Secondary Forest	25° 40′ 19.3″	97° 37′ 18.6″	389 m	
28	Lwengu,Bentbane, beside Mayhka River	Low Land Secondary Forest	25° 34′ 04.0″	97° 46′ 32.1″	583 m	
29	59 miles	Low Land Secondary Forest	25° 42′ 48.7″	97° 50′ 37.3″	258 m	
30	Bentbane,beside Mayhka River	Low Land Secondary Forest	25° 34′ 50.4″	97° 47′ 42.0″	224 m	
31	Bentbane,beside Mayhka River	Low Land Secondary Forest	25° 34′ 53.8″	97° 47′ 42.8″	188 m	
No.	**Locality**	**Vegatation Type**	**Latitude**	**Longitude**	**Altitude**	**Notes**

32	Bentbane,beside Mayhka River	Low Land Secondary Forest	25° 34′ 47.8″	97° 47′ 27.5″	314 m	
33	Bentbane,beside Mayhka River	Low Land Secondary Forest	25° 34′ 45.9″	97° 47′ 23.8″	334 m	
34	Bentbane,beside Mayhka River	Low Land Secondary Forest	25° 34′ 45.5″	97° 47′ 19.0″	237 m	
35	Lwengu,Bentbane, beside Mayhka River	Oak Forest	25° 33' 56.8"	97° 47' 11.6″	388 m	
36	Lwengu,Bentbane, beside Mayhka River	Oak Forest	25° 34′ 04.3″	97° 46′ 31.8″	440 m	
37	59 miles	Oak Forest	25° 41' 59.3"	97° 52' 96.5″	216 m	*Fagus crenata, Lithocarpus sp., Quercus sp., Castanopsis sp., associate* with *Ostrya sp., Garcinia sp., Chisocheton siamensis & Mesua nervosa* are found in tree layer. Ground layer is dominated by Lasianthus cyanocarpus 3/5, Arenga triandra 3/5, Garcinia merguensis1/5, Goniothalamus sp. 2/5 & Commelina sp. 1/5.
38	59 miles, Along the Mayhka River	Oak Forest	25° 39′ 28.6″	97° 53′ 43.3″	224 m	
39	Mada-Taung, Bentbane- near Mayhka River	Oak Forest	25° 40′ 43.9″	97° 41′ 16.0″	196 m	
40	59 miles	Degraded Forest (Shrub Type)	25° 41' 47.9"	97° 52' 30.2″	213 m	
41	59 miles	Degraded Forest (Shrub Type)	25° 41' 45.4"	97° 52' 26.2″	214 m	
42	Myit sone, Junction of Mayhka River and Malihka River	Bamboo Forest	25° 35′ 06.5″	97° 49′ 46.2″	272 m	
43	Myit sone, Junction of Mayhka River andMalihka River	Bamboo Forest	25° 36′ 01.9″	97° 47′ 04.3″	131 m	Dendrocalamus hamiltonii Ness(Wabo Myatsan),D.giganteusMunro(Wabo wa), Cephalostachyum pallidum Munro (Tinkhawa), Pseudostachyum sp. (Wanibar),Bambusa londispiculata Gamble
44	59 miles, Along the Mayhka River	Bamboo Forest	25° 39′ 36.1″	97° 53′ 22.7″	223 m	
45	60 miles, Along the Mayhka River	Bamboo Forest	25° 39′ 29.4″	97° 53′ 40.3″	230 m	
46	61 miles, Along the Mayhka River	Bamboo Forest	25° 39′ 36.3″	97° 53′ 22.6″	213 m	
47	Bentbane,beside Mayhka River	Bamboo Forest	25° 35′ 01.3″	97° 47′ 58.1″	132 m	
48	Bentbane,beside Mayhka River	Bamboo Forest	25° 37′ 54.3″	97° 47′ 44.5″	140 m	
49	Bentbane,beside Mayhka River	Bamboo Forest	25° 38′ 54.1″	97° 43′ 51.1″	150 m	
50	Bentbane,beside Mayhka River	Bamboo Forest	25° 34′ 55.4″	97° 44′ 43.7″	170 m	
51	Bentbane,beside Mayhka River	Bamboo Forest	25° 34′ 55.4″	97° 44′ 43.8″	170 m	
No.	**Locality**	**Vegatation Type**	**Latitude**	**Longitude**	**Altitude**	**Notes**

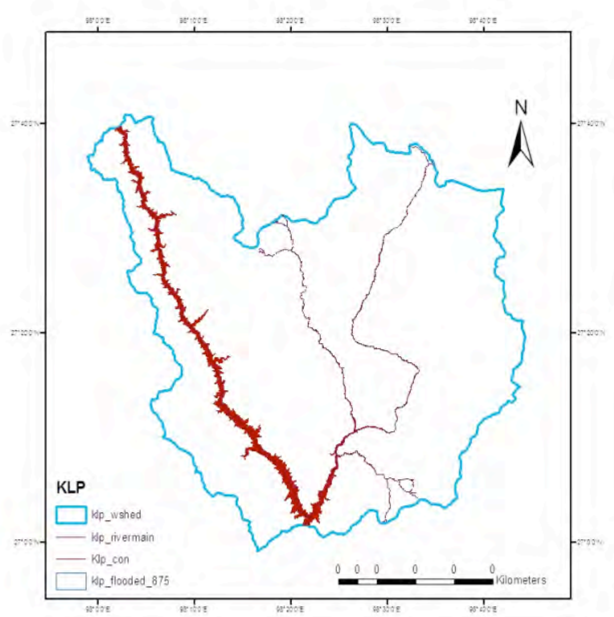
52	Bentbane,beside Mayhka River	Bamboo Forest	25° 34′ 47.9″	97° 47′ 38.6″	265 m	
53	Bentbane,beside Mayhka River	Bamboo Forest	25° 34′ 48.2″	97° 47′ 33.5″	301 m	
54	Bentbane,beside Mayhka River	Bamboo Forest	25° 47′ 25.8″	97° 47′48.3″	320 m	
55	Bentbane,beside Mayhka River	Bamboo Forest	25° 34′ 17.4″	97° 48′ 16.1″	235 m	
56	Bentbane,beside Mayhka River	Bamboo Forest	25° 35′ 06.5″	97° 49′ 46.2″	346 m	
57	Bentbane,beside Mayhka River	Bamboo Forest	25° 41′ 12.2″	97° 36′ 42.4″	308 m	
58	Bentbane,beside Mayhka River	Bamboo Forest	25° 40′ 27.9″	97° 37′ 35.1″	471 m	
59	Bentbane,beside Mayhka River	Bamboo Forest	25° 34′ 17.4″	97° 48′ 16.1″	235 m	
60	Lwengu,Bentbane, beside Mayhka River	Bamboo Forest	25° 33′ 59.1″	97° 40′ 44.2″	466 m	
61	Lwengu,Bentbane, beside Mayhka River	Bamboo Forest	25° 34′ 01.8″	97° 46′ 42.0″	516 m	
62	Lwengu,Bentbane, beside Mayhka River	Bamboo Forest	25° 34′ 03.0″	97° 46′ 38.9″	535 m	
63	Mada-Taung,Bentbane-near Mayhka River	Bamboo Forest	25° 41′ 34.4″	97° 37′ 09.8″	251 m	
64	59 miles	Bamboo Forest	25° 42' 49.9"	97° 50' 42.3″	246 m	
65	59 miles	Bamboo Forest	25° 42' 47.7"	97° 50' 49.3″	231 m	
66	59 miles	Bamboo Forest	25° 43' 36.4"	97° 52' 07.0″	240 m	
67	Mayhka River	Bamboo Forest	25° 40′ 24.7″	97° 09′ 35.1″	471 m	
68	Bentbane,beside Mayhka River	Banana Forest	25° 36′ 01.9″	97° 47′ 04.3″	138 m	
69	Bentbane,beside Mayhka River	Banana Forest	25° 36′ 01.7″	97° 47′ 04.0″	183 m	
70	Bentbane,beside Mayhka River	Banana Forest	25° 40′ 59.8″	97° 36′ 54.9″	220 m	
71	Bentbane,beside Mayhka River	Citrus plantation	25° 33′ 58.8″	97° 48′ 03.3″	223 m	
72	Bentbane,beside Mayhka River	Citrus plantation	26° 04' 55.8"	98° 12' 14.9″	362 m	
No.	**Locality**	**Vegatation Type**	**Latitude**	**Longitude**	**Altitude**	**Notes**

73	Bentbane,beside Mayhka River	Rubber Plantation	25° 35′ 19.5″	97° 46′ 43.1″	360 m	Special Region II, 2023.431 hectare
74	Bentbane,beside Mayhka River	See-ohn Plantation	25° 34′ 42.5″	97° 48′ 16.5″	176 m	
75	Bentbane,beside Mayhka River	Grass land	25° 41′ 36.5″	97° 36′ 35.9″	159 m	*Phragmites* sp., *Chrysopogon aciculatus*
76	Bentbane,beside Mayhka River	Grass land	25° 41′ 29.1″	97° 36′ 38.6″	164 m	
77	Bentbane,beside Mayhka River	Rice field	25° 21′ 48.9″	97° 36′ 38.4″	150 m	5 or 3 years rotation clycle is needed for one shift cultivation
78	Along the Malihka River	(River Bank)	25° 52′ 34.0″	97° 31′ 19″	271 m	Shrub layer is dominated by *Homonoia riparia, Rhododendron sp. & Euphorbiaceae.* Herb layer is dominated by *Stenoloma chusanum, Viola acuminata &Youngia japonica.*
79	Bentbane,beside Mayhka River	Shifting Cultivation	25° 36′ 01.9″	97° 47′ 04.3″	242 m	*Brassica* sp.
80	Bentbane,beside Mayhka River	Shifting Cultivation	25° 41′ 43.4″	97° 36′ 34.4″	243 m	
81	Bentbane,beside Mayhka River	Shifting Cultivation	25° 39′ 28.6″	97° 53′ 43.3″	244 m	

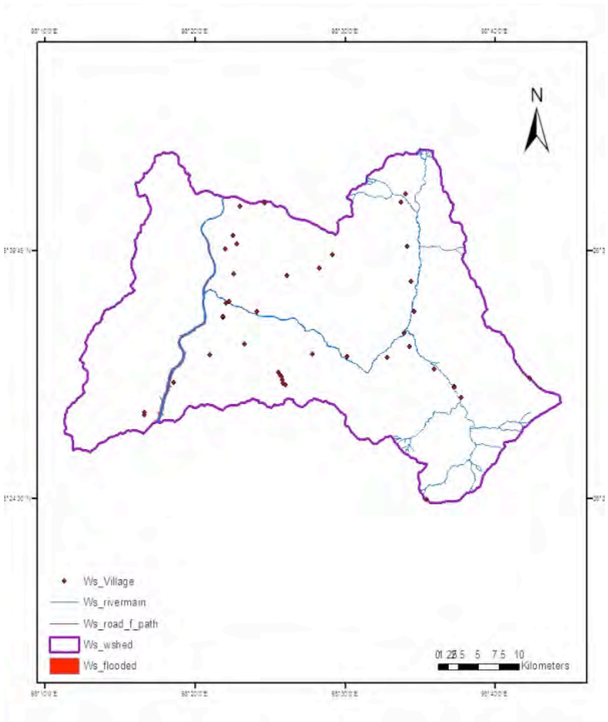
Location map of study areas



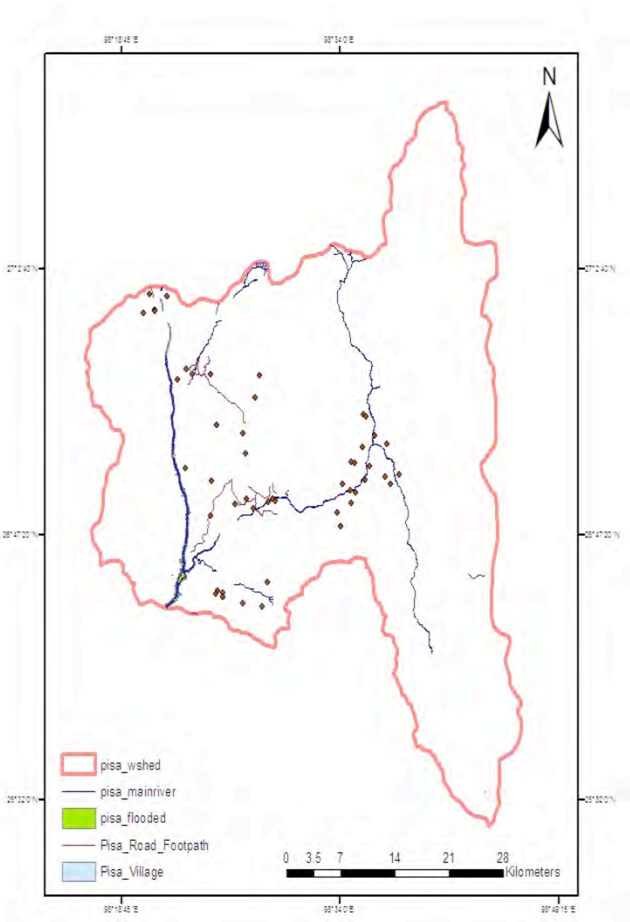
Map - Yenam Area



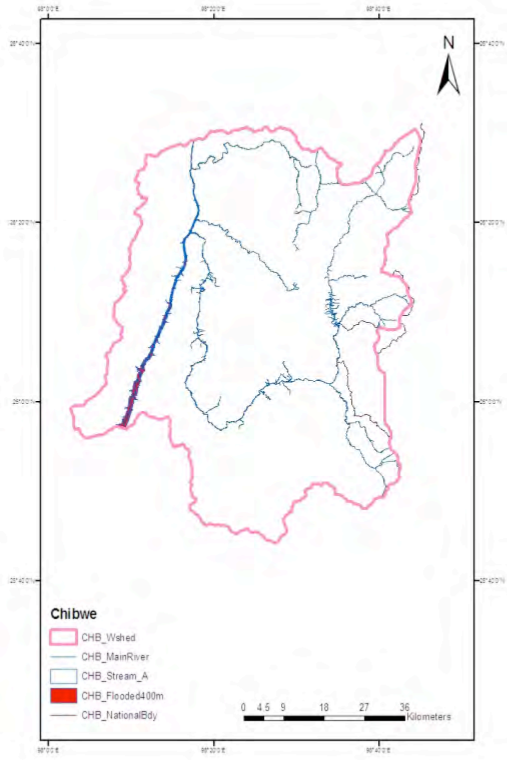
Map – Khaunglanhpu Area



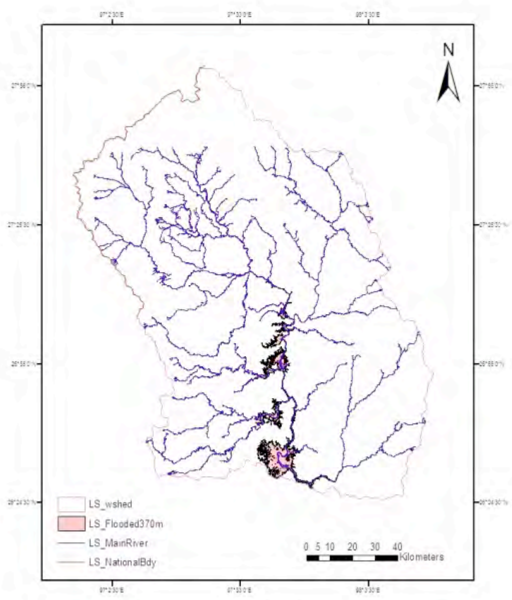
Map - Wusok Area



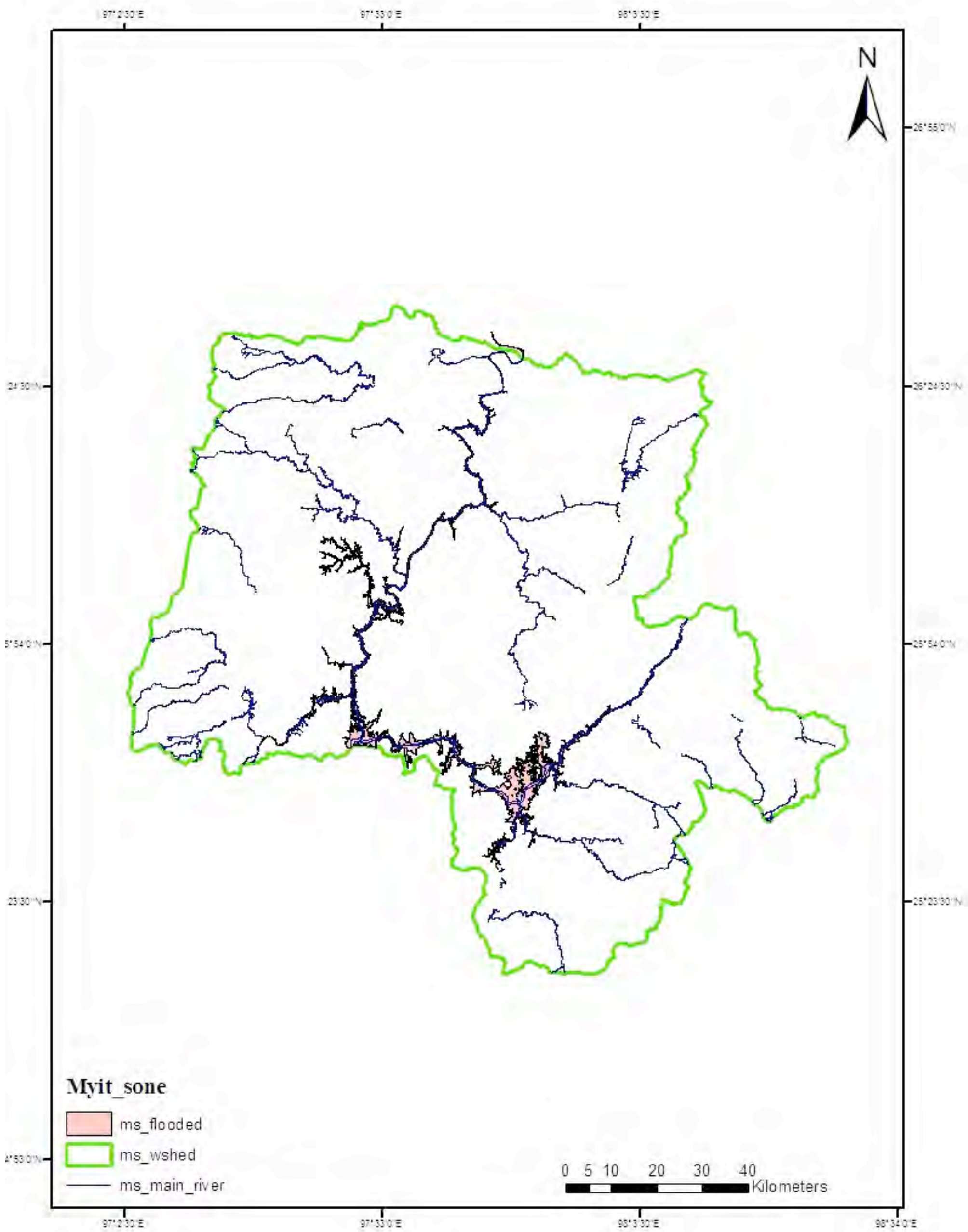
Map - Pisa Area



Map - Chibwe Area



Map – Lasa Area



Map – Myitsone Area

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Plate – 36 Secondary forest in Myitsone

Flora Ecology Report

Chapter I

1. Myitsone Dam

1.1. General Introduction

The northern part of Myanmar lies in four WWF Eco-region namely East-Hamalayan alpine shrub/meadow, Mizoram-Manipur-Kachin moist evergreen forests, Northern Triangle temperate forest. The Kachin State is also located within two priority corridor, namely Northern Mountain Forest Complex and Upper Chindwin lowlands for conservation investment in Myanmar (Tordoff et. al., 2004). This large conservation area including Pidaung Wildlife Sanctuary (W.S), Khakaborazi National Park, Indawgyi W.S, Hukaung Valley W.S, Hukaung Valley W.S (Extension), Hpongan Razi W.S and Bumphabum W.S, are one of the biodiversity hotspots and is nationally essential, regionally significant and globally outstanding. Kachin State is one of the most interesting botanical and zoological natural sanctuaries in Southeast Asia. The state is well known for rich biodiversity and it has a wealth of abundant valuable natural resources (Naw, L.B.2007).

Vegetation ecology includes the investigation of species composition and sociological interaction of species in communities (Mueller-Dombois and Ellenberg, 1974). The structural property of a community is the quantitative relationship in between the species growing around. The quantitative study of vegetation is called phytosociology and its principal aim is to describe the vegetation, explain or predict its pattern and classify it in a meaningful way (Ilorka and Khatri, 2003). It indicates species diversity which determines the distribution of individuals among the species in a particular habitat. A sound understanding of species diversity is necessary for appropriate conservation and restoration of the biological diversity.

Specific community types are often named by describing the particular plants in that community. However, plant communities are often too heterogeneous to be described by a single dominant species or by listing all the species present. Thus, communities are often described by the species or genera that are determined to be the most dominant in the community. The dominant species can be quantified by calculating a statistic known as 'importance value" (Smith and Smith, 2001). Once importance values are determined, a specific community can be described in terms of its most important species. Importance values can be calculated after the size and number of individual trees of the various species is measured. The trees with the highest importance values will be those that exist in the greatest number or are of the greatest size, these are the trees that may have the greatest effect on the community.

What is the value of knowing the physical structure of a plant community? It can tell us something about the biological structure of the community, something about interactions between species and how the community functions in gathering energy and cycling nutrients. The structure of the plant community determines the animals that can be present, so is of use in wildlife management. Studies of plant communities over the course of many years have allowed biologists to understand ecological succession, the replacement of species by other species over time (and therefore the replacement of communities over time). In addition to dominance and importance, community structure includes characteristics such as the number of species, and the relative abundance of each species (Krebs, 1985). The number of species is known as the **species richness;** it is simply the number of different species of organisms in a community. Measuring the relative abundance of species, **species heterogeneity**, or species diversity is a bit more complex.

Information on the distribution and abundance of tree species is of primary importance in the planning and implementation of biodiversity conservation. Tree species diversity in the study area varies greatly from place to place mainly due to variation in biogeography, habitat and disturbance. On account of their economic exploitation, evergreen forests are most threatened ecosystems in Kachin State. But so far no efforts have been made to quantify the tree species parameters in this study area. The present study is an attempt to record structural composition and diversity of tree species along the altitudinal gradients in Myitsone area.

1.2. Objectives

The main objectives of the present study are to record the floristic composition and forest structure of each dam site, to evaluate the forest by quantitative analysis, to clarify the tree species diversity, to highlight the impact of dam on forest ecosystem, to formulate appropriate conservation and management strategies for terrestrial ecosystem.

1.3. Study area

The location of Myitsone area is (25° 45′ N, 97° 45′ E) in Myitkyina District, Kachin State, which is situated in junction of the N' mai Hka River and the Malihka River. The N' mai Hka River and the Malihka river, their rivulets and the Tanaikha river flow into the Ayeyarwaddy river. From biodiversity standpoint, the study area lies WWF Eco-regions of Mizoram-Manipur-Kachin moist evergreen forest. A detailed map of the study area is given in figure (1).

1.3.1. Climate

There are three distinct seasons; a cool and dry season between November and February, warm and dry season between March and May, warm and wet season between June and October, and there is usually no rain in December and January. The annual rainfall during rainy season is rather uniform. The monthly mean rainfall is from 569 mm (max.) to 0 mm (min.). The highest mean temperature is 28.6° C and the lowest 18.1° C. The monthly mean humidity ranges from 68% to 62%. The monthly mean wind speed and direction were recorded for the year of 2008. The highest wind speed is 2.4 m.p.h and the lowest 0.5 m.p.h. in this study area.

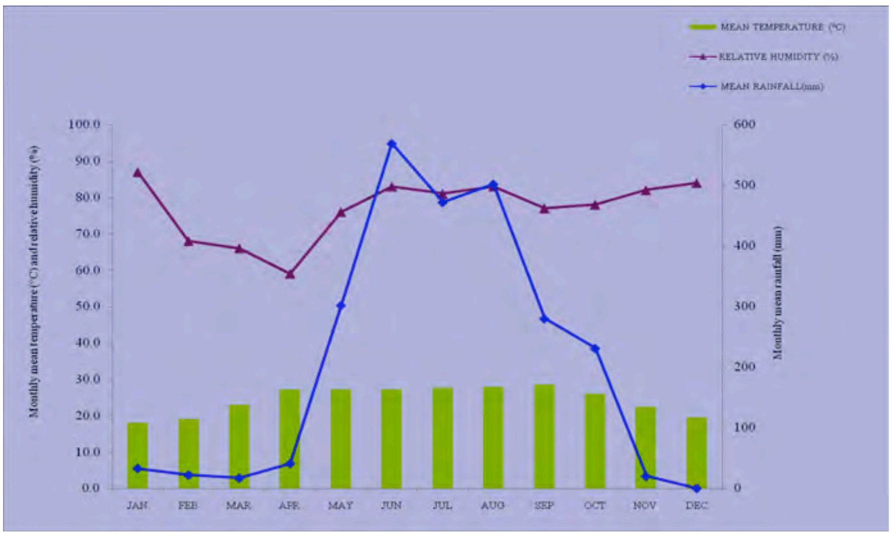


Figure (2) Monthly Mean Rainfall, Temperature and Humidity (2008)

1.4 Methodology

1.4.1. Data collection

To clarify the tree species composition and their distribution, twenty five quadrats (20x20 m each) were set up and observed in the flooded area of Myitsone dam site. The spatial location (latitude, longitude and altitude) of each quadrat was collected using a Global Positioning System (GPS). Care has been taken to cover different elevation, slope, aspects, drainage density, rainfall and temperature gradients to study overall spectrum of tree species diversity. Samples were taken for almost all individuals ≥3cm diameter at breast height (DBH). The families were identified by using key to the families of the flowering plants, issued by Department of Botany, Yangon University (1994). Specimen identification was performed with the use of literatures by Backer *et al.,* 1963, and Kress *et al*. 2003 and confirmed at Herbarium in Department of Botany, University of Yangon, where all materials had been mounted for herbarium sheets and deposited.

1.4.2. Data analysis

The field data collected was analyzed for number of species, stand density (trees) per hectare, basal area per hectare. Quantitative analysis of dominance and their relative values of frequency, density and basal area were calculated and summed to get Importance Value Index. Population structure of tree species were analyzed across fixed DBH classes. Species and their corresponding individuals were proportionately analyzed by height class intervals. Diversity statistics applied to the data, generated in this study were calculated using the software package; Species Diversity & Richness IV (SDR) for window 2007.

1.4.3. Participants

U Nyo Maung, Dr Myint Aung, Dr Win Myint, Dr Kalayar Lu, Daw Thin Thin Su, Daw Khin Swe Lwin, Daw Khin Khin Soe, U Tayzar Aung, and U Nay Phyo Aung.

1.5. Results

1.5.1. Forest composition

In the twenty five sampling plots (1ha), total number of species with DBH ≥3cm was 231 species; of which 61 species are under identification. The dominant families of tree species were Euphorbiaceae (14 species), Lauraceae (12 species), Moraceae (11 species), Fagaceae (11 species), Anacardiaceae (9 species), Verbenaceae (8 species), Meliaceae (7 species), Dipterocarpaceae (6 species), Rubiaceae (6 species), Annonaceae (5 species), Lythraceae (5 species) Figure (3). The main vegetation types discovered in Myitsone Dam site can be grouped into five formations; low land evergreen forest, oak forest, lowland secondary forest, bamboo forest, and grass land. In some disturbed sites, wild banana and bamboo can be seen as in patches. In low land evergreen forests, *Dipterocarpus turbinatus,* and *D. obtusifolious* occupied mostly in crown cover and in some places *Baccurea sapida, Chisocheton siamensis,* and *Dracotonmelon* sp. are mixed with them. The ground cover is dominated by *Pronephrium triphyllum, Begonia roxburghii*. Oak forest mainly composed of *Fagus crenata, F.* sp., *Castanopsis diversifolia, C. indica, C. tribuloides, C.* spp. (chestnuts). The ground cover of Oak forest is dominated by *Gnetum* spp., *Molineria capitulata* (Kywet-malut), and *Psychotria* sp. In the lowland secondary forest, *Gnetum* sp., *Piper* sp., *Commelina* sp., *Selaginella* sp. and *Phrynium capitatum* are occupied in most places. In the bamboo forest *Dendrocalamus hamiltonii* Nees (Wabo Myatsan), *D. longistathus* mainly occur.

D. giganteus Munro (Wabowa), *Cephalostachyum pallidum* Munro (Tinkhawa), *Pseudostachyum* sp. (Wanibar), and *Bambusa londispiculata* Gamble are mixed in the area. *Phragmites* sp., and *Chrysopogon aciculatus* are commonly occur in grass land.

The species area curves of the investigated stands are shown in the figure (4). The species area curves, which express the number of species in relation to change in area of habitat, not only to consider the minimum representative area but also to detect the habitat diversity within the survey area (Fangliang He and Pierre Legendre, 1996). The trend of species area curve showed tendency towards flattening. Therefore the sample areas can be said to be sufficient as a minimum representative area for the study.

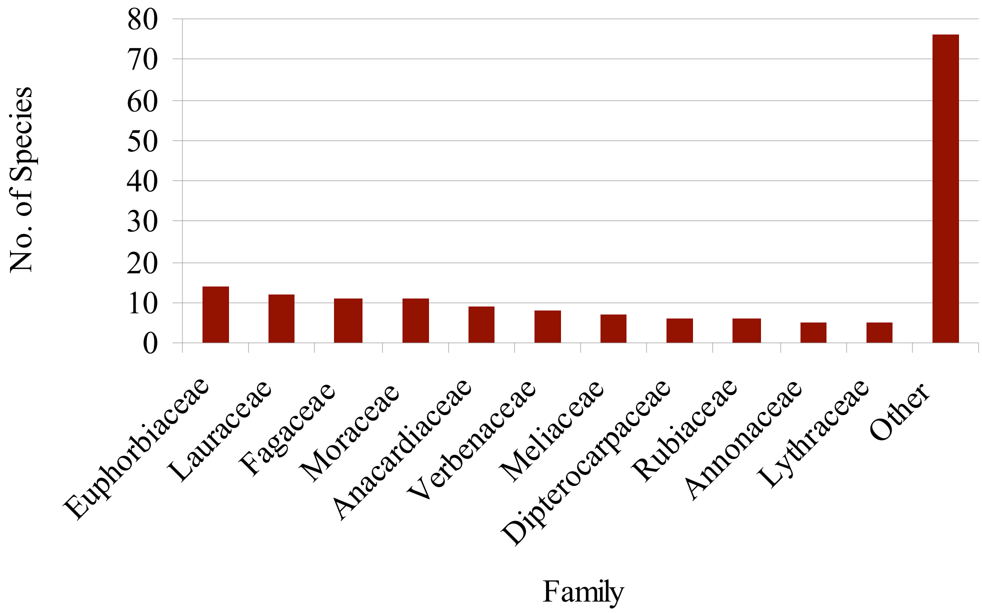


Figure (3) Ranking of dominant family by number of species composition

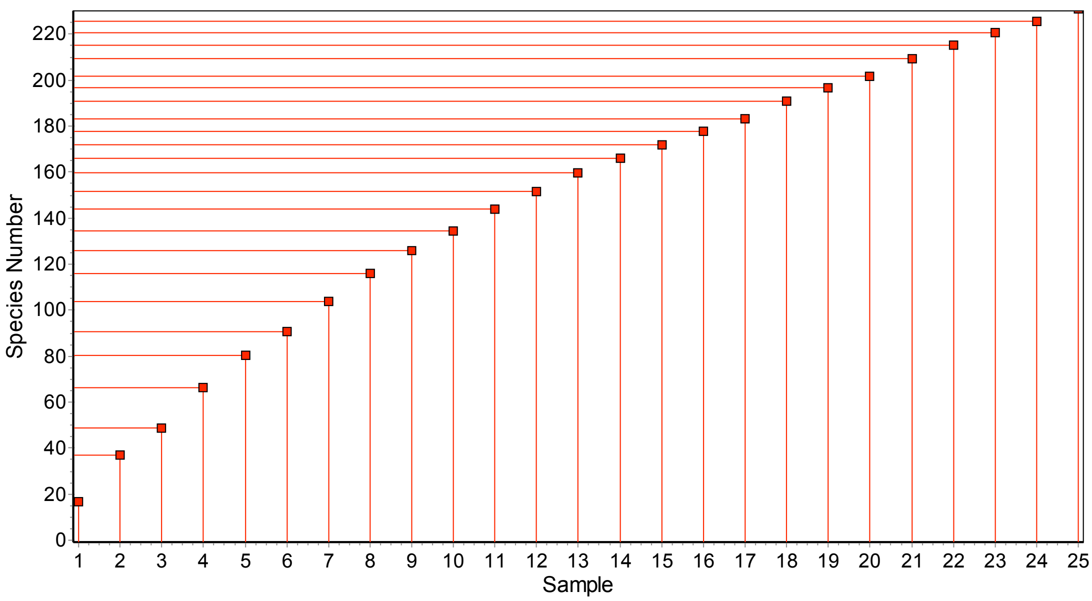


Figure (4) Plot of species accumulation in the Myitsone Dam Site

1.5.2. Important Value Index (IVI)

Ranking of ecological significance by IVI of tree species in the study area are given in appendix (1). The tree layer in the study area is dominated by *Dracontomelon* sp. with the highest IVI of 14.33%, the second most dominant species is *Fagus crenata* Blume (IVI = 10.53%) and *Dipterocarpus obtusifolius* Teysm.ex.Mig. (IVI= 9.43%) is the third. The number of species greater than 5% IVI value was only nine species (Figure 5). Those nine species could be considered as ecological indicator species of Myitsone area. Representation of 231 species and the high proportion of dominant species in the study area can directly be attributed to the favorable climatic and edaphic condition.

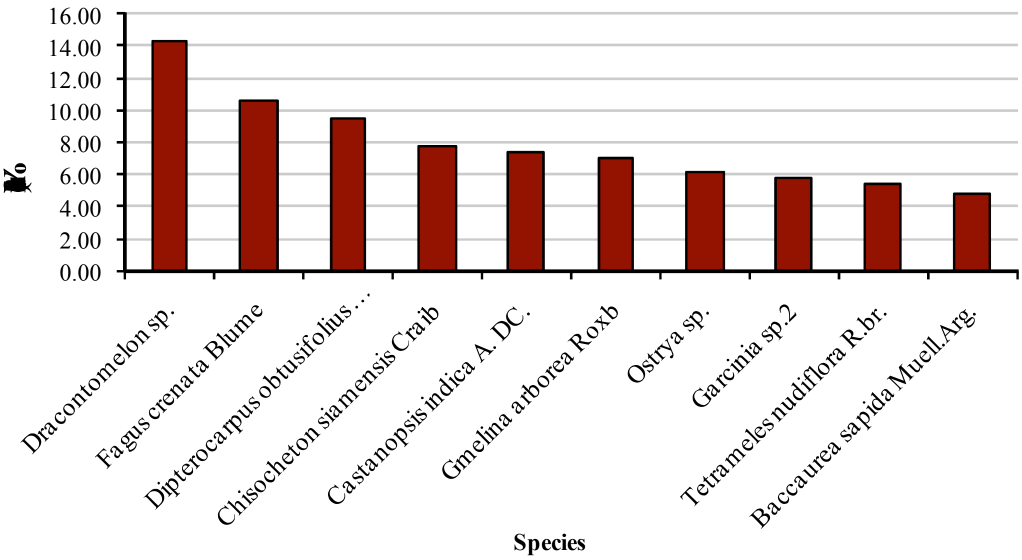


Figure (5) Important Value Index of top ten species in the Myitsone Dam Site

1.5.3. Species distribution by frequency classes

In order to clarify the homogeneity or heterogeneity of the floristic distribution in the study area, species distribution by frequency classes was examined. According to the outcome of frequency chart, 99.56% of the total number of species was in lower frequency classes, A and B, while low value was observed only in higher frequency class D (Table 1, Figure 6). It indicates that the forest in Myitsone area is floristically heterogeneous according to Lamprecht (1989). The species which fall in high frequency class D was *Chisocheton siamensis* Craib. The species can be considered as the most common species in the Myitsone area.

Table (1) Species distribution by frequency classes ≥3cm

Frequency Class	Frequency Range	No of Species	% of Total Species Frequency Distribution
A	1-20 %	216	93.51
B	21-40 %	14	6.06
C	41-60 %	0	0
D	61-80 %	1	0.43
E	81-100 %	0	0

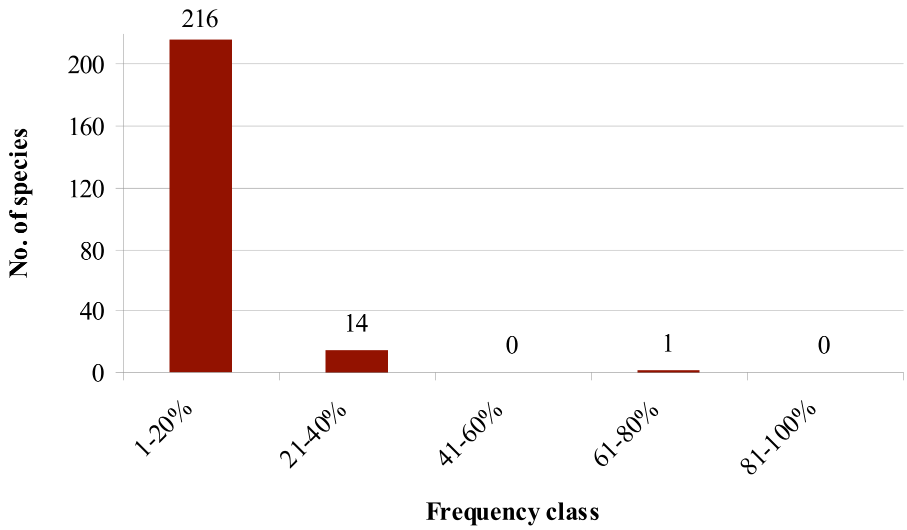


Figure (6) Species distribution by frequency classes ≥3cm

1.5.4. Diversity indices and evenness

Among the different measurement of species diversity indices, the floristic diversity of the Myitsone area was analyzed using the Shannon Wiener index (H), Simpsons index (D), Brillouin (D), Shannon Maximum and minimum evenness (E), Brillouin (E) because these indices not only take taxa richness into account but also depend on the relative distribution of individuals. The value of diversity indices and evenness indices of individual sample plot and all sample indices are shown in table (2) and (3). According to the result, though the diversity indices of individual sample plot are not too high, all sample index are relatively high. Diversity value for all sample index of Shannon Wiener index (H) is 4.749, Simpsons index (D) is 73.07, Brillouin (D) is 4.512. Presence of high species diversity and richness indicates uniqueness and potentiality of study area for conservation of ecosystem in totality.

Table (3) Species diversity indices in the Myitsone Dam site

Sample	Shannon Wiener H	Variance H	Simpsons Index (D)	Brillouin (D)
MS 1	3.056	0.018	19.45	2.501
MS 2	2.560	0.015	9.45	2.225
MS 3	2.175	0.019	6.19	1.869
MS 4	2.086	0.035	4.94	1.723
MS 5	2.576	0.009	12.95	2.222
MS 6	2.901	0.017	12.41	2.459
MS 7	2.179	0.024	5.34	1.868
MS 8	2.226	0.020	6.66	1.897
MS 9	2.932	0.009	21.85	2.469
MS 10	2.842	0.013	15.38	2.402
MS 11	2.223	0.032	5.67	1.843
MS 12	2.770	0.015	12.38	2.351
MS 13	2.562	0.019	12.07	2.113
MS 14	2.340	0.016	10.65	1.937
MS 15	1.317	0.050	2.68	1.049
MS 16	1.994	0.039	3.91	1.647
MS 17	3.017	0.015	26.05	2.423
MS 18	2.624	0.014	11.51	2.249
MS 19	2.715	0.010	13.14	2.373
MS 20	3.215	0.013	19.37	2.717
MS 21	3.148	0.011	12.77	2.78
MS 22	2.195	0.019	8.17	1.825
MS 23	2.789	0.015	21.30	2.239
MS 24	1.517	0.012	4.24	1.328
MS 25	2.401	0.019	10.90	1.972
All Sample Index	4.749		73.07	4.512
Jackknife Std Error	0.098		11.55	0.09697

Table (3) Evenness indices in the Myitsone Dam site

Sample	Shannon Maximum	Shannon Minimium	Simpsons Evenness (E)	Brillouin (E)
MS 1	3.401	2.377	0.648	0.9005
MS 2	3.135	1.398	0.411	0.8161
MS 3	2.639	1.122	0.442	0.8176
MS 4	2.773	1.49	0.309	0.7413
MS 5	2.833	1.287	0.762	0.9113
MS 6	3.401	1.912	0.414	0.8548
MS 7	2.89	1.285	0.297	0.7473
MS 8	2.708	1.239	0.444	0.8179
MS 9	3.135	1.791	0.950	0.9419
MS 10	3.135	1.726	0.669	0.9093
MS 11	2.89	1.581	0.315	0.7613
MS 12	3.178	1.7	0.516	0.872
MS 13	2.89	1.733	0.671	0.8907
MS 14	2.565	1.408	0.819	0.9113
MS 15	1.946	1.9811	0.383	0.6572
MS 16	2.773	1.423	0.245	0.7034
MS 17	3.219	2..386	1.042	0.9459
MS 18	3.045	1.487	0.548	0.8622
MS 19	3.091	1.336	0.597	0.8796
MS 20	3.584	2.161	0.538	0.9013
MS 21	3.714	1.616	0.312	0.8472
MS 22	2.485	1.296	0.681	0.8813
MS 23	2.944	2.061	1.121	0.9473
MS 24	1.792	0.5779	0.707	0.8425
MS 25	2.708	1.6	0.727	0.8908
All Sample Index	5.442	1.273	0.316	0.8755
Jackknife Std Error	0.07223	0.08403	0.045	0.01204

1.5.5. Forest structure

Stem density of ≥3cm was 1486 ha^{-1} and basal area was 60.35 m^2/ha in the Myitsone dam site Table (4). Among the 25 sample plots studies, 231 tree species were recorded. Only one individual of 73 species were found and these species were considered as unique species.

The 10 most abundance species in terms of basal area occupied 49.45% of the total, of which *Dracotomelon* sp. was the most dominant species in the study area with 11.24%, followed by *Dipterocarpus obtusifolius* 6.74%, *Gmelina arborea* 5.31%, *Fagus crenata* 4.36%, *Tetrameles* sp. 4.27%, *Semecarpus* sp. 4.07%, *Castanopsis indica* 4.05%, *Tetrameles nudiflora* 4.02%, *Lithocarpus* sp. (3) 3.11%, and UN (61) 2.23%of the total basal area (Figure (7)).

Table (4) Consolidated detail of species inventory in the Myitsone Dam site

Description	Results
No. of Sample points	25
No. of tree speciies	231
Density (stem/ha)	1486
Basal area (m2/ha)	60.35
Total no. of unique species	73

The distribution of the basal area across DBH interval classes reveals the dominance of small stemmed individuals in the study area. The population structure by DBH class decreased from class to class with a steeper gradient in lower DBH classes and with a gentle slope in higher classes Figure (8) and Table (5). Out of total number of stems inventoried, 55.38% of stems were accumulated in the 3-30cm DBH class, 18.78% of stems in the 30-60cm, 11.64% in the 60-90cm, 5.59% in the 90-120cm, 3.23% in 120-150cm, only 5.28% occurs I 150-480cm. The highest DBH was measured in the case of *Gmelina arborea* (470cm), *Dracotomelon* sp. (430cm), *Tetrameles nudiflora* (380cm), *Dracotomelon* sp. (350cm).

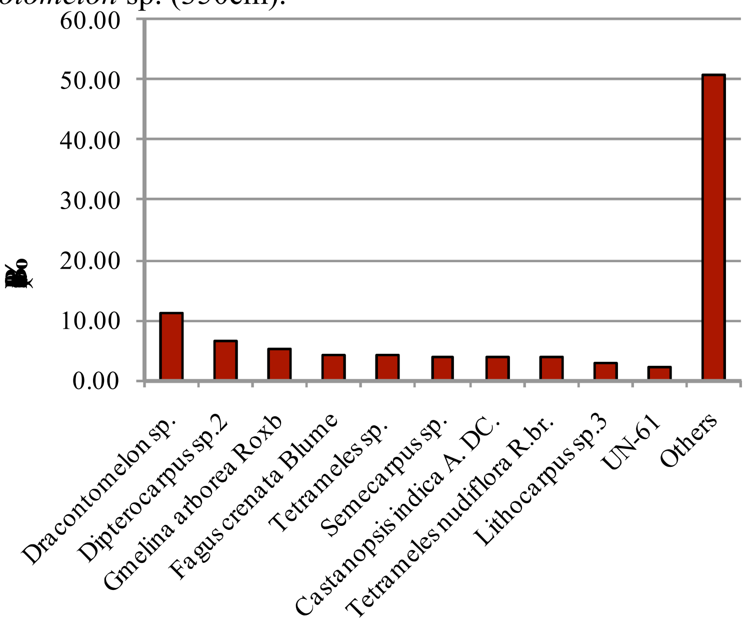


Figure (7) Ranking of relative basal area by species in the Myitsone Dam site

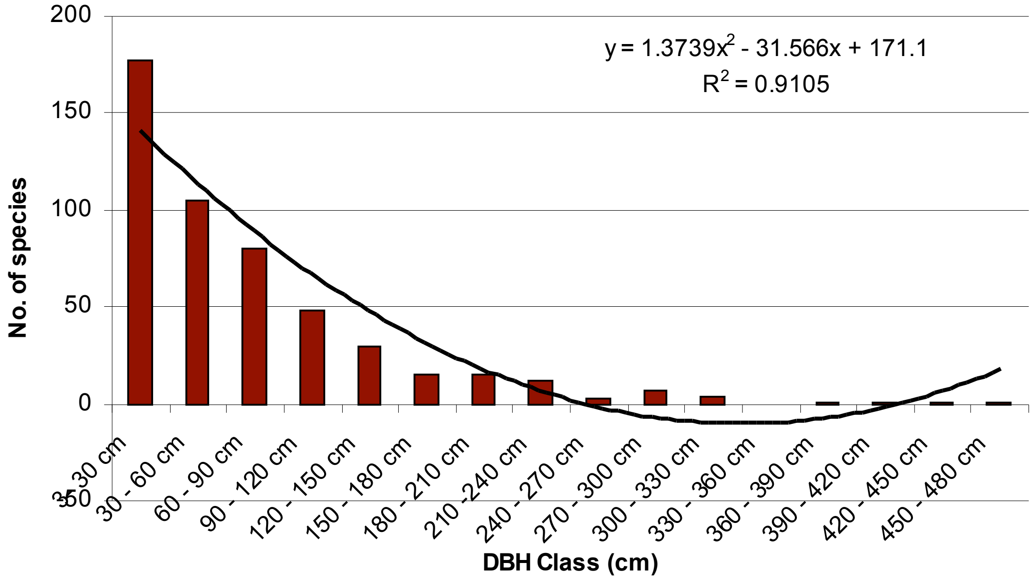


Figure (8) Species distribution by DBH classes

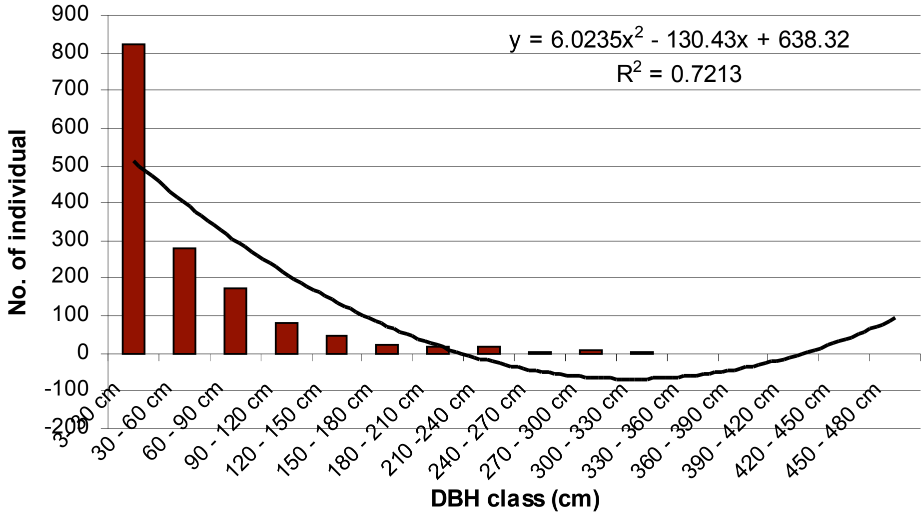


Figure (9) Population distribution by DBH classes

Table (5) Population density of tree species across DBH class interval

DBH Classes	No. of species	% of species	Total number of individual	% of total species	% of total individual
3-30 cm	177	76.29	823	35.40	55.38
30-60 cm	105	45.26	279	21.00	18.78
60-90 cm	80	34.48	173	16.00	11.64
90-120 cm	48	20.69	83	9.60	5.59
120-150 cm	30	12.93	48	6.00	3.23
150-180 cm	15	6.47	25	3.00	1.68
180-210 cm	15	6.47	19	3.00	1.28
210-240 cm	12	5.17	17	2.4	1.14
240-270 cm	3	1.29	3	0.6	0.20
270-300 cm	7	3.02	7	1.4	0.47
300-330 cm	4	1.72	5	0.8	0.34
330-360 cm	-	-	-	-	-
360-390 cm	1	0.43	1	0.2	0.07
390-420 cm	1	0.43	1	0.43	0.07
420-450 cm	1	0.43	1	0.43	0.07
450-480 cm	1	0.43	1	0.43	0.07
Total	**232**		**1486**	**100.00**	**100.00**

Tree distribution by height intervals shows that among the total number of 1486 individuals, 656 individuals (44.15%) belong to 3-10m category, followed by 494 individuals (33.24%) in 10-17m, 225 individuals (15.14%) in 17-24m, and 96 individuals (6.46%) in 24-31m. The height class of >31m includes only (0.47%) of total individuals (Table (6)). <3m high trees of 8 individuals (0.54%) infer natural regeneration is poor or frequent disturbance on ground cover plant. The population structure by height classes in the Myitsone area is highest in 3-10m class and gradually decreases to higher class (Figure 10 and 11). The tallest individual trees were *Dipterocarpus obtusifolius* (35m), *Dracontomelon* sp. (35m), *Duabanga grandiflora* (35m), *Cedrela toona* (35m), *Ficus* sp.3 (33m), and *Phoebe* sp.2 (33m). Total picture of height class shows that, 44.68% belong to <3-10m category, 48.38% in 10-24m, and 6.93% in 24->31m. The overall population structure indicates that study area represents mature stand.

Table (6) Population density of tree species across height class interval

Height classes	No. of species	Total number of individual	% of total species	% of total individual
< 3m		8	1.58	0.54
3-10 m		656	37.92	44.15
10-17 m		494	31.15	33.24
17-24 m		225	19.86	15.14
24-31 m		96	8.13	6.46
> 31 m		7	1.35	0.47
Total		**1486**	**100.00**	**100.00**

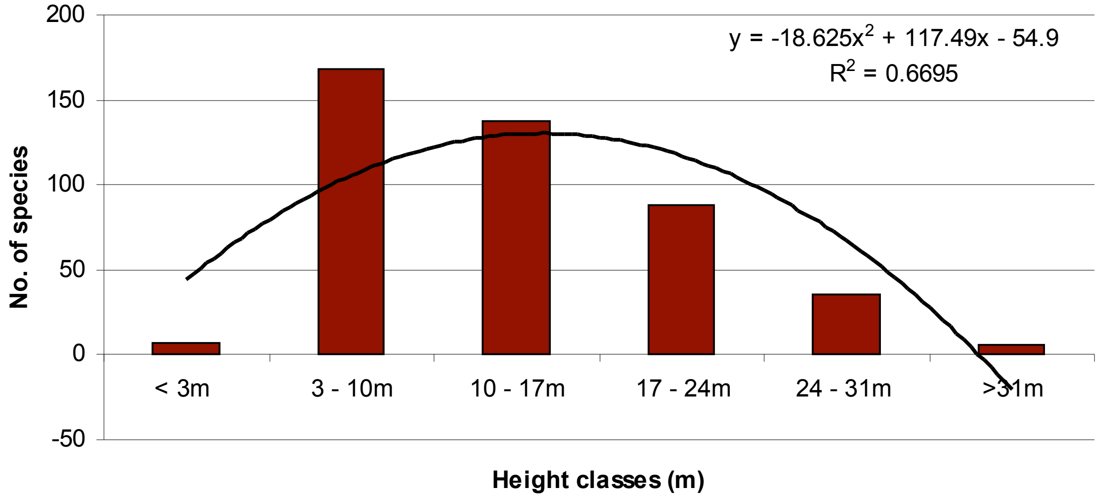


Figure (10) Species distribution by height classes

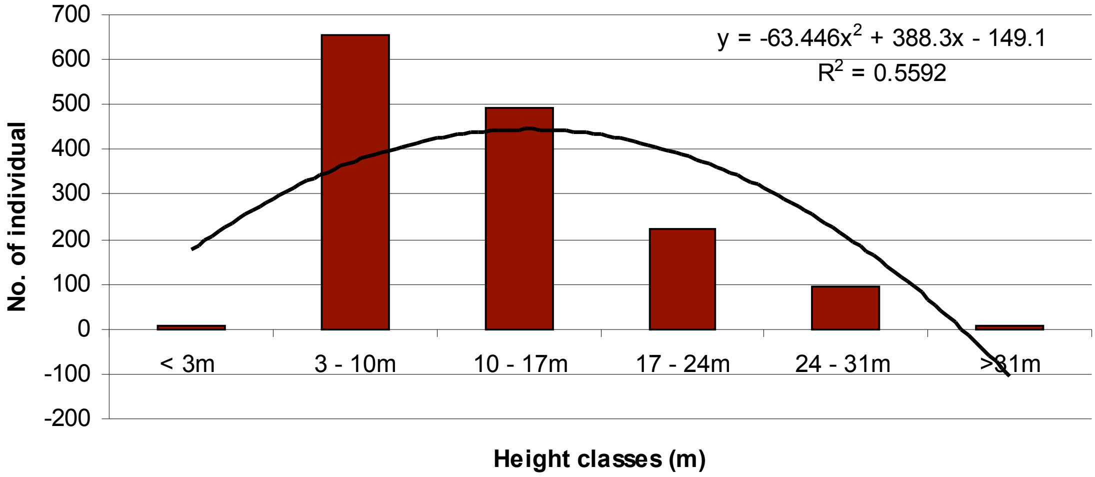


Figure (11) Population distribution by DBH classes

1.6. Discussion and Conclusion

A total of 231 tree species representing 176 genera and 48 families were analyzed in the study area. The main vegetation types discovered in Myitsone Dam site can be grouped into five formations, i.e. low land evergreen forest, oak forest, lowland secondary forest, bamboo forest, and grass land. In some disturbed sites, wild banana and some bushes can be seen in patches.

The important value index is imperative to compare the ecological significance of species (Lamprecht, 1989). It indicates the extent of dominance of a species in the structure of a forest stand (Curtis and McIntosh, 1950). It is stated that species with the greatest important value are the leading dominants of the forest. Accordingly, the ten leading dominants in study area were *Dracontomelon* sp, *Fagus crenata, Dipterocarpus obtusifolius, Chisocheton siamensis, Castanopsis indica, Gmelina arborea, Ostrya* sp., *Garcinia* sp.2, *Tetrameles nudiflora,* and *Baccaurea sapida* contributing highest IVI value (14.33, 10.53, 9.43, 7.73, 7.34, 7.06, 6.12, 5.8, 5.43, 4.84) respectively. Those tree species could be considered as ecological indicator species of the study area.

In mature site, the largest trees can reach up to >31m in height while the main canopy is 24-31m with well developed understoreys. The canopy of the forest is more or less close, but in some disturbed sites, the canopy is open and the estimated height was probably not more than 15m, including stunted and cutover regrowth of the tree species.

Diversity indices are commonly used to assess the state of an ecosystem (e.g., as a criterion for conservation evaluation), with high diversity generally being considered a desirable property in a community or ecosystem. Presence of high species diversity and richness indicates that uniqueness and potentiality of Myitsone area for conservation of ecosystem in totality.

The forest structures in the study area show all types of disturbance. The surrounding Myitsone area has insufficient protection status that allows the exploitation of natural resources; such as logging, shifting cultivation, hunting and gold mining. Logging and gold mining are the major destructive force and one of the influencing factors for forest structure and surrounding ecosystem.

The following species that recorded in the study area assessed in IUCN Red list as follows;

No.	Botanical Name	Family	Red Lists	Year
1.	*Aquilaria malaccensis* Lam.	Thymeliaceae	Vu Alcd	IUCN-2000
2.	*Caesalpinia sappan* L.	Caesalpiniaceae	Lower Risk/ Least concern	IUCN-2009
3.	*Dipterocarpus turbinatus* Gaertn.f.	Dipterocarpaceae	RC Alcd + 2cd	IUCN-2000
4.	*Holarrhena pubescens* Wall. ex G.Don	Apocynaceae	EX	IUCN-2000
5.	*Shorea assamica* Dyer	Dipterocarpaceae	Cr Alcd, B1 + 2c	IUCN-2000
6.	*Elaeocarpus prunifolius* Wall. Ex C.Muell.	Elaeocarpaceae	VU B1 + 2c	IUCN-2000

1.7. Recommendation

1. Infrastructure development as well as new access road from Myitkyina to Putao should be carried out with great care and it should have minimal impacts on environment, and social and cultural aspects of the indigenous people.
2. Extension of the existing national park and wildlife sanctuaries should be implemented, to balance the forest ecosystem services loss due to dam construction.
3. In addition, one or more compensatory protected area should be established and managed under the project.

The remaining forest cover should be systematically managed and conserved since the action not only maintain the watershed area but also support the biodiversity rich ecosystem.

Appendix (1) Ranking of Important Value Index (IVI) in the Myitsone Area

No.	Species Name	R.D. %	R.D.m %	R.F %	IVI %
1	*Dracontomelon* sp.	1.48	11.245	1.60	14.33
2	*Fagus crenata* Blume	4.17	4.362	2.00	10.53
3	*Dipterocarpus obtusifolius* Teysm.ex.Mig.	2.29	6.743	0.40	9.43
4	*Chisocheton siamensis* Craib	4.04	0.894	2.80	7.73
5	*Castanopsis indica* A. DC.	2.29	4.053	1.00	7.34
6	*Gmelina arborea* Roxb	0.74	5.318	1.00	7.06
7	*Ostrya* sp.	4.04	0.085	2.00	6.12
8	*Garcinia* sp.2	2.29	2.114	1.40	5.80
9	*Tetrameles nudiflora* R.br.	0.40	4.023	1.00	5.43
10	*Baccaurea sapida* Muell.Arg.	2.15	0.691	2.00	4.84
11	*Tetrameles* sp.	0.20	4.277	0.20	4.68
12	*Mallotus* sp.	1.28	2.199	1.20	4.68
13	*Semecarpus* sp.	0.20	4.079	0.20	4.48
14	*Myristica angustifolia* Roxb.	3.43	0.001	1.00	4.43
15	*Lithocarpus* sp.3	0.67	3.111	0.20	3.98
16	*Mesua nervosa* Planch.&Triana	1.68	0.002	2.00	3.68
17	*Wisteria* sp.	1.88	0.813	0.80	3.50
18	*Bischofia javanica* Blume	0.74	2.049	0.60	3.39
19	*Cinnamomum* sp.	1.28	0.302	1.80	3.38
20	*Cananga* sp.	1.68	0.747	0.80	3.23
21	*Machilus* sp.1	0.74	2.064	0.40	3.20
22	*Symplocos* sp.1	1.95	0.007	1.20	3.16
23	*Ficus* sp.1	0.87	0.731	1.40	3.01
24	*Arenga* sp.	1.08	1.372	0.40	2.85
25	*Diospyros* sp.	1.01	0.226	1.60	2.84
26	*Lithocarpus* sp. 1	1.55	0.211	1.00	2.76
27	*Albizia lucidior* (Steud.) Nielsen	0.81	1.343	0.60	2.75
28	*Mallotus paniculatus* Muell. Arg.	2.42	0.004	0.20	2.63
29	*Litsea* sp.1	1.82	0.009	0.80	2.63
30	*Leea* sp.	1.28	0.051	1.20	2.53
31	UN-61	0.07	2.233	0.20	2.50
32	*Lithocarpus* sp. 2	1.01	0.466	1.00	2.48
33	*Glochidion* sp.	1.41	0.182	0.80	2.40
34	*Schima wallichii* (DC.) Korth.	0.61	0.671	1.00	2.28
35	*Castanopsis* sp.1	0.87	0.560	0.80	2.23
36	*Lagerstromia macrophylla* Kurz	0.54	0.885	0.80	2.22
37	*Symplocos* sp.2	0.40	0.866	0.80	2.07
No.	**Species Name**	**R.D. %**	**R.D.m %**	**R.F %**	**IVI %**

38	UN-8	0.61	0.638	0.80	2.04
39	*Alphonsea* sp.	0.67	0.157	1.20	2.03
40	*Shorea* sp.	0.13	1.420	0.40	1.95
41	*Actinodaphane* sp.	0.54	0.605	0.80	1.94
42	UN-59	1.21	0.104	0.60	1.91
43	*Pavetta indica* L.	0.07	1.605	0.20	1.87
44	*Ardisia* sp.	0.61	0.037	1.20	1.84
45	*Ficus* sp. 3	0.13	1.365	0.20	1.70
46	*Stereospermum colaris* (B. -H. ex Dillw.)	0.54	0.156	1.00	1.69
47	*Ziziphus* sp.	0.81	0.082	0.80	1.69
48	*Cedrela toona* Roxb.	0.27	0.757	0.60	1.63
49	*Ficus fistulosa* Reinw.	0.81	0.217	0.60	1.62
50	*Lannea coromandelica* (Houtt.) Merr.	0.20	0.821	0.60	1.62
51	*Fagus* sp.	0.54	0.681	0.40	1.62
52	*Toisusu urbaniana* Seem.	0.13	1.266	0.20	1.60
53	*Drimycarpus racemosus* Hook.f.	0.54	0.253	0.80	1.59
54	*Duabanga grandiflora* (Roxb. ex DC.) Walp.	0.40	0.777	0.40	1.58
55	UN-38	0.20	0.956	0.40	1.56
56	*Swintonia floribunda* Griff.	0.74	0.004	0.80	1.54
57	*Sterculia* sp.	0.61	0.116	0.80	1.52
58	*Pittostoropsis kerii* Craib	0.07	1.218	0.20	1.49
59	*Oroxylum indicum* (L.) Kurz	0.47	0.005	1.00	1.48
60	*Ficus* sp.2	0.61	0.230	0.60	1.44
61	*Pterospermum cinnamonemum* Kurz	0.27	0.561	0.60	1.43
62	*Ostodes paniculata* Blume	0.61	0.201	0.60	1.41
63	*Arenga triandra* Roxb.	0.54	0.013	0.80	1.35
64	*Vitex* sp.	0.34	0.206	0.80	1.34
65	UN-1	0.07	1.034	0.20	1.30
66	UN-13	0.74	0.073	0.40	1.21
67	*Garcinia* sp.1	0.34	0.254	0.60	1.19
68	*Dipterocarpus* sp.3	0.27	0.112	0.80	1.18
69	*Anacardium* sp.	0.13	0.646	0.40	1.18
70	*Micromelum minutum* (G. Forst.) Wight & Arn.	0.07	0.878	0.20	1.15
71	UN-5	0.87	0.062	0.20	1.14
72	*Knema furfuracea* (HK. F.et Th.) Warb.	0.61	0.110	0.40	1.12
73	*Wendlandia tinctoria* DC.	0.87	0.025	0.20	1.10
74	UN-43	0.87	0.006	0.20	1.08
75	*Hibiscus macrophyllus* Roxb.	0.13	0.539	0.40	1.07
76	*Symplocos macrophylla* Wight	0.13	0.698	0.20	1.03
No.	**Species Name**	**R.D. %**	**R.D.m %**	**R.F %**	**IVI %**

77	*Lagerstroemia tomentosa* Presl	0.34	0.094	0.60	1.03
78	UN-46	0.61	0.022	0.40	1.03
79	UN-24	0.20	0.609	0.20	1.01
80	*Syzygium* sp.1	0.40	0.004	0.60	1.01
81	*Shorea obtusa* Wall	0.47	0.132	0.40	1.003
82	*Spondias pinnata* (L.) Kurz.	0.20	0.195	0.60	0.997
83	*Casearia* sp.	0.67	0.121	0.20	0.994
84	UN-25	0.54	0.036	0.40	0.974
85	*Adenantra* sp.	0.47	0.299	0.20	0.970
86	*Duabranga denticulata* Kunth	0.27	0.287	0.40	0.956
87	*Dracaena* sp.	0.54	0.017	0.40	0.955
88	*Aglaia lawii* (Wight) Sald.& Rama.	0.40	0.142	0.40	0.946
89	UN-3	0.74	0.003	0.20	0.943
90	*Dalbergia* sp.	0.34	0.205	0.40	0.942
91	*Phoebe* sp.2	0.54	0.002	0.40	0.941
92	*Ficus hispida* L.f.	0.27	0.233	0.40	0.902
93	*Spondias* sp.	0.27	0.223	0.40	0.893
94	UN-23	0.27	0.221	0.40	0.890
95	*Aralia* sp.	0.40	0.082	0.40	0.885
96	UN-40	0.20	0.274	0.40	0.875
97	*Sterculia lanceolata* Buch-Ham.	0.27	0.001	0.60	0.870
98	*Dipterocarpus* sp.1	0.27	0.199	0.40	0.868
99	*Terminalia chebula* Retz.	0.27	0.190	0.40	0.859
100	UN-45	0.20	0.431	0.20	0.833
101	*Castanopsis* sp.2	0.20	0.209	0.40	0.811
102	*Polyalthia* sp.	0.40	0.000	0.40	0.804
103	*Antidesma* sp.	0.54	0.064	0.20	0.802
104	*Croton joufra* Roxb.	0.34	0.061	0.40	0.797
105	*Vitis* sp.	0.13	0.458	0.20	0.792
106	*Sterculia balanghas* L.	0.07	0.519	0.20	0.786
107	*Litsea* sp.2	0.20	0.370	0.20	0.771
108	*Ficus semicordata* Buch.-Ham. ex J.E. Sm.	0.34	0.034	0.40	0.771
109	UN-14	0.27	0.093	0.40	0.762
110	*Artocarpus lakoocha* Roxb.	0.13	0.223	0.40	0.758
111	*Terminalia* sp.	0.34	0.019	0.40	0.756
112	*Morinda* sp.	0.13	0.211	0.40	0.745
113	*Schefflera* sp.	0.34	0.008	0.40	0.744
114	UN-60	0.27	0.071	0.40	0.740
115	*Meliosma simplicifolia* Walp.	0.27	0.056	0.40	0.725
No.	**Species Name**	**R.D. %**	**R.D.m %**	**R.F %**	**IVI %**

No.	Species Name	R.D. %	R.D.m %	R.F %	IVI %
116	*Syzygium* sp.3	0.47	0.053	0.20	0.724
117	UN-53	0.27	0.027	0.40	0.696
118	*Quercus* sp.	0.47	0.006	0.20	0.678
119	*Schima* sp.	0.20	0.074	0.40	0.676
120	UN-32	0.07	0.391	0.20	0.659
121	*Rapanea* sp.	0.20	0.248	0.20	0.649
122	*Dysoxylum binectariferum* Hook.f.	0.20	0.019	0.40	0.621
123	*Dolichandrone serrulata* Seem.	0.20	0.217	0.20	0.619
124	*Ficus annulata* Bl.	0.13	0.075	0.40	0.610
125	*Garcinia merguensis* Wight	0.20	0.008	0.40	0.610
126	*Knema erratica* (Hk. F & Th.) Sinclair	0.40	0.001	0.20	0.604
127	UN-4	0.13	0.266	0.20	0.601
128	*Mangifera indica L.*	0.07	0.316	0.20	0.583
129	UN-42	0.20	0.176	0.20	0.578
130	*Berrya* sp.	0.34	0.038	0.20	0.575
131	*Streblus* sp.	0.07	0.296	0.20	0.563
132	UN-55	0.13	0.015	0.40	0.550
133	*Chukrasia tabularis* A. Juss Wight & Arn.	0.27	0.078	0.20	0.547
134	*Callicarpa arborea* Roxb.	0.13	0.012	0.40	0.546
135	*Syzygium* sp.2	0.27	0.075	0.20	0.545
136	UN-51	0.13	0.008	0.40	0.542
137	*Alstonia scholaris* (L.) R.Br.	0.13	0.007	0.40	0.541
138	UN-50	0.13	0.006	0.40	0.540
139	*Gnetum montanum* Markgraf	0.13	0.002	0.40	0.537
140	UN-57	0.13	0.001	0.40	0.536
141	*Lagerstroemia parviflora* Roxb.	0.13	0.191	0.20	0.525
142	*Castanopsis diversifolia* King	0.07	0.244	0.20	0.511
143	UN-22	0.13	0.156	0.20	0.491
144	*Macaranga* sp.	0.27	0.021	0.20	0.490
145	*Anneslea fragrans* Wall.	0.07	0.203	0.20	0.470
146	*Diospyros packmanni* C.B. Clarke	0.20	0.056	0.20	0.458
147	UN-2	0.20	0.049	0.20	0.451
148	*Elaeocarpus* sp.	0.20	0.037	0.20	0.439
149	UN-9	0.13	0.100	0.20	0.434
150	UN-12	0.13	0.087	0.20	0.421
151	UN-47	0.20	0.010	0.20	0.412
152	UN-30	0.20	0.006	0.20	0.408
153	*Myristica* sp.	0.07	0.140	0.20	0.408
154	*Litsea monopetala* (Roxb.) Pers.	0.20	0.005	0.20	0.407

No.	Species Name	R.D. %	R.D.m %	R.F %	IVI %
155	UN-56	0.13	0.069	0.20	0.404
156	UN-36	0.20	0.001	0.20	0.403
157	UN-10	0.20	0.000	0.20	0.402
158	UN-15	0.07	0.132	0.20	0.399
159	UN-39	0.07	0.127	0.20	0.394
160	*Glyscomis* sp.	0.07	0.127	0.20	0.394
161	UN-48	0.07	0.122	0.20	0.39
162	*Litsea glutinosa* (Lour.)C.B. Rob.	0.13	0.052	0.20	0.39
163	*Casearia grewiaefolia* Vent.	0.13	0.048	0.20	0.38
164	*Meliosma* sp.	0.07	0.110	0.20	0.38
165	UN-33	0.13	0.032	0.20	0.37
166	UN-49	0.07	0.087	0.20	0.35
167	UN-28	0.07	0.076	0.20	0.34
168	*Bischofia* sp.	0.13	0.008	0.20	0.34
169	*Nephelium* sp.	0.13	0.008	0.20	0.34
170	*Betula* sp.	0.13	0.008	0.20	0.34
171	*Canthium* sp.	0.13	0.005	0.20	0.34
172	*Machilus* sp.2	0.13	0.003	0.20	0.34
173	*Goniothalamus* sp.	0.13	0.003	0.20	0.34
174	*Callicarpa* sp.1	0.13	0.002	0.20	0.34
175	*Clerodendrum* sp.	0.13	0.002	0.20	0.34
176	*Sapindus* sp.	0.13	0.002	0.20	0.34
177	*Capparis* sp.	0.13	0.001	0.20	0.34
178	*Albizia* sp.	0.07	0.065	0.20	0.33
179	*Mussaenda* sp.	0.07	0.065	0.20	0.33
180	*Adina cordifolia* Hook.f.	0.07	0.059	0.20	0.33
181	*Viburnum* sp.	0.07	0.054	0.20	0.32
182	*Boehmerra cledemioides* Miq.	0.07	0.054	0.20	0.32
183	*Syzygium megacarpum* (Craib) Rathakr.& N.C.Nair	0.07	0.049	0.20	0.32
184	UN-6	0.07	0.049	0.20	0.32
185	UN-17	0.07	0.047	0.20	0.31
186	UN-16	0.07	0.038	0.20	0.31
187	UN-52	0.07	0.037	0.20	0.30
188	*Ficus roxburghii* Wall.	0.07	0.036	0.20	0.30
189	*Holarrhena pubescens* Wall. ex G.Don	0.07	0.030	0.20	0.30
190	*Juglans regia* L.	0.07	0.030	0.20	0.30
191	*Grewia* sp.	0.07	0.026	0.20	0.29
192	UN-19	0.07	0.026	0.20	0.29

193	UN-7	0.07	0.024	0.20	0.29
194	*Macarenga denticulata* Muell. Arg.	0.07	0.018	0.20	0.29
195	UN-44	0.07	0.017	0.20	0.28
196	*Callicarpa* sp.2	0.07	0.016	0.20	0.28
197	UN-27	0.07	0.016	0.20	0.28
198	UN-29	0.07	0.016	0.20	0.28
199	UN-21	0.07	0.015	0.20	0.28
200	UN-37	0.07	0.014	0.20	0.28
201	UN-11	0.07	0.012	0.20	0.28
202	*Shorea assamica*Dyer	0.07	0.012	0.20	0.28
203	UN-41	0.07	0.011	0.20	0.28
204	*Suregada multifolra* (A. Juss.) Baill.	0.07	0.011	0.20	0.28
205	*Celtis* sp.	0.07	0.010	0.20	0.28
206	*Dalbergia oliveri Gamble*	0.07	0.010	0.20	0.28
207	*Acronychia* sp.	0.07	0.008	0.20	0.27
208	*Castanopsis* sp.3	0.07	0.008	0.20	0.27
209	*Engelhardtia spicata* Blume	0.07	0.007	0.20	0.27
210	*Meliosma pinnata* Roxb.	0.07	0.007	0.20	0.27
211	UN-35	0.07	0.006	0.20	0.27
212	*Aporusa roxburghii* Baill.	0.07	0.006	0.20	0.27
213	*Archidendron* sp.	0.07	0.006	0.20	0.27
214	*Bauhinia* sp.	0.07	0.005	0.20	0.27
215	*Rhus succedanea* L.	0.07	0.005	0.20	0.27
216	UN-34	0.07	0.005	0.20	0.27
217	*Atalantia roxburghiana* Hk.f.	0.07	0.004	0.20	0.27
218	UN-18	0.07	0.004	0.20	0.27
219	UN-54	0.07	0.004	0.20	0.27
220	*Magnolia* sp.	0.07	0.003	0.20	0.27
221	*Aglaia* sp.	0.07	0.003	0.20	0.27
222	*Carallia brachiata* (Lour.) Merr.	0.07	0.003	0.20	0.27
223	*Emblica officinalis* Gaertn.	0.07	0.003	0.20	0.27
224	*Neolitsea* sp.	0.07	0.002	0.20	0.27
225	*Morus* sp.	0.07	0.002	0.20	0.27
226	*Phoebe* sp.1	0.07	0.001	0.20	0.27
227	UN-31	0.07	0.001	0.20	0.27
228	*Miliusa* sp.	0.07	0.001	0.20	0.27
229	UN-26	0.07	0.001	0.20	0.27
230	UN-20	0.07	0.001	0.20	0.27
231	UN-58	0.07	0.0003	0.20	0.27
	Total	100.00	100.00	100.00	300.00

2. Yenam Dam

2.1. Study area

The location of Yenam area is ´20”N, 97º 01´36”E and 27º48´18”N, 98º 98´97”E near Aliaung village on downstream confluence mouth of Mayhka river and Tarone stream. The study area lays WWF Eco-region of Northern Triangle Temperate forest. It is also located within the priority sites for conservation investment of Northern mountain forest complex. Its watershed area also comprises Hkakaborazi N.P and Hpongan Razi W.S. which are the biodiversity hot-spots and globally outstanding conservation areas. A detailed map of the study area is given in figure (1.1).

2.1.1. Participants

Dr Myint Aung, Daw Thin Thin Su, Daw Khin Khin Soe, and U Tayzar Aung.

2.2. Results

2.2.1. Forest composition

To clarify the tree species composition and their distribution, twelve quadrats (20x20 m each) were set up and observed in the flooded area of Yenam dam site. In the twelve sampling plots (.48 ha), total number of species with DBH ≥ 3cm was 113 species; of which 26 species are under identification. The dominant families of tree species were Lauraceae (12 species), Fagaceae (9 species), Rubiaceae (7 species), Mimosaceae (4 species), Moraceae (4 species), Myrtaceae (4 species), Symplocaceae (4 species), Aceraceae (3 species), Actinidiaceae (3 species), Myrsinaceae (3 species) and Araliaceae (3 species) Figure (2). The main vegetation types discovered in Yenam Dam site can be grouped into four formations, i.e. high land evergreen forest, oak forest, high land secondary forest, and bamboo forest. In some disturbed sites, there are wild banana and degraded forest patches. In the high land evergreen forest, *Exbucklandia populnea, Engelhardtia* sp. & *Eurya* sp. are found in tree layer. Shrub layer is dominated by *Oxyspora paniculata, Symplocos macrophylla & Maesa montana.* Herb layer is dominated by *Selaginella* sp. & *Dipteris chinensis*. In the oak forest, *Castanopsis* spp., *Lithocarpus* sp. assosiate with *Syzygium* sp. in tree layer. Shrub layer is dominated by *Oxyspora paniculata, Lasianthus* sp., *Symplocos macrophylla & Symplocos* sp.. The ground cover of Oak forest is dominated by *Selaginella* sp. In the high land secondary forest, *Syzygium* sp., *Acer* sp. occupied mostly in crown cover and in some places *Symplocos* sp., *Wendlandia tinctoria* DC. and *Eurya* sp. are mixed with them. The ground cover is dominated by *Selaginella* sp., *Adiantum* sp., *Asplenium* sp. and *Polypodium* sp. occupy in most places. In the bamboo forest *Dendrocalamus hamiltonii* Ness (Wabo Myatsan), *D. giganteus* Munro (Wabowa) mainly occur.

The species area curves of the investigated stands are shown in the figure (3). The species area curves, which express the number of species in relation to change in area of habitat, not only to consider the minimum representative area but also to detect the habitat diversity within the survey area (Fangliang He and Pierre Legendre, 1996). The trend of species area curve shows tendency towards flattening. Therefore the sample areas can be said to be sufficient as a minimum representative area for the study.

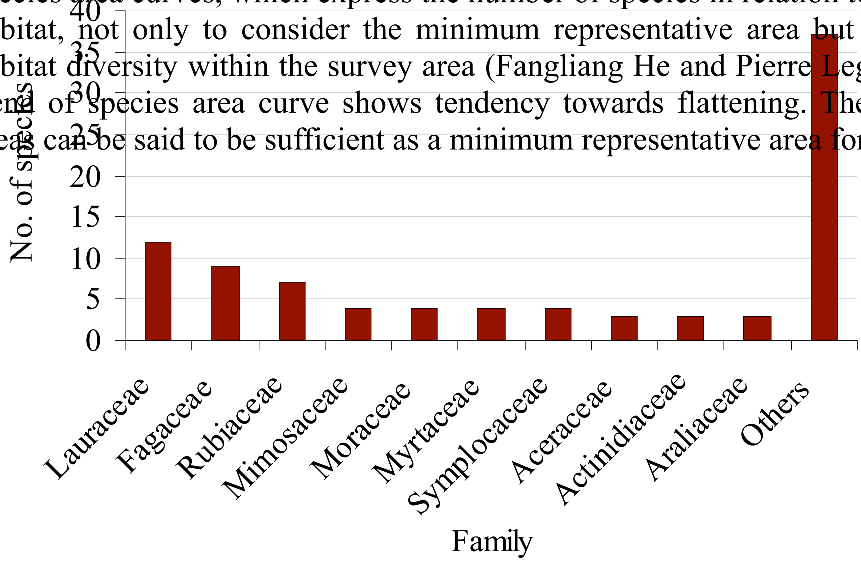


Figure (2) Ranking of dominant family by number of species composition

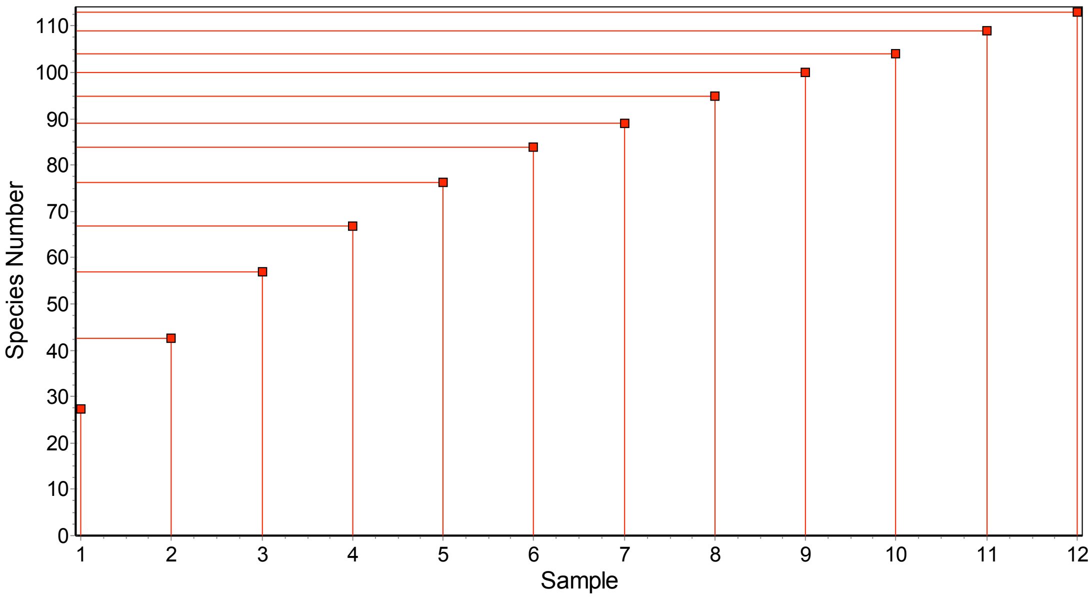


Figure (3) Plot of species accumulation in the Yenam Dam Site

2.2.2. Important Value Index (IVI)

Ranking of ecological significance by IVI of tree species in the study area is given in appendix (1). The tree layer in the study area is dominated by *Castanopsis tribuloides* A.DC. with the highest IVI of 22.02 %, the second most dominant species is *Sterculia* sp. (IVI = 20.81%) and *Symplocos* sp.1. (IVI= 20.72%) is third. The number of species greater than 5% IVI value was only fourteen species (Figure 4, Appendix 1). Those twelve species could be considered as ecological indicator species of Yenam area. Representation of 113 species and the high proportion of dominant species in the study area can directly be attributed to the favorable climatic and edaphic condition.

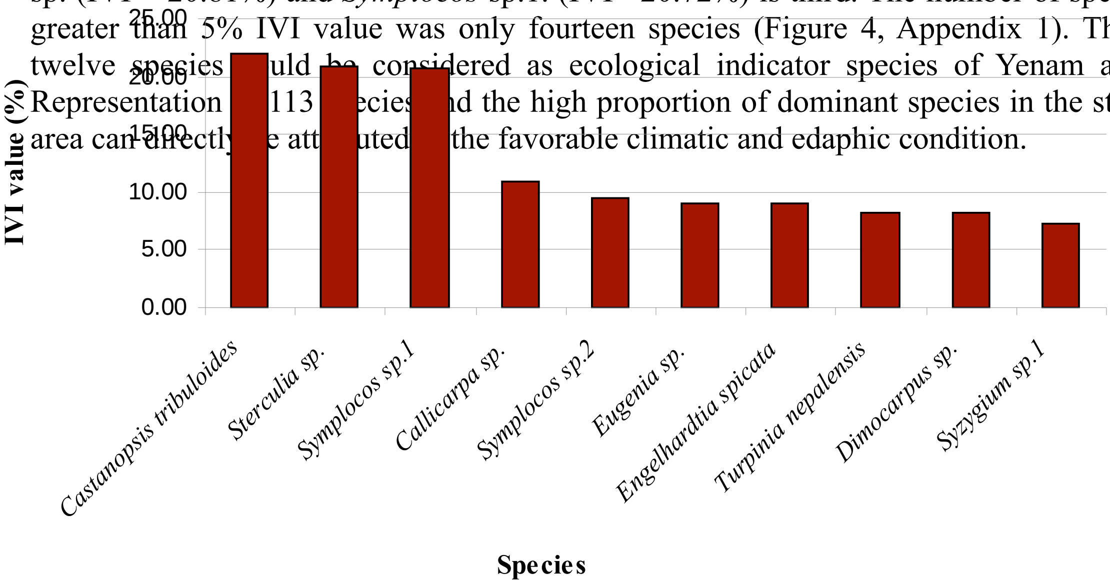


Figure (4) Important Value Index of top ten species in the Yenam Dam Site

2.2.3. Species distribution by frequency classes

In order to clarify the homogeneity or heterogeneity of the floristic distribution in the study area, species distribution by frequency classes was examined. According to the outcome of frequency chart, 74.34 % of the total number of species was in lower frequency classes, A and B, while low value was observed only in higher frequency class E (Table 1, Figure 5). It indicates that the forest in Yenam area is floristically heterogeneous, according to Lamprecht (1989). The species which fall in high frequency class E were UN-2 and *Cinnamomum* sp.2. The two species can be considered as the most common species in the Yenam area.

Table (1) Species distribution by frequency classes ≥ 3cm

Frequency class	Frequency range	No. of species	% of total species frequency distribution
A	1-20%	65	57.52
B	21-40%	19	16.81
C	41-60%	16	14.16
D	61-80%	11	9.73
E	81-100%	2	1.77

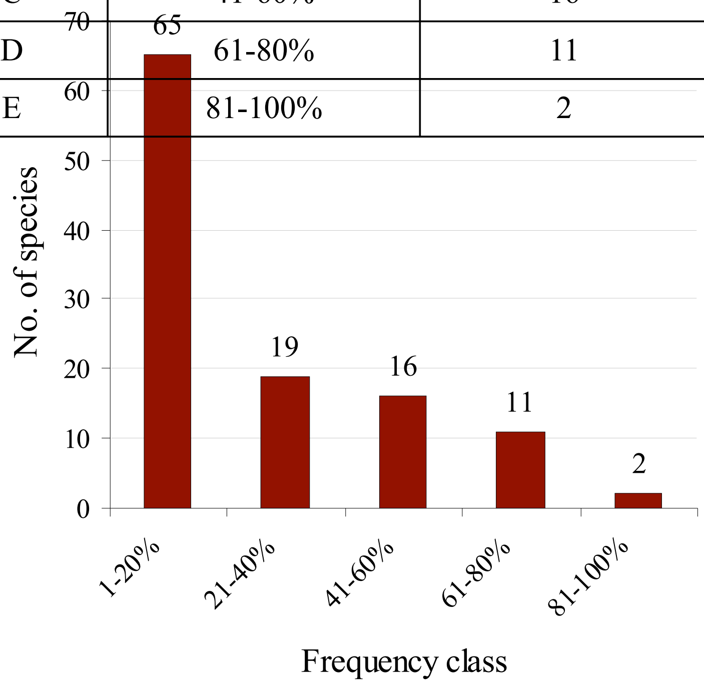


Figure (5) Species distribution by frequency classes ≥3cm

2.2.4. Diversity indices and evenness

Among the different measurement of species diversity indices, the floristic diversity of the Yenam area was analyzed using the Shannon Wiener index (H), Simpsons index (D), Brillouin (D), Shannon Maximum and minimum evenness (E), Brillouin (E) because these indices not only take taxa richness into account but also depend on the relative distribution of individuals. The value of diversity indices and evenness indices of individual sample plot and all sample indices are shown in table (2) and (3). According to the result, though the diversity indices of individual sample plot are not too high, all sample indexes are relatively high.

Diversity value for all sample index of Shannon Wiener index (H) is 3.662, Simpsons index (D) is 18.910, and Brillouin (D) is 3.587. Presence of high species diversity and richness indicates uniqueness and potentiality of study area for conservation of ecosystem in totality.

Table (2) Species diversity indices in the Yenam Dam site

Sample	Shonnon Wiener H	Variance H	Simpsons Index (D)	Brillouin (D)
PND 1	2.723	0.006	12.400	2.467
PND 2	2.486	0.010	8.638	2.240
PND 3	2.568	0.003	10.220	2.430
PND 4	2.711	0.004	11.540	2.525
PND 5	2.836	0.004	11.430	2.659
PND 6	2.566	0.012	9.101	2.273
PND 7	2.520	0.011	6.549	2.280
PND 8	2.808	0.005	9.856	2.633
PND 9	2.249	0.005	3.781	2.141
PND 10	2.973	0.004	15.130	2.765
PND 11	2.428	0.005	6.300	2.295
PND 12	3.136	0.006	19.320	2.813
All Sample Index	3.662		18.910	3.587
Jackknife Std Error	0.228		9.487	0.217

Table (3) Evenness indices in the Yenam Dam site

Sample	Shonnon Wiener H	Variance H	Simpsons Index (D)	Brillouin (D)
PND 1	3.178	1.003	0.517	0.858
PND 2	3.178	1.034	0.360	0.781
PND 3	3.091	0.509	0.464	0.830
PND 4	3.178	0.697	0.481	0.853
PND 5	3.584	0.762	0.317	0.792
PND 6	3.135	1.188	0.396	0.817
PND 7	3.219	0.959	0.262	0.777
PND 8	3.611	0.736	0.266	0.776
PND 9	3.738	0.480	0.090	0.596
PND 10	3.497	0.840	0.459	0.851
PND 11	3.296	0.523	0.233	0.733
PND 12	3.555	1.349	0.522	0.884
All Sample Index	4.727	0.337	0.167	0.775
Jackknife Std Error	0.053	0.062	0.088	0.047

2.2.5. Forest structure

Stem density of ≥3cm was 6227 ha^{-1} and basal area was 73.3 m^2/ha in the Yenam dam site Table (4). Among the 12 sample plots studies, 113 tree species were recorded. Only one individual of 15 species were found and these species were considered as unique species.

The 10 most abundance species in terms of basal area occupied 63.63% of the total, of which *Sterculia* sp. was the most dominant species in the study area with 17.46%, followed by *Castanopsis tribuloides* A.DC. 11.27%, *Engelhardtia spicata* Blume 8.44 %, *Turpinia nepalansis* Wall. 6.10%, *Dimocarpus* sp. 4.67%, *Exbucklandia populnea* (R. Br. ex Griff.) R.W. Br. 3.44%, *Engelhardtia* sp. 3.07%, *Castanopsis diversifolia* King 2.89%, and *Symplocos* sp.2 2.86 %, of the total basal area Figure (6).

Table (4) Consolidated detail of species inventory in the Yenam Dam site

Description	Results
No. of sample points	12
No. of tree species	113
Density (stem/ha)	6227
Basal area (m^2/ha)	73.3
Total no. of unique species	**15**

The distribution of the basal area across DBH interval classes reveals the dominance of small stemmed individuals in the study area. The population structure by DBH class distinctly increases in lower DBH class, <30cm (83.1%). The population gradually decreases from class to class in higher DBH classes Figure (8) and Table (5). Out of total number of stems inventoried, 10.51% of stems were accumulated in the 30-60cm DBH class, 2.68% of stems in the 60-90cm, 1-61% in the 90-120cm. Other higher DBH classes are less than 1% of stem in each class interval. The highest DBH was measured in the case of *Sterculia* sp. (407cm), *Engelhardtia spicata* Blume (394cm), *Castanopsis* sp. (324cm), *Ficus roxburghii* Wall. (286cm).

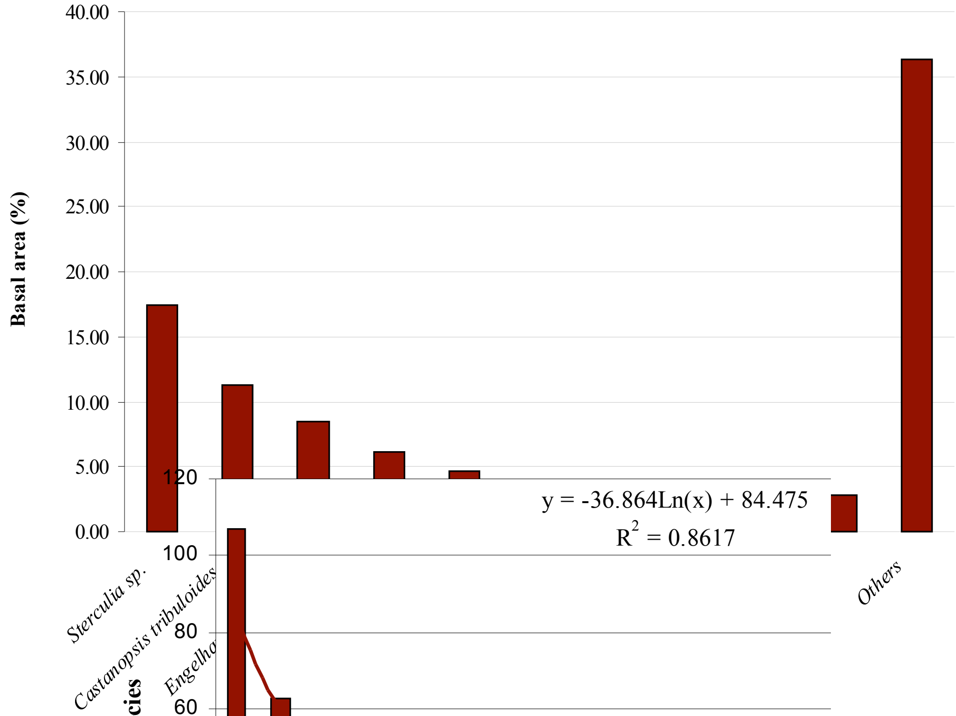


Figure (6) Ranking of relative basal area by species in the Yenam Dam site

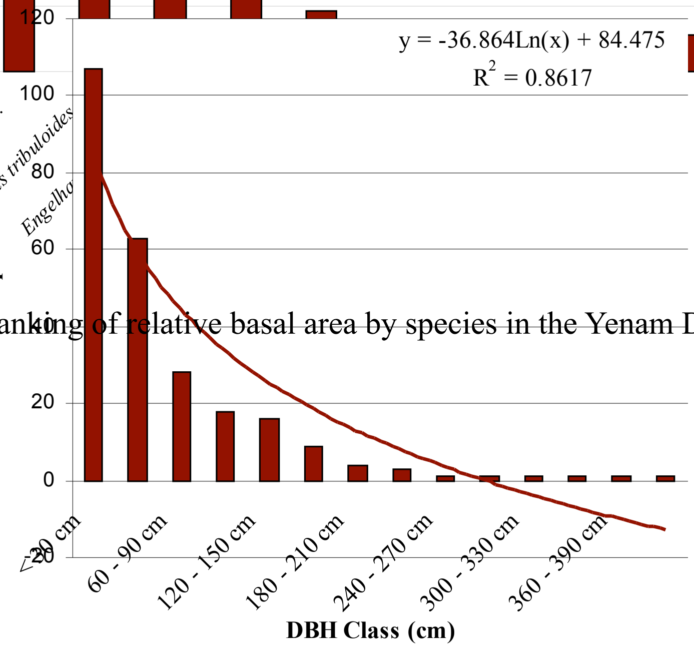


Figure (7) Species distribution by DBH classes

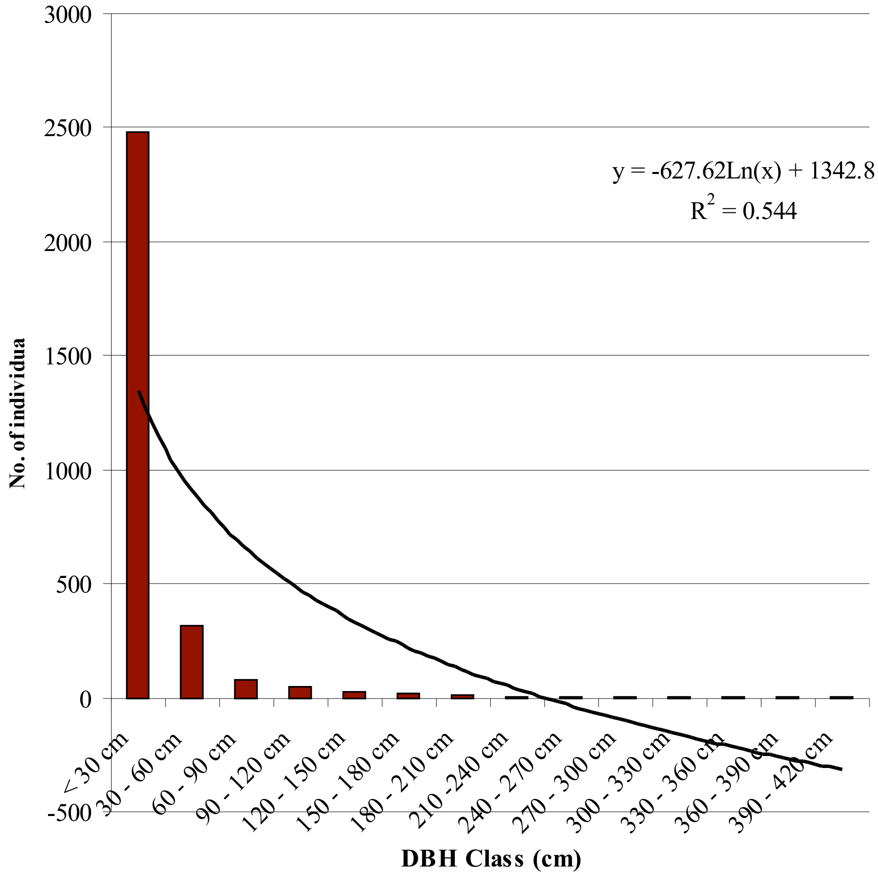


Figure (8) Population distribution by DBH classes

Table (5) Population density of tree species across DBH class interval

DBH classes	No. of species	Total number of individual	% of total species	% of total individual
< 30 cm	107	2484	42.13	83.10
30-60 cm	63	314	24.80	10.51
60-90 cm	28	80	11.02	2.68
90-120 cm	18	48	7.09	1.61
120-150 cm	16	24	6.30	0.80
150-180 cm	9	17	3.54	0.57
180-210 cm	4	9	1.57	0.30
210-240 cm	3	4	1.18	0.13
240-270 cm	1	1	0.39	0.03
270-300 cm	1	2	0.39	0.07
300-330 cm	1	1	0.39	0.03
330-360 cm	1	1	0.39	0.03
360-390 cm	1	2	0.39	0.07
390-420 cm	1	2	0.39	0.07
Total	**113**	**2989**	**100.00**	**100.00**

Tree distribution by height intervals shows that among the total number of 2989 individual, 1747 individuals (58.45%) belong to 3-10m category, followed by 642 individuals (21.48%) in 10-17m, 287 individuals (9.6%) in 17-24m, and 102 individuals (3.41%) in 24-31m Table (6). Where as <3m high trees of 211 individuals (7.02%) infer natural regeneration is poor or frequent disturbance on ground cover plant. The population structure by height classes in the Yenam area is highest in 3-10m class and gradually decreases to higher class (Figure 10 and 11). The tallest individual trees were *Lithocarpus* sp.4 (28m), *Exbucklandia populnea* (R. Br. ex Griff.) R.W. Br. (28m), *Eugenia* sp. (28m), *Wendlandia tinctoria* DC. (27m), *Elaeocarpus* sp. (27m), and *Cinnamomum* sp. (27m). Total picture of height class shows that, 45.64% belong to <3-10m category, 44.25% in 10-24m, and 10.10% in 24-31m. The overall population structure indicates that study are represents mature stand.

Table (6) Population density of tree species across height class interval

Height classes	No. of species	Total number of individual	% of total species	% of total individual

< 3 m	38	211	13.24	7.06
3-10 m	93	1747	32.40	58.45
10-17 m	80	642	27.87	21.48
17-24 m	47	287	16.38	9.60
24-31 m	29	102	10.10	3.41
Total	**113**	**29.89**	**100.00**	**100.00**

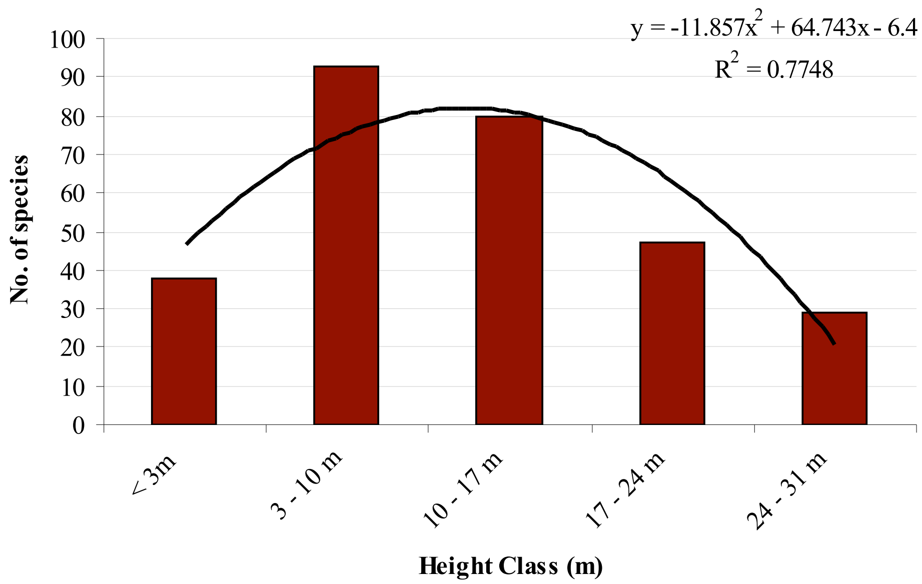


Figure (9) Species distribution by height classes

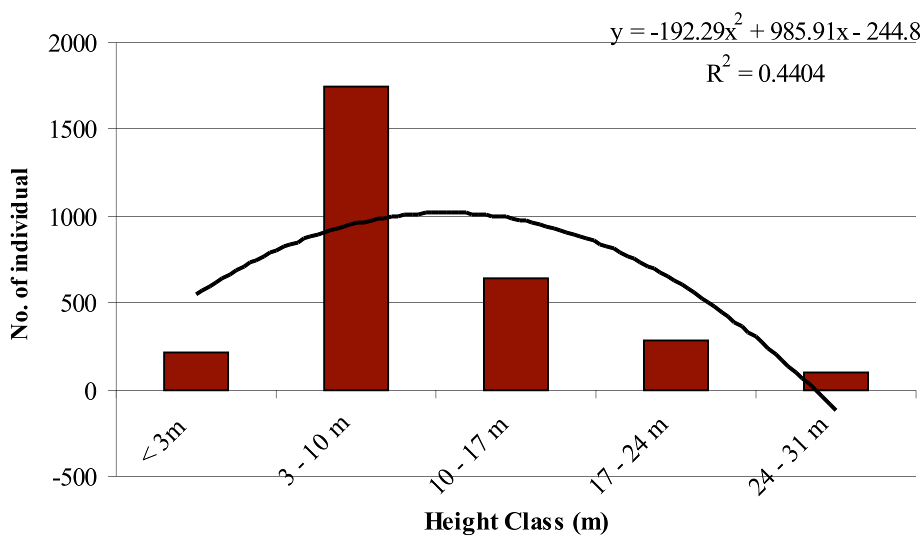


Figure (10) Population distribution by Height classes

2.4. Discussion and Conclusion

A total of 113 tree species representing 86 genera and 34 families were analyzed in the study area. The main vegetation types discovered in Yenam Dam site can be grouped into four formations, i.e. highland evergreen forest, oak forest, highland secondary forest, and bamboo forest. In some disturbed sites, some bushy, degraded forest and wild banana can be seen in patches. The most dominant family in the study area are Lauraceae, Fagaceae, and Rubiaceae.

Accordingly, the ten leading dominants discovered in study area were *Castanopsis tribuloides* A.DC., *Sterculia* sp., *Symplocos* sp.1, *Callicarpa* sp., *Symplocos* sp.2, *Eugenia* sp, *Engelhardtia spicata* Blume., *Turpinia nepalensis*, *Dimocarpus* sp. and *Syzygium* sp.1 contributing highest IVI value (22.02, 20.81, 20.72, 10.94, 9.44, 9.02, 8.96, 8.27, 8.19, 7.23) respectively. Those tree species could be considered as ecological indicator species of the study area. In mature site, the largest trees can reach up to >31m in height while the main canopy is 24-31m with well developed understoreys. The canopy of the forest is more or less close, but in some disturbed sites, the canopy is open and the estimated height were probably not more than 15m, including stunted and cutover regrowth of the tree species.

Presence of relatively high species diversity and richness indicates uniqueness and potentiality of Yenam area for conservation of ecosystem in totality.

The forests in the study area show some types of disturbance such as, fire wood collection, shifting cultivation, and hunting. The forest in accessible area is more or less degraded and it indicates the influence of human impact on forest. Shifting cultivation was the major destructive force and one of the influencing factors for forest structure.

2.5. Recommendation

1. Infrastructure development as well as new access road from Rabbot to Panandim should be implemented cautiously and it should be least impacts on environment, since the forest along the way is primary condition in recently.
2. Though the lost of forest cover area by dam construction is small, one or more compensatory protected area should be established and managed under the project.
3. Since accessibility is one of the major reasons for biodiversity degradation, the remaining forest cover should be systematically managed and conserved after dam.

The catchments area of Yenam dam embrace Hkakaborazi N.P and Hpongan Razi W.S. which are the biodiversity hot-spots and globally outstanding areas. To substitute and minimize the biodiversity loss by dam, the protection and conservation of these areas should be extended.

Appendix (1) Ranking of Important Value Index (IVI) in the Yenam Area

No.	Species Name	R.D. %	R.D.m %	R.F %	IVI %

1	*Castanopsis tribuloides* A.DC.	8.50	11.27	2.25	22.02
2	*Sterculia* sp.	1.10	17.46	2.25	20.81
3	*Symplocos* sp.1	17.30	1.18	2.25	20.72
4	Callicarpa sp.	4.72	2.86	3.37	10.94
5	*Symplocos* sp.2	4.05	2.86	2.53	9.44
6	*Eugenia* sp.	3.35	3.43	2.25	9.02
7	*Engelhardtia spicata* Blume.	0.23	8.44	0.28	8.96
8	Turpinia nepalensis Wall.	1.04	6.10	1.12	8.27
9	*Dimocarpus* sp.	1.27	4.67	2.25	8.19
10	*Syzygium* sp.1	4.62	1.20	1.40	7.23
11	*Syzygium* sp.2	3.78	1.11	2.25	7.14
12	*Mallotus* sp.	3.98	0.27	2.53	6.78
13	*Cinnamomum* sp.2	1.04	1.53	3.09	5.66
14	*Lasianthus* sp.2	3.08	0.16	2.25	5.49
15	UN-20	1.10	2.14	1.69	4.93
16	*Ilex* sp.2	1.37	1.00	2.53	4.90
17	*Castanopsis* sp.4	1.00	2.44	1.12	4.56
18	*Engelhardtia* sp.	0.33	3.07	1.12	4.53
19	*Exbucklandia populnea* (R. Br. ex Griff.) R.W. Br.	0.47	3.44	0.56	4.47
20	*Eurya* sp.	2.14	0.88	1.40	4.42
21	*Wendlandia tinctoria* DC.	1.94	0.79	1.69	4.41
22	*Eurya* sp.2	1.84	0.73	1.69	4.26
23	UN-16	1.20	1.04	1.97	4.21
24	*Castanopsis diversifolia* King	0.64	2.89	0.56	4.09
25	*Acer* sp.2	1.51	0.99	1.40	3.90
26	*Oxyspora paniculata* (D.Don)DC.	2.07	0.13	1.69	3.89
27	UN-22	0.84	0.94	1.97	3.74
28	*Aralia leschenaultii* (DC.) J. Wen	1.00	0.44	2.25	3.69
29	*Canthium* sp.	2.61	0.07	0.84	3.53
30	*Schefflera* sp.1	0.30	1.77	1.12	3.20
31	*Castanopsis* sp.2	0.10	2.68	0.28	3.06
32	UN-18	0.57	1.08	1.40	3.05
33	*Rhamnus* sp.	0.77	0.28	1.97	3.02
34	*Ficus roxburghii* Wall.	0.17	2.28	0.56	3.01
35	UN-17	1.10	0.76	1.12	2.99
36	*Sterculia* sp.1	0.54	0.26	1.69	2.48
37	*Entada phaseoloides* Tamur.E.nepal	0.74	0.28	1.40	2.42
No.	**Species Name**	**R.D. %**	**R.D.m %**	**R.F %**	**IVI %**
38	*Acer* sp.1	0.23	0.81	1.12	2.17
39	*Cyathea gigantea* (Wall. ex Hook.) Holttum	0.60	0.71	0.84	2.16

40	*Betula* sp.	0.84	0.16	1.12	2.12
41	*Lithocarpus* sp.3	0.64	0.21	1.12	1.97
42	*Litsea* sp.2	0.40	0.16	1.40	1.96
43	*Fatsia japonica* (Thunb.) Decne. & Planch.	0.40	0.14	1.40	1.95
44	*Saurauia napaulensis* DC.	1.34	0.18	0.28	1.80
45	*Machilus* sp.2	0.27	0.02	1.40	1.69
46	*Symplocos microphylla* Wight.	0.60	0.19	0.84	1.63
47	*Ficus hispida* Forsk.	0.23	0.53	0.84	1.61
48	*Diospyros* sp.	0.87	0.12	0.56	1.55
49	*Archidendron* sp.	0.84	0.05	0.56	1.44
50	*Archidendron clyperaria* (Jack) Nielsen	0.54	0.03	0.84	1.41
51	*Sonerila* sp.	0.54	0.02	0.84	1.40
52	UN-9	0.27	0.19	0.84	1.30
53	UN-8	0.23	0.14	0.84	1.21
54	*Lasianthus* sp.1	0.30	0.03	0.84	1.17
55	UN-6	0.27	0.05	0.84	1.16
56	UN-25	0.20	0.09	0.84	1.13
57	*Maesa montana* A.DC.	0.74	0.01	0.28	1.03
58	*Machilus* sp.1	0.43	0.03	0.56	1.02
59	UN-15	0.03	0.65	0.28	0.97
60	*Albizia odoratissima* (L.f.) Benth.	0.03	0.62	0.28	0.94
61	*Castanopsis* sp.1	0.23	0.12	0.56	0.92
62	*Saurauia* sp.1	0.57	0.07	0.28	0.92
63	*Machilus thunbergii* Sieb. Et Zucc.	0.30	0.04	0.56	0.90
64	*Alnus trabeculosa* Hand.-Mazz.	0.13	0.20	0.56	0.89
65	*Eleocarpus* sp.	0.13	0.19	0.56	0.89
66	*Columnea* sp.	0.13	0.16	0.56	0.86
67	*Luculia* sp.	0.27	0.01	0.56	0.84
68	*Saurauia roxburghii* Wall.	0.43	0.11	0.28	0.83
69	*Litsea* sp.3	0.23	0.03	0.56	0.83
70	*Lindera* sp.	0.20	0.05	0.56	0.81
71	UN-4	0.17	0.08	0.56	0.81
72	UN-26	0.40	0.11	0.28	0.79
73	*Litsea* sp.4	0.20	0.01	0.56	0.77
74	UN-7	0.17	0.02	0.56	0.75
75	UN-2	0.10	0.05	0.56	0.71
76	*Persea* sp.	0.10	0.01	0.56	0.67
No.	**Species Name**	**R.D. %**	**R.D.m %**	**R.F %**	**IVI %**
77	*Mussaenda* sp.	0.10	0.01	0.56	0.67
78	*Magnolia* sp.1	0.07	0.01	0.56	0.64

79	UN-13	0.20	0.07	0.28	0.55
80	*Litsea* sp.1	0.17	0.06	0.28	0.50
81	*Garcinia merguensis* Wight	0.17	0.05	0.28	0.49
82	UN-5	0.10	0.09	0.28	0.47
83	*Castanopsis* sp.3	0.17	0.02	0.28	0.47
84	*Syzygium* sp.3	0.17	0.02	0.28	0.47
85	UN-11	0.17	0.01	0.28	0.46
86	*Piper* sp.2	0.17	0.00	0.28	0.45
87	*Lithocarpus* sp.4	0.07	0.08	0.28	0.43
88	*Meliosma* sp.	0.13	0.00	0.28	0.42
89	UN-23	0.10	0.01	0.28	0.39
90	UN-14	0.10	0.01	0.28	0.39
91	*Ficus* sp.	0.07	0.04	0.28	0.39
92	*Acer* sp.3	0.07	0.03	0.28	0.38
93	UN-12	0.07	0.02	0.28	0.37
94	*Elaeocarpus lanceifolius* Roxb.	0.07	0.02	0.28	0.37
95	*Acronychia* sp.	0.07	0.01	0.28	0.36
96	UN-21	0.07	0.01	0.28	0.35
97	UN-19	0.07	0.01	0.28	0.35
98	*Macaranga siamensis* S.J. Davies	0.03	0.04	0.28	0.35
99	UN-3	0.07	0.00	0.28	0.35
100	*Dichroa febrifuga* Lour.	0.07	0.00	0.28	0.35
101	*Maesa chisia* Godayari	0.07	0.00	0.28	0.35
102	*Bauhinia* sp.	0.03	0.02	0.28	0.33
103	*Ardisia* sp.	0.03	0.01	0.28	0.32
104	UN-1	0.03	0.01	0.28	0.32
105	UN-24	0.03	0.01	0.28	0.32
106	*Streblus* sp.	0.03	0.004	0.28	0.32
107	*Chisocheton* sp.	0.03	0.003	0.28	0.32
108	*Symplocos* sp.	0.03	0.002	0.28	0.32
109	UN-10	0.03	0.002	0.28	0.32
110	*Aglaia* sp.	0.03	0.002	0.28	0.32
111	*Sambucus* sp.	0.03	0.002	0.28	0.32
112	*Ixora* sp.	0.03	0.001	0.28	0.32
113	*Gmelina oblongifolia* Roxb.	0.03	0.001	0.28	0.31
Total		100.00	100.00	100.00	300.00

Chapter III

3. Chibwe Dam

3.1. Study area

The location of Chibwe area lies between 25º58´N and 98º 09´ E and reach about 20 kilometre on upstream confluence mouth of Myahka river and Chibwe Stream near Mandon Village. Dam site lies in the lowland area but Mayhka River flows in the narrow valley of High Mountain and has steep slope. The flooded area is long and narrow in upstream and a little broad near dam site. The study area lies WWF Eco-regions of Mizoram-Manipur-Kachin moist evergreen forest. The watershed area of Chibwe Dam area includes Bumphabum W.S and Emawbon Mountain forest and is one of the hotspots and outstanding area for conservation. A detailed map of the study area is given in figure (1.2).

3.1.1. Participants

U Nyo Maung, Dr. Kalayar Lu, Dr. Kyaw Soe Naing, Daw Thin Thin Su, and U Tayzar Aung

3.2. Results

3.2.1. Forest composition

To clarify the tree species composition and their distribution, eighteen quadrats (20x20 m each) were set up and observed in the flooded area of Chibwe dam site. In the eighteen sampling plots (0.72ha), total number of species with DBH ≥3cm was 204 species; of which 5 species are under identification. The dominant families of tree species are Euphorbiaceae (19 species), Moraceae (19), Lauraceae (18 species), Fagaceae (11 species), Rubiaceae (8 species), Annonaceae (6 species), Araliaceae (6), Dipterocarpaceae (6 species), Sterculiaceae (6), Aquifoliaceae (5), Meliaceae (5 species), Verbenaceae (5 species) Figure (2). The main vegetation types discovered in Chibwe Dam site can be grouped into four formations, i.e. low land evergreen forest, oak forest, lowland secondary forest, and bamboo forest. In some disturbed sites, there are wild banana and degraded forest can be seen in patches. Low land evergreen forests mainly composed of *Schima wallichii, Duabanga grandiflora,* & *Pterospermum cinnamomemum* in tree layer and *Knema furfuracea, Chisocheton siamensis* & *Polyalthia* sp. are mixed with them. Shrub layer is dominated by *Arenga triandra, Aglaia* sp., *Clausena* sp., *Calamus* sp., & *Phrynium capitatum*. Herb layer is dominated by *Begonia* sp., *Calanthe triplicata, Athyrium silvicola, Alphanamixis* sp., *Allantodia similis, Tectaria* sp., In the Oak forest, *Lithocarpus* sp., *Castanopsis* spp*., Fagus* sp. & *Quercus* sp. assosiate with *Schima wallichii, & Pterospermum cinnamomeum* in tree layer. Shrub layer is dominated by *Arenga triandra, Aglaia* sp.. Herb layer is dominated by *Elatostema* sp., *Calanthe triplicata, Phrynium capitatum & Stachyphrynium spicatum.* In the lowland secondary forest, *Saurauia* sp*., Ilex* sp., *Alnus nepaulensis,* and *Ficus fistulosa* are found in tree layer. Shrub layer is dominated by *Arenga triandra & Melastoma* sp.. Herb layer is dominated by *Alphanamixis silvicola, Begonia* sp. & *Neolepisorus* sp.. In the bamboo forest *Dendrocalamus hamiltonii* Ness (Wabo Myatsan), and *D. giganteus* Munro(Wabowa) mainly occur.

The species area curves of the investigated stands are shown in the figure (4). The species area curves, which express the number of species in relation to change in area of habitat, not only to consider the minimum representative area but also to detect the habitat diversity within the survey area (Fangliang He and Pierre Legendre, 1996). The trend of species area curve shows tendency towards flattening. Therefore the sample areas can be said to be sufficient as a minimum representative area for the study.

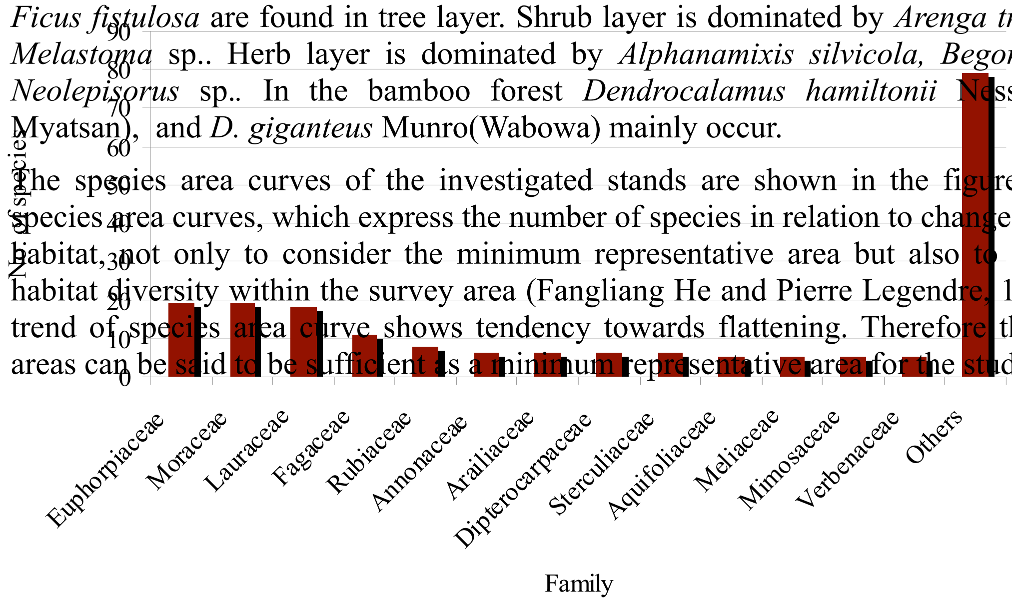


Figure (2) Ranking of dominant family by number of species composition

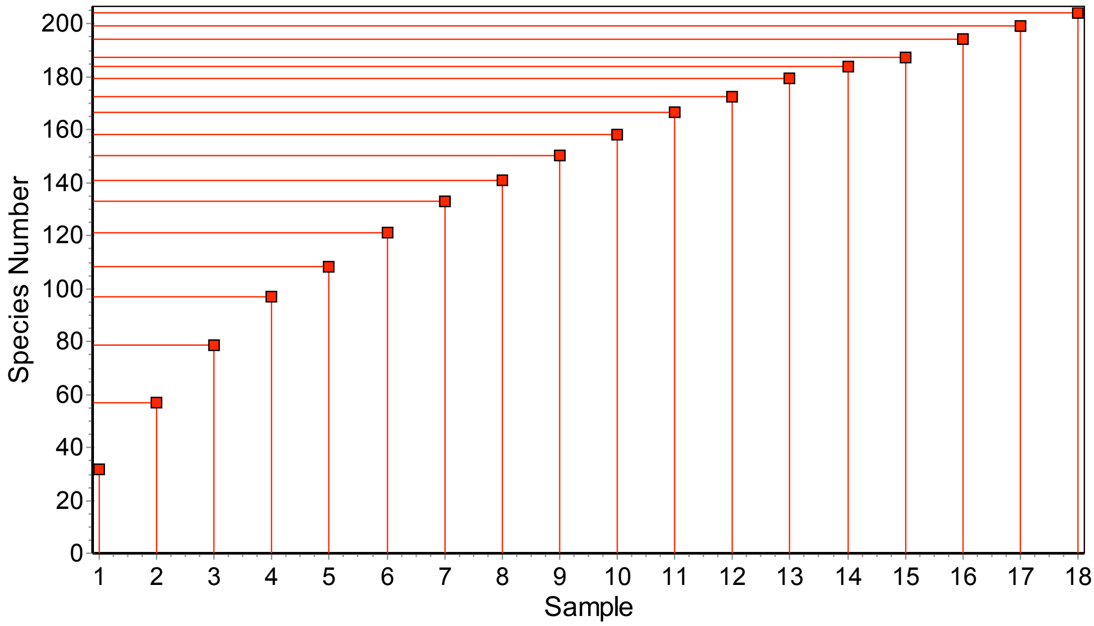
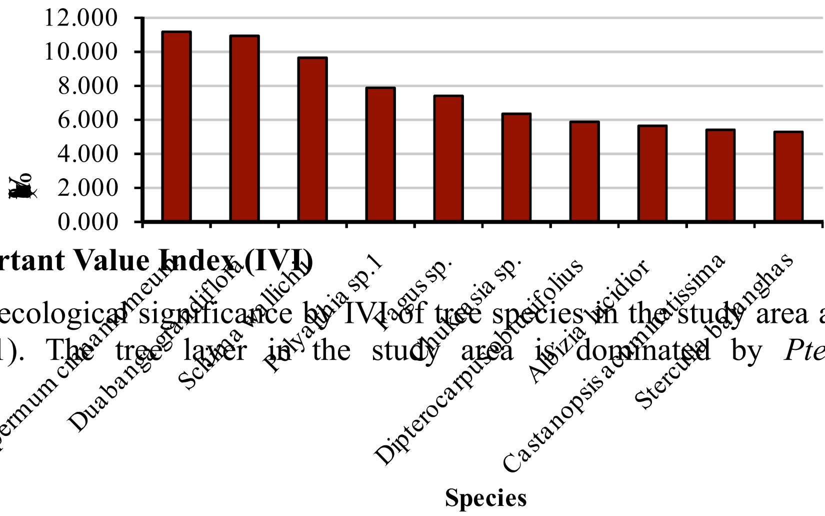


Figure (3) Plot of species accumulation in the Chibwe Dam Site



3.2.3. Important Value Index (IVI)

Ranking of ecological significance by IVI of tree species in the study area are given in appendix (1). The tree layer in the study area is dominated by *Pterospermum* *cinnamomeum* with the highest IVI of 11.19%, the second most dominant species is *Duabanga grandiflora* (IVI = 10.95%) and *Schima wallichii* (IVI= 9.7%) is the third. The number of species greater than 5% IVI value was only six species (Figure 5). Those six species could be considered as ecological indicator species of Chibwe area. Representation of 204 species and the high proportion of dominant species in the study area can directly be attributed to the favorable climatic and edaphic condition.

Figure (4) Important Value Index of top ten species in the Chibwe Dam Site

3.2.4. Species distribution by frequency classes

In order to clarify the homogeneity or heterogeneity of the floristic distribution in the study area, species distribution by frequency classes was examined. According to the outcome of frequency chart, 89.71% of the total number of species was in lower frequency classes, A and B, while low value 10.29% was observed in higher frequency classes C and D (Table 1, Figure 5). It indicates that the forest in Chibwe area is floristically heterogeneous, according to Lamprecht (1989). The species which fall in high frequency class D was *Pterospermum cinnamomeum, Chisocheton siamensis, Duabanga grandiflora, Sterculia balanghas,* and *Polyalthia* sp. 1. These species can be considered as the most common species in the Chibwe area.

Table (1) Species distribution by frequency classes ≥3cm

Frequency class	Frequency range	No. of species	% of total species frequency distribution
A	1-20 %	141	69.12
B	21-40 %	42	20.59
C	41-60 %	15	7.35
D	61-80%	6	2.94
E	81-100%	0	0

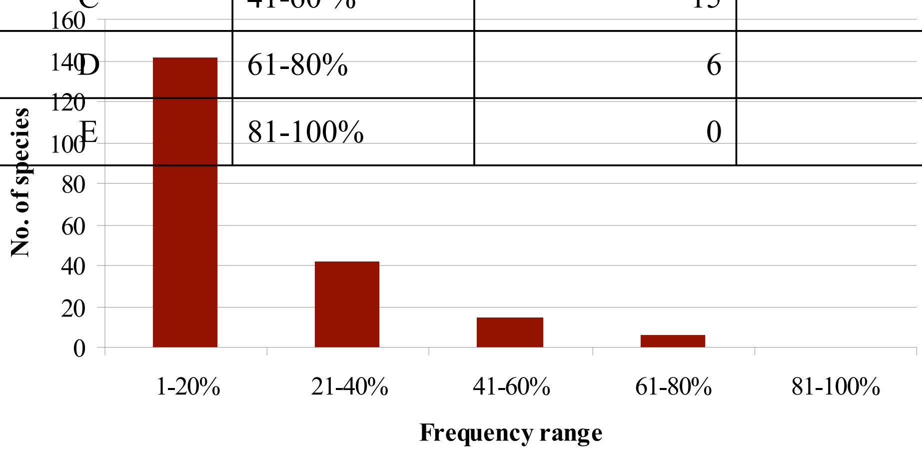


Figure (5) Species distribution by frequency classes ≥3cm

3.2.5. Diversity indices and evenness

Among the different measurement of species diversity indices, the floristic diversity of the Chibwe area was analyzed using the Shannon Wiener index (H), Simpsons index (D), Brillouin (D), Shannon Maximum and minimum evenness (E), Brillouin (E) because these indices not only take taxa richness into account but also depend on the relative distribution of individuals. The value of diversity indices and evenness indices of individual sample plot and all sample indices are shown in table (2) and (3). According to the result, though the diversity indices of individual sample plot are not too high, all sample index are relatively high. Diversity value for all sample index of Shannon Wiener index (H) is 4.605, Simpsons index (D) is 68.44, Brillouin (D) is 4.458. Presence of high species diversity and richness indicates uniqueness and potentiality of study area for conservation of ecosystem in totality.

Table (3) Species diversity indices in the Chibwe Dam site

Sample	Shannon Wiener (H)	Variance H	Simpson Index (D)	Brillouin Index (D)
Chibwe 1	2.167	0.01298	5.955	1.938
Chibwe 2	2.763	0.01152	15.38	2.344
Chibwe 3	2.104	0.0247	4.062	1.821
Chibwe 4	3.073	0.008702	17.67	2.689
Chibwe 5	2.928	0.008571	12.97	2.619
Chibwe 6	3.438	0.005907	34.57	2.961
Chibwe 7	2.965	0.007367	11.89	2.698
Chibwe 8	3.321	0.006406	20.6	2.968
Chibwe 9	3.727	0.003837	38.45	3.33
Chibwe 10	3.007	0.008386	12.57	2.702
Chibwe 11	3.214	0.006515	19.26	2.87
Chibwe 12	2.477	0.01313	5.085	2.235
Chibwe 13	3.254	0.006649	22.48	2.862
Chibwe 14	3.611	0.004088	29.94	3.262
Chibwe 15	3.367	0.006884	26.17	2.942
Chibwe 16	3.261	0.009532	21.93	2.814
Chibwe 17	2.608	0.01431	8.983	2.283
Chibwe 18	2.323	0.01683	7	2.023
All Sample Index	4.605		68.44	4.458
Jackknife Std Error	0.06397		5.227	0.05909

Table (3) Evenness indices in the Chibwe Dam site

Sample	Shannon Maximum	Shannon Minimium	Simpson Evenness (E)	Brillouin (E)
Chibwe 1	2.89	0.9301	0.3308	0.7465
Chibwe 2	3.045	1.615	0.7323	0.9088
Chibwe 3	3.045	1.228	0.1934	0.6795
Chibwe 4	3.466	1.597	0.5521	0.8891
Chibwe 5	3.497	1.322	0.393	0.8377
Chibwe 6	3.664	2.015	0.8864	0.9449
Chibwe 7	3.738	1.214	0.283	0.7919
Chibwe 8	3.807	1.566	0.4578	0.875
Chibwe 9	4.06	1.779	0.6629	0.9224
Chibwe 10	3.611	1.313	0.3398	0.8323
Chibwe 11	3.664	1.472	0.4937	0.8785
Chibwe 12	3.584	1.104	0.1413	0.6833
Chibwe 13	3.584	1.63	0.6244	0.9111
Chibwe 14	4.025	1.558	0.5346	0.8991
Chibwe 15	3.714	1.842	0.6384	0.9085
Chibwe 16	3.664	1.971	0.5622	0.8947
Chibwe 17	3.296	1.431	0.3327	0.7909
Chibwe 18	2.944	1.207	0.3684	0.7839
All Sample Index	5.318	0.7307	0.3355	0.8675
Jackknife Std Error	0.04382	0.06821	0.0194	0.007935

3.2.6. Forest structure

Stem density of ≥3cm was 3378 ha^{-1} and basal area was 117.6 m^2/ha in the Chibwe dam site (Table (4)). Among the 18 sample plots studies, 204 tree species were recorded.

Only one individual of 43 species were found and these species were considered as unique species.

The 10 most abundance species in terms of basal area occupied 43.81% of the total, of which *Pterospermum cinnamomeum* was the most dominant species in the study area with 7.05%, followed by *Duabanga grandiflora* 6.9%, *Schima wallichii* 5.26%, *Shorea assamica* 4.53%, *Fagus* sp. 4.44%, *Chukiasia* sp. 4.12%, *Albizia lucidior* 3.13%, *Castanopsis* sp. (1) 3.04%, *Dipterocarpus* sp. 2.68%, and *Ficus curtipes* 2.66% of the total basal area Figure (7).

Table (4) Consolidated detail of species inventory in the Chibwe Dam site

Description	Results
No. of Sample points	18
No. of tree species	204
Density (stem/ha)	3378
Basal area (m^2/ha)	117.6
Total No. of unique species	43

The distribution of the basal area across DBH interval classes reveals the dominance of small stemmed individuals in the study area. The population structure by DBH class decreased from class to class with a steeper gradient in lower DBH classes and with a gentle slope in higher classes Figure (7, 8) and Table (5). Out of total number of stems inventoried, 79.69% of stems were accumulated in the 3-60cm DBH class, 15.79% of stems in the 60-150cm, 3.33% in the 150-240cm, 0.86% in the 240-330cm, 0.21% in 330-390cm, and only 0.12% in 480-580cm above. The highest DBH was measured in the case of *Shorea assamica* (607cm), *Pterospermum cinnamomeum* (501cm), *Duabanga grandiflora* (494cm), *Vitex* sp. (372cm).

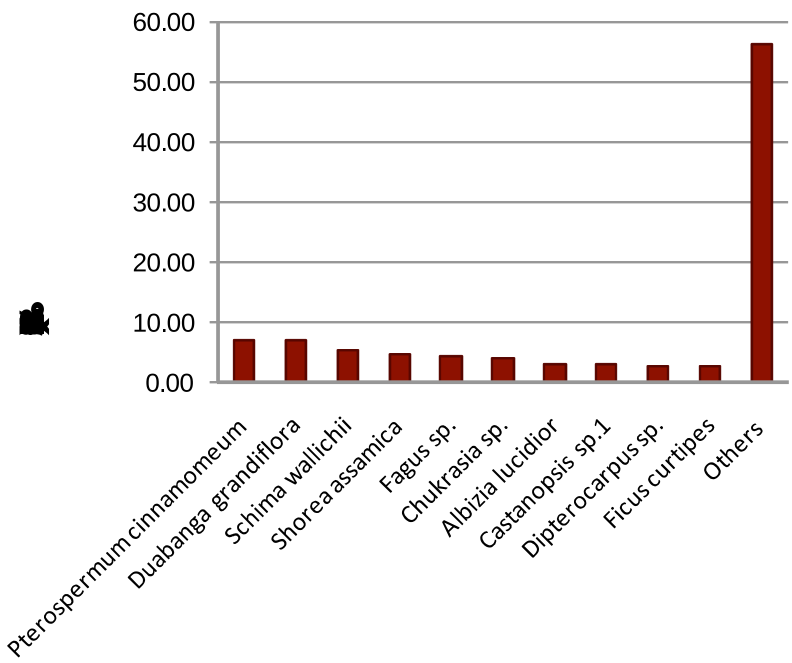


Figure (6) Ranking of relative basal area by species in the Chibwe Dam site

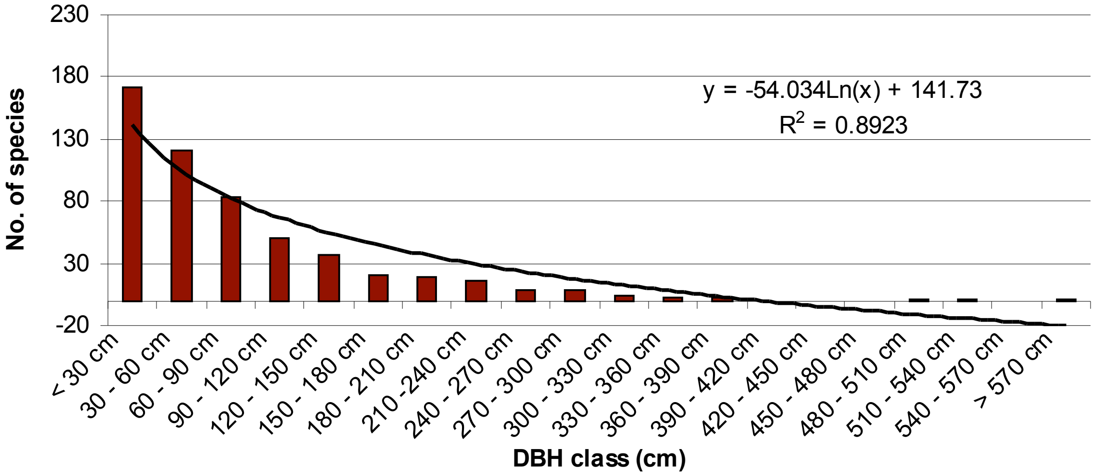


Figure (7) Species distribution by DBH classes

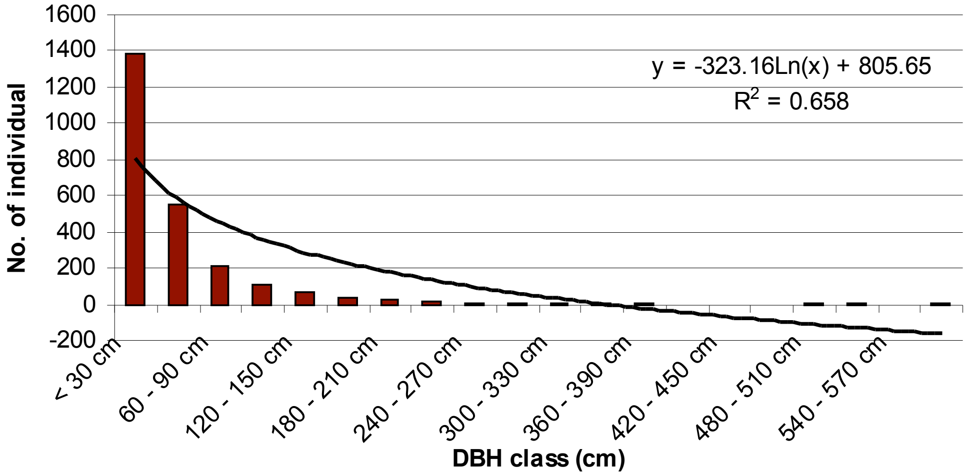


Figure (8) Population distribution by DBH classes

Table (5) Population density of tree species across DBH class interval

DBH Classes	No. of species	Total number of individual	% of total species	% of total individual
< 30 cm	171	1385	31.26	56.95
30-60 cm	121	553	22.12	22.74
60-90 cm	84	213	15.36	8.76
90-120 cm	50	106	9.14	4.36
120-150 cm	37	65	6.76	2.67
150-180 cm	21	37	3.84	1.52
180-210 cm	19	24	3.47	0.99
210-240 cm	16	20	2.93	0.82
240-270 cm	8	9	1.46	0.37
270-300 cm	8	8	1.46	0.33
300-330 cm	4	4	0.73	0.16
330-360 cm	3	3	0.37	0.12
360-390 cm	2	2	0.55	0.08
390-420 cm	-	-	-	-
420-450 cm	-	-	-	-
450-480 cm	-	-	-	-
480-510 cm	1	1	0.18	0.04
510-540 cm	1	1	0.18	0.04
540-570 cm	-	-	0.00	-
> 570 cm	1	1	0.18	0.04
Total	204	2432	100.00	100.00

Tree distribution by height intervals shows that among the total number of 2432 individual, 1186 individuals (45.93%) belong to 3-10m category, followed by 769 individuals (31.62%) in 10-17m, 270 individuals (11.1%) in 17-24m, 189 individuals (7.77%) in 24-31m, and 17 individuals (0.7%) in 31-38m. The height class of >38m includes only (0.04%) of total individuals (Table (6)). <3m high trees of 69 individuals (2.84%) infer natural regeneration is relatively fair in study site. The population structure by height classes in the Chibwe area is highest in 3-10m class and gradually decreases to higher class (Figure 10 and 11). The tallest individual trees were *Styrax* sp. (43m), *Chukrasia* sp. (35m), *Dipterocarpus obtusifolius* (35m), *Dipterocarpus* spp. (35m), *Duabanga grandiflora* (35m), and *Fagus* sp.12 (35m), *Lithocarpus* sp.2 (35m), *Pterospermum cinnamomeum* (35m), *Vitex* sp. (35m). The overall population structure indicates that study area represents mature stand.

Table (6) Population density of tree species across height class interval

Height Classes	No. of species	Total number of individual	% of total species	% of total individual
< 3 m	32	69	6.72	2.84
3-10 m	162	1117	34.03	45.93
10-17 m	136	769	28.57	31.62
17-24 m	81	270	17.02	11.10
24-31 m	54	189	11.34	7.77
31-38 m	10	17	2.10	0.70
> 38 m	1	1	0.21	0.04
Total	**204**	**2432**	**100.00**	**100.00**

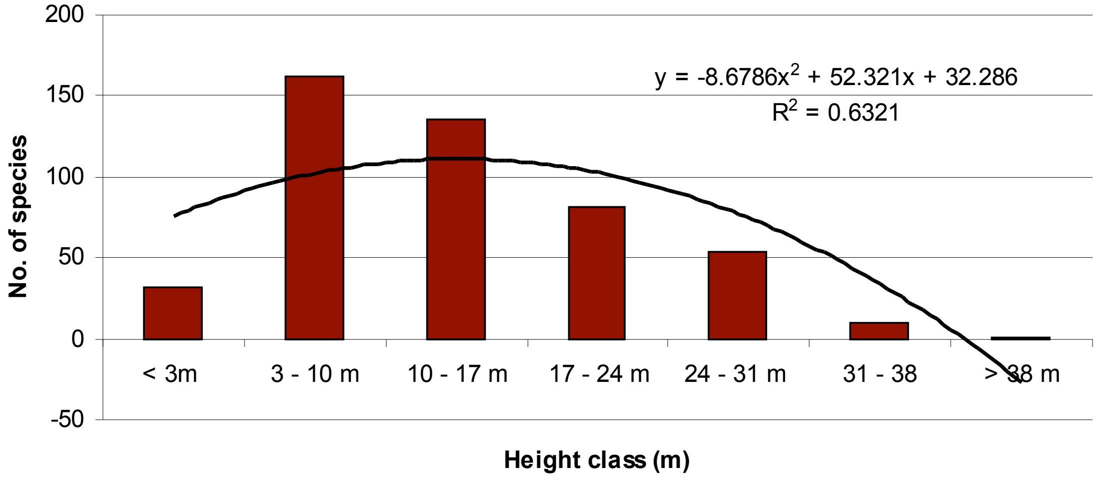


Figure (10) Species distribution by height classes

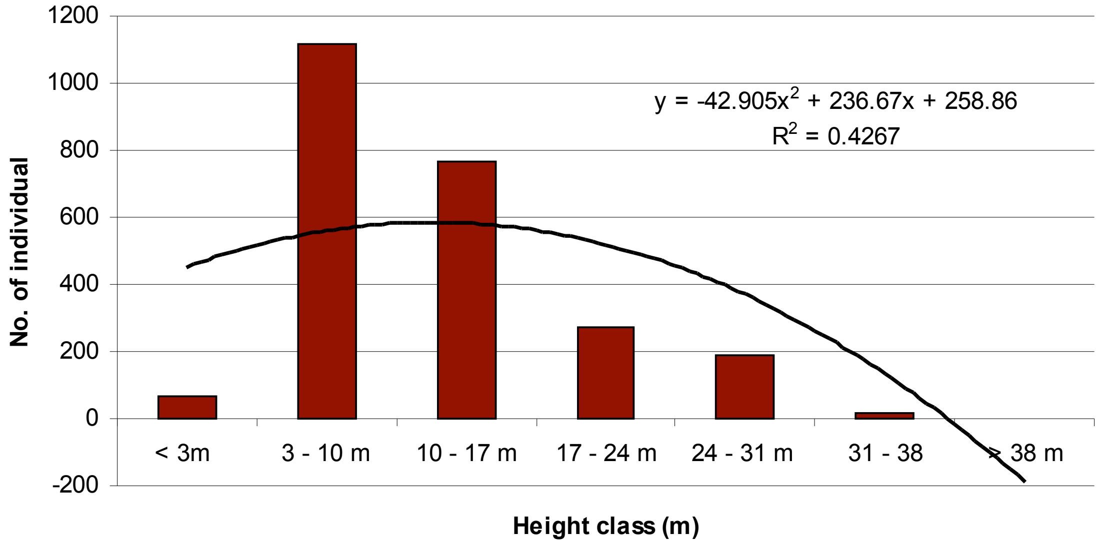


Figure (11) Population distribution by DBH classes

3.3. Discussion and Conclusion

A total of 204 tree species representing 128 genera and 60 families were analyzed in the study area. The main vegetation types discovered in Chibwe Dam site can be grouped into four; low land evergreen forest, oak forest, lowland secondary forest, and bamboo forest. Degraded forest occurs in some places especially in lowland area.

The ten leading dominants in study area were *Pterospermum cinnamomeum* Kurz, *Duabanga grandiflora* (Roxb. ex DC.) Walp., *Schima wallichii* (DC.) Korth., *Polyalthia* sp.1, *Chisocheton siamensis, Castanopsis indica, Gmelina arborea, Ostrya* sp*., Garcinia* sp.2, *Fagus* sp., *Chukrasia* sp., *Dipterocarpus obtusifolius* Teysm.ex.Mig., *Albizia lucidior* (Steud.) Nielsen, *Castanopsis acuminatissima* (Bl.) A. DC., *Sterculia balanghas* L. *Tetrameles nudiflora,* and *Baccaurea sapida* contributing highest IVI value. Those tree species could be considered as ecological indicator species of the study area. In mature site, the largest trees can reach up to >38m in height while the main canopy is 17-24m, and 24-31m with well developed understoreys. The canopy of the forest is 3 or 4 layers and generally close, but in some disturbed sites, the canopy is open and the estimated height were probably not more than 15m, including stunted and cutover regrowth of the tree species.

The watershed area of Chibwe Dam includes Bumphabum W.S and Emawbum Mountain forest and is one of the hotspots and outstanding area for conservation. The Chibwe area shows high species diversity and richness so planning for natural resource management and conservation should be carefully done.

Overexploitation of timber wood was noticed in Chibwe area. Due to the accessible road, the forest degradation is very rapid and noticeable. All the forest products are exported to China by motor road. The primary forests are found only in the area of high mountain region and non-accessible area. The rapid degradation of forest indicates the habitat loss for other organisms and lead to biodiversity lost and climate change as a long term impact. In addition, due to soil erosion of denuded site, speedy sedimentation may influence on water storage capacity of dam in a short time.

The following species that recorded in the study area assessed in IUCN Red list as follows;

No.	Botanical Name	Family	Red Lists	Year
1.	*Taiwania cryptomeriodes* Hayata	Taxodiaceae	VU Ald	IUCN-2000
2.	*Cephalotaxus griffithii* Hook.f.	Cephalotaxaceae	LR/nt	IUCN-2000
3.	*Dipterocarpus turbinatus* Gaertn.f.	Dipterocarpaceae	CR Alcd+2cd	IUCN-2000

3.4. Recommendation

1. The socioeconomic development and community awareness on environment should be planned and implemented under the project. It may support the conservation and maintenance of remaining forest.
2. Reforestation project should be introduced and implemented in degraded area.
3. One or more compensatory protected area should be established and managed under project, to offset the loss of natural habitat.

The flooded areas of dams are narrow and damage is minimal on terrestrial ecosystem since Chibwe dam is cascade, the cumulative impact assessment of hydrology should be carried out with special attention.

Appendix (1) Ranking of Important Value Index (IVI) in the Chibwe Area

No.	Species Name	R.D. %	R.D.m %	R.F %	IVI %
1	*Pterospermum cinnamonemum* Kurz	2.26	7.0509	1.88	11.19
2	*Duabanga grandiflora* (Roxb. ex DC.) Walp.	2.01	6.8999	2.03	10.95
3	*Schima wallichii* (DC.) Korth.	3.50	5.2620	0.94	9.70
4	*Polyalthia* sp.1	3.95	1.7147	2.19	7.85
5	*Fagus* sp.	1.69	4.4410	1.25	7.38
6	*Chukrasia* sp.	0.99	4.1235	1.25	6.36
7	*Dipterocarpus obtusifolius* Teysm.ex.Mig.	3.82	1.7081	0.31	5.85
8	*Albizia lucidior* (Steud.) Nielsen	1.11	3.1252	1.41	5.64
9	*Castanopsis acuminatissima*(Bl.) A. DC.	2.67	1.7657	0.94	5.38
10	*Sterculia balanghas* L.	2.47	0.8201	2.03	5.32
11	*Chisocheton siamensis* Craib	2.22	1.0518	2.03	5.31
12	*Saurauia* sp.1	3.29	0.6202	1.10	5.01
13	*Shorea assamica* Dyer	0.12	4.5281	0.31	4.96
14	*Castanopsis* sp.1	1.07	3.0379	0.63	4.73
15	*Castanopsis diversifolia* (Kurz) King	1.07	2.3697	1.25	4.69
16	*Cinnamomum* sp.	2.01	1.3585	1.25	4.63
17	*Lithocarpus* sp.1	2.30	1.0440	1.25	4.60
18	*Dipterocarpus* sp.	1.27	2.6831	0.63	4.58
19	*Syzygium* sp.1	1.81	0.3759	1.72	3.91
20	*Ficus auriculata* Lour.	1.64	0.9863	1.25	3.88
21	*Knema furfuracea* (HK. F.et Th.) Warb.	1.85	0.8053	0.94	3.59
22	*Lithocarpus* sp.	0.45	1.8891	1.25	3.59
23	*Sapium* sp.	2.10	0.7134	0.78	3.59
24	*Streblus*sp.	0.78	1.4635	1.25	3.50
25	*Phoebe* sp.2	1.56	0.9577	0.94	3.46
26	*Castanopsis* sp.2	0.45	2.2895	0.63	3.37
27	*Ficus curtipes* Corn.	0.25	2.6560	0.16	3.06
28	*Caryota urens*L.	0.86	0.5649	1.56	2.99
29	*Leea* sp.	1.40	0.1622	1.41	2.97
30	*Engelhardtia spicata* Blume	0.49	1.2774	1.10	2.87
31	*Ostodes* sp.	0.90	0.5726	1.25	2.73
32	*Polyalthia* sp.2	1.32	0.1399	1.25	2.71
33	*Bischofia javanica* Blume	0.25	1.8047	0.63	2.68
34	*Garcinia* sp.	1.11	0.1388	1.41	2.66
35	*Ficus fistulosa* Reinw.	1.15	0.2154	1.25	2.62
36	*Machilus* sp.2	0.99	0.4302	1.10	2.51
37	*Toona ciliata* M. Roemer	0.62	0.7760	1.10	2.49
No.	**Species Name**	**R.D. %**	**R.D.m %**	**R.F %**	**IVI %**

38	*Lithocarpus* sp.2	0.37	1.5523	0.47	2.39
39	*Styrax* sp.	1.15	0.3850	0.78	2.32
40	*Machilus* sp.3	1.48	0.2072	0.63	2.31
41	*Atalantia roxburghiana* Hk.f.	1.27	0.2137	0.78	2.27
42	*Machilus* sp.1	1.11	0.3023	0.78	2.19
43	*Actinodaphne* sp.	0.70	0.3514	1.10	2.15
44	*Sapindus* sp.	1.07	0.3538	0.63	2.05
45	*Wendlandia* sp.	0.95	0.1526	0.94	2.04
46	*Artocarpus* sp.	0.21	1.1908	0.63	2.02
47	*Phoebe* sp.1	0.45	0.5947	0.94	1.99
48	*Alnus nepalensis* D. Don	0.53	0.9762	0.47	1.98
49	*Syzygium megacarpum* (Craib) Rathakr.& N.C.Nair	1.15	0.0767	0.63	1.85
50	*Cleidion spiciflorum* Merr.	0.82	0.1391	0.78	1.74
51	*Alangium chinense* (Lour.) Harms	0.78	0.4775	0.47	1.73
52	*Albizia* sp.	0.37	0.7162	0.63	1.71
53	*Vitex* sp.	0.08	1.3030	0.31	1.70
54	*Quercus* sp.1	0.16	1.3562	0.16	1.68
55	*Goniothalamus* sp.	0.49	0.0284	1.10	1.62
56	*Ilex* sp.4	0.90	0.2302	0.47	1.60
57	*Callicarpa arborea* Roxb.	0.41	0.4083	0.78	1.60
58	*Dalbergia* sp.	0.37	0.2783	0.94	1.59
59	Cotoneaster sp.	1.27	0.1467	0.16	1.58
60	*Morus* sp.	0.29	0.6477	0.63	1.56
61	*Quercus* sp.	0.62	0.0045	0.94	1.56
62	*Aglaia* sp.	0.82	0.1077	0.63	1.56
63	*Baccaurea sapida* Muell.Arg.	0.37	0.3928	0.78	1.55
64	*Canthium* sp.	0.45	0.0380	0.94	1.43
65	*Fagus* sp.12	0.12	1.1430	0.16	1.42
66	*Dolichandrone serrulata* Seem.	0.41	0.3582	0.63	1.40
67	*Dipterocarpus* sp.2	0.08	1.1387	0.16	1.38
68	*Ficus hispida* Forsk.	0.33	0.0638	0.94	1.33
69	*Daphtimorpha* sp.	1.03	0.1443	0.16	1.33
70	*Machilus odoratissima* Nees.	0.58	0.5786	0.16	1.31
71	*Symplocos microphylla* Wight.	0.74	0.0831	0.47	1.29
72	*Micromelum minutum* (G. Forst.) Wight & Arn.	0.45	0.0564	0.78	1.29
73	*Acer oblongum* Wall.	0.37	0.7514	0.16	1.28
74	*Mallotus* sp.3	0.66	0.4515	0.16	1.27
75	*Syzygium cumini* (L.) Skeels	0.25	0.3788	0.63	1.25
No.	**Species Name**	**R.D. %**	**R.D.m %**	**R.F %**	**IVI %**

76	*Ficus semicordata* Buch.-Ham. ex J.E. Sm.	0.29	0.4918	0.47	1.25
77	*Gnetum gnemon* L.	0.53	0.0696	0.63	1.23
78	*Turpinia* sp.	0.37	0.0690	0.78	1.22
79	*Litsea* sp.3	0.37	0.2132	0.63	1.21
80	*Cyathea* sp.	0.62	0.2657	0.31	1.20
81	*Mangifera indica* L.	0.33	0.4664	0.31	1.11
82	*Ficus* sp.7	0.29	0.1563	0.63	1.07
83	*Sterculia* sp.4	0.49	0.2332	0.31	1.04
84	*Alangium begoniifolia* (Roxb.) Baill.	0.25	0.4488	0.31	1.01
85	*Litsea* sp.4	0.25	0.2320	0.47	0.95
86	*Rhus chinensis* Mill.	0.49	0.1289	0.31	0.94
87	*Dipterocarpus* sp.3	0.16	0.5714	0.16	0.89
88	*Eurya* sp.	0.37	0.0488	0.47	0.89
89	*Meliosma* sp.	0.37	0.0398	0.47	0.88
90	*Sterculia* sp.3	0.33	0.0648	0.47	0.86
91	*Lasianthus* sp.	0.33	0.0522	0.47	0.85
92	*Maesa montana* A.DC.	0.37	0.0078	0.47	0.85
93	*Glochidion* sp.	0.21	0.0077	0.63	0.84
94	*Ilex* sp.3	0.29	0.0733	0.47	0.83
95	*Acacia* sp.	0.08	0.5635	0.16	0.80
96	*Alstonia scholaris* (L.) R.Br.	0.25	0.0822	0.47	0.80
97	*Aglaia lawii* (Wight) Sald.& Rama.	0.12	0.3505	0.31	0.79
98	*Betula* sp.	0.25	0.0668	0.47	0.78
99	*Syzygium* sp.2	0.21	0.1059	0.47	0.78
100	*Cornus* sp.	0.04	0.5785	0.16	0.78
101	*Litsea cubeba* (Lour.) Pers.	0.25	0.0359	0.47	0.75
102	*Swintonia floribunda* Griff.	0.25	0.3381	0.16	0.74
103	*Mallotus* sp.1	0.33	0.0728	0.31	0.71
104	*Schefflera* sp.2	0.16	0.0741	0.47	0.71
105	*Hydrangea* sp.	0.21	0.0167	0.47	0.69
106	*Symplocos* sp.	0.21	0.0070	0.47	0.68
107	*Aporusa* sp.	0.21	0.1496	0.31	0.67
108	*Citrus* sp.	0.29	0.0521	0.31	0.65
109	*Rhododendron indicum* Sw.	0.04	0.4552	0.16	0.65
110	*Clausena* sp.	0.16	0.0045	0.47	0.64
111	*Archidendron clyperaria* (Jack) Nielsen	0.16	0.0027	0.47	0.64
112	*Capparis* sp.	0.45	0.0228	0.16	0.63
113	*Euonymus* sp.	0.21	0.1070	0.31	0.63
114	*Irvingia* sp.	0.33	0.1276	0.16	0.61
No.	**Species Name**	**R.D. %**	**R.D.m %**	**R.F %**	**IVI %**

115	*Glochidion* sp.2	0.12	0.0150	0.47	0.61
116	*Oroxylum indicum* (L.) Kurz	0.16	0.1215	0.31	0.60
117	*Ficus* sp.	0.04	0.3953	0.16	0.59
118	*Saurauia* sp.2	0.21	0.2159	0.16	0.58
119	*Cananga* sp.	0.25	0.0071	0.31	0.57
120	*Betula utilis* D. Don	0.21	0.1885	0.16	0.55
121	*Trevesia* sp.	0.16	0.0718	0.31	0.55
122	*Erythrina* sp.	0.04	0.3396	0.16	0.54
123	*Ilex liukiuensis* Loes.	0.12	0.0929	0.31	0.53
124	UN-4	0.21	0.0077	0.31	0.53
125	*Sauropus* sp.	0.16	0.0476	0.31	0.53
126	*Spondias* sp.	0.08	0.1265	0.31	0.52
127	*Clerodendron* sp.3	0.21	0.0026	0.31	0.52
128	*Balakata baccata* (Roxb.) Esser	0.16	0.0369	0.31	0.51
129	*Mallotus paniculatus* Muell. Arg.	0.12	0.0558	0.31	0.49
130	*Litsea* sp.1	0.16	0.0118	0.31	0.49
131	*Melastoma* sp.	0.16	0.0058	0.31	0.48
132	*Litsea* sp.2	0.12	0.0405	0.31	0.48
133	*Elaeocarpus* sp.	0.08	0.0760	0.31	0.47
134	*Ostyra* sp.	0.12	0.0272	0.31	0.46
135	*Clerodendron* sp.1	0.29	0.0079	0.16	0.45
136	*Bridelia stipularis* (L.) Blume	0.12	0.0139	0.31	0.45
137	*Ficus variegata* Blume	0.08	0.2050	0.16	0.44
138	*Phoebe* sp.3	0.16	0.0958	0.16	0.42
139	*Litsea monopetala* (Roxb.) Pers.	0.08	0.0112	0.31	0.41
140	*Diospyros* sp.	0.08	0.0109	0.31	0.41
141	*Ficus* sp.6	0.16	0.0811	0.16	0.40
142	*Exbucklandia populnea* (R. Br. ex Griff.) R.W. Br.	0.08	0.0061	0.31	0.40
143	*Mussaenda* sp.2	0.08	0.0046	0.31	0.40
144	*Oxyspora* sp.	0.08	0.0032	0.31	0.40
145	*Tabernaemontana* sp.	0.08	0.0028	0.31	0.40
146	*Clerodendron* sp.2	0.08	0.0018	0.31	0.40
147	*Celtis* sp.	0.08	0.1120	0.16	0.35
148	*Albizia chinensis* (Osbeck.) Merr.	0.08	0.0941	0.16	0.33
149	*Ficus* sp.12	0.08	0.0935	0.16	0.33
150	*Ilex* sp.2	0.08	0.0776	0.16	0.32
151	*Dimocarpus* sp.	0.04	0.1077	0.16	0.31
152	*Meliosma pinnata* Roxb.	0.08	0.0622	0.16	0.30
No.	**Species Name**	**R.D. %**	**R.D.m %**	**R.F %**	**IVI %**

153	*Turpinia cochinchinensis* (Lour.) Merr.	0.12	0.0165	0.16	0.30
154	*Antidesma montanum* Bl.	0.12	0.0164	0.16	0.30
155	*Aralia montana* Bl.	0.08	0.0540	0.16	0.29
156	*Nephelium* sp.	0.12	0.0073	0.16	0.29
157	*Carallia brachiata* (Lour.) Merr.	0.04	0.0762	0.16	0.27
158	*Dipterocarpus* sp.1	0.04	0.0728	0.16	0.27
159	*Pterospermum grandiflorum*Craib	0.08	0.0306	0.16	0.27
160	*Sterculia* sp.2	0.08	0.0271	0.16	0.27
161	*Ficus* sp.10	0.08	0.0237	0.16	0.26
162	*Sterospermum* sp.	0.08	0.0200	0.16	0.26
163	*Ficus* sp.9	0.08	0.0120	0.16	0.25
164	*Ficus* sp.5	0.08	0.0079	0.16	0.25
165	*Mallotus* sp.2	0.08	0.0051	0.16	0.24
166	*Zizyphus* sp.	0.08	0.0033	0.16	0.24
167	*Xantolis* sp.	0.08	0.0032	0.16	0.24
168	*Boehmeria platyphyllum* Buch. - Ham. ex D.don	0.08	0.0026	0.16	0.24
169	*Glochidion* sp.1	0.04	0.0374	0.16	0.24
170	*Memecylon* sp.	0.04	0.0350	0.16	0.23
171	*Cleyera* sp.	0.04	0.0274	0.16	0.23
172	*Ficus* sp.4	0.04	0.0245	0.16	0.22
173	*Ficus* sp.8	0.04	0.0245	0.16	0.22
174	*Gmelia arborea* Roxb	0.04	0.0169	0.16	0.21
175	*Schefflera* sp.1	0.04	0.0136	0.16	0.21
176	*Garcinia* sp.1	0.04	0.0109	0.16	0.21
177	*Hibiscus macrophyllus* Roxb.	0.04	0.0109	0.16	0.21
178	*Macaranga* sp.	0.04	0.0102	0.16	0.21
179	UN-2	0.04	0.0102	0.16	0.21
180	*Ficus* sp.11	0.04	0.0096	0.16	0.21
181	*Ficus* sp.3	0.04	0.0074	0.16	0.20
182	*Lindera* sp.	0.04	0.0059	0.16	0.20
183	*Sterculia* sp.	0.04	0.0054	0.16	0.20
184	*Vernonia* sp.	0.04	0.0041	0.16	0.20
185	*Pavetta indica* L.	0.04	0.0038	0.16	0.20
186	*Holarrhena pubescens* Wall. ex G.Don	0.04	0.0027	0.16	0.20
187	*Elatostema* sp.	0.04	0.0026	0.16	0.20
188	*Mussaenda* sp.	0.04	0.0024	0.16	0.20
189	*Olea*sp.	0.04	0.0024	0.16	0.20
190	*Antidesma* sp.	0.04	0.0021	0.16	0.20
No.	**Species Name**	**R.D. %**	**R.D.m %**	**R.F %**	**IVI %**

191	*Aralia* sp.1	0.04	0.0021	0.16	0.20
192	*Meliosma simplicifolia* Walp.	0.04	0.0021	0.16	0.20
193	*Actinodaphne sesquipedalis* Hook. f. & Thoms. ex Meissner	0.04	0.0018	0.16	0.20
194	*Gnetum montanum* Markgraf	0.04	0.0018	0.16	0.20
195	*Aralia* sp.2	0.04	0.0014	0.16	0.20
196	*Ziziphus* sp.1	0.04	0.0014	0.16	0.20
197	*Ilex micrococca* Maxim.	0.04	0.0011	0.16	0.20
198	*Miliusa* sp.3	0.04	0.0011	0.16	0.20
199	UN-1	0.04	0.0011	0.16	0.20
200	*Goniothalamus* sp.1	0.04	0.0009	0.16	0.20
201	UN-5	0.04	0.0009	0.16	0.20
202	*Dracaena* sp.	0.04	0.0006	0.16	0.20
203	*Ixora* sp.	0.04	0.0005	0.16	0.20
204	UN-3	0.04	0.0002	0.16	0.20
Total		100.00	100.00	100.00	300.00

4. Wusok and Pisa Dam

4.1. Study area

The Wusok Dam lies between 26º31´N and 98º 18´ E and about 34.5 km away from Pisa Dam. The Pisa Hydropower Dam area is located between 26º44´N and 98º 22´E. Both Pisa and Wusok dam sites lie in the high mountain and riverine. These dam areas lie in WWF Eco-regions of Northern Triangle temperate forest and Mizoram-Manipur-Kachin moist evergreen forest. It is also located near the priority site for conservation investment of Northern mountain forest complex. The forests in the watershed areas of the dams are Hkakaborazi N.P Hponganrazi W.S and Emawbum mountain forests. So the areas are the biodiversity hot-spot areas and globally outstanding for conservation. A detailed map of the study area is given in figure (1.3).

4.1.1. Participants

Dr Myint Aung, Dr. Kalayar Lu, Dr. Kyaw Soe Naing, Daw Thin Thin Su, Daw Khin Khin Soe, and U Tayzar Aung.

4.2. Results

4.2.1. Forest composition

To clarify the tree species composition and their distribution, eleven quadrats (20x20 m each) were set up and observed in the flooded area of Wusok dam site. In the eleven sampling plots (.44ha), total number of species with DBH ≥3cm was 110 species; of which 12 species are under identification. The dominant families of tree species are Lauraceae (11species), Fagaceae (8species), Moraceae (8species), Euphorbiaceae (6species), Sterculiaceae (5 species), Actinidiaceae (4 species), Myrsinaceae (4species), Verbenaceae (4 species) Figure (2). The main vegetation types discovered in Wusok Dam site can be grouped into four formations, i.e. low land evergreen forest, oak forest, low land secondary forest, and bamboo forest. In some disturbed sites, some bushes and degraded forest can be seen in patches. Low land evergreen forests can be typically distinguished by *Dipterocarpus obtusifolius, Ilex micrococca, Saurauia* sp., *Ficus* sp.3, and *Eleocarpus* sp. in tree layer. Shrub layer is dominated by *Schefflera* sp., *Canthium* sp., and *Oxyspora paniculata*. Herb layer is dominated by *Aslpenium* sp., *Pronephrium* sp., *Pronephrium triphyllum,* and *Pseudocyclosourus* sp.. Oak forest is mainly composed of *Castanopsis* spp*., Quercus* sp., *Lithocarpus* sp., *Sterculia* sp.1, and *Saurauia sp.,* in tree layer. Shrub layer is dominated by *Stachyphrynium spicatum,* and *Eurya* sp.. Herb layer is dominated by *Pteris* sp*., Piper* sp*., Arenga* sp., *Pronephrium* sp..In the low land secondary forest, *Mallotus* sp., *Sterculia* sp.1, *Maesa* sp., *Callicarpa* sp. are found in tree layer. Shrub layer is dominated by *Gnetum* sp., *Wallichia siamensis, Stachyphrynium spicatum, Arenga triandra, Eurya* sp., and *Symplocos macrophylla*. Herb layer is dominated by *Pteris* sp., *Tectaria simonsii, Selaginella* sp., *Begonia* sp., *Piper* sp., *Pronephrium* sp. & *Commelina* sp. In the bamboo forest *Dendrocalamus hamiltonii* Ness (Wabo Myatsan), *D. giganteus* Munro (Wabowa) mainly occur.

The species area curves of the investigated stands are shown in figure (3). The species area curves, which express the number of species in relation to change in area of habitat, not only consider the minimum representative area but also detect the habitat diversity within the survey area (Fangliang He and Pierre Legendre, 1996). The trend of species area curve shows tendency towards flattening. Therefore the sample areas can be said to be sufficient as a minimum representative area for the study.

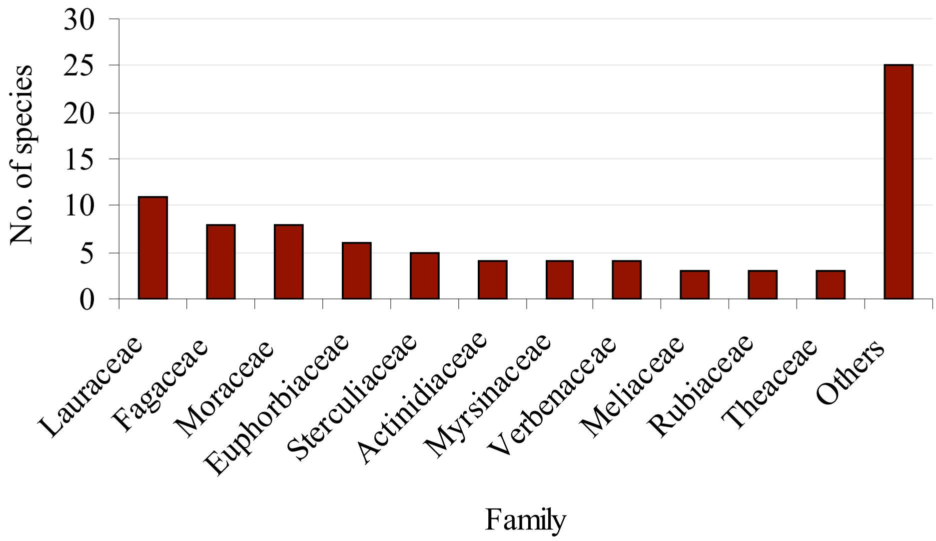


Figure (2) Ranking of dominant family by number of species composition

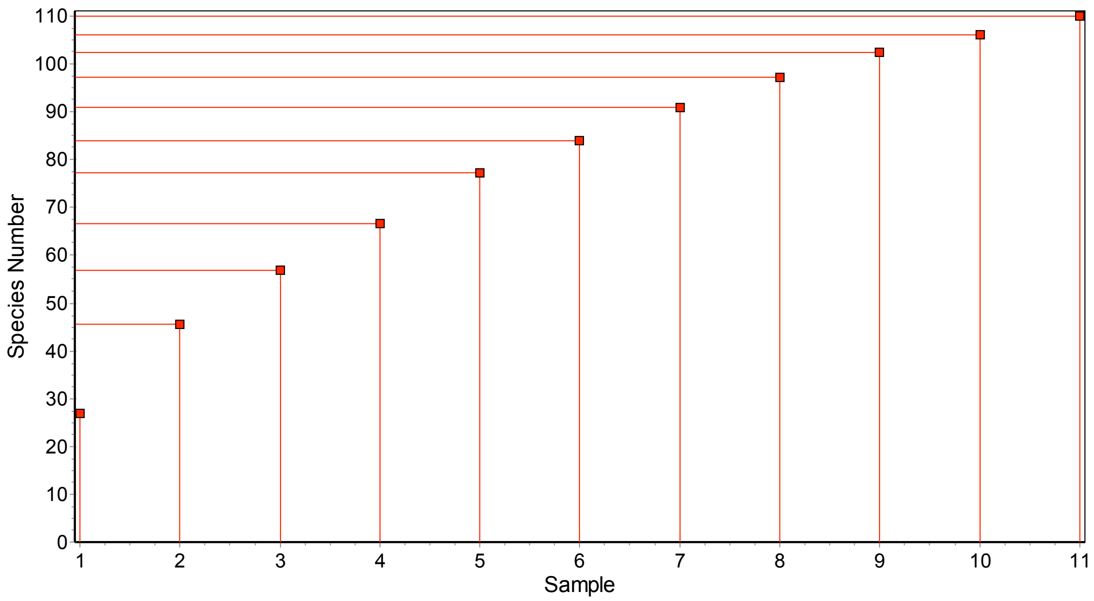


Figure (3) Plot of species accumulation in the Wusok Dam Site

4.2.3. Important Value Index (IVI)

Ranking of ecological significance by IVI of tree species in the study area are given in appendix (1). The tree layer in the study area is dominated by *Dipterocarpus obtusifolius* Teysm.ex.Mig. with the highest IVI of 37.63%, the second most dominant species is *Sterculia* sp.1 (IVI = 14.23%) and *Ficus* sp.3 (IVI= 12.13%) is the third. Ecologically dominance of top ten species based on IVI value is shown in figure 4. Those species could be considered as ecological indicator species of Wusok area. The number of species greater than 5% IVI value was seventeen species (Appendix 1). Representation of 110 species and the high proportion of dominant species in the study area can directly be attributed to the favorable climatic and edaphic condition.

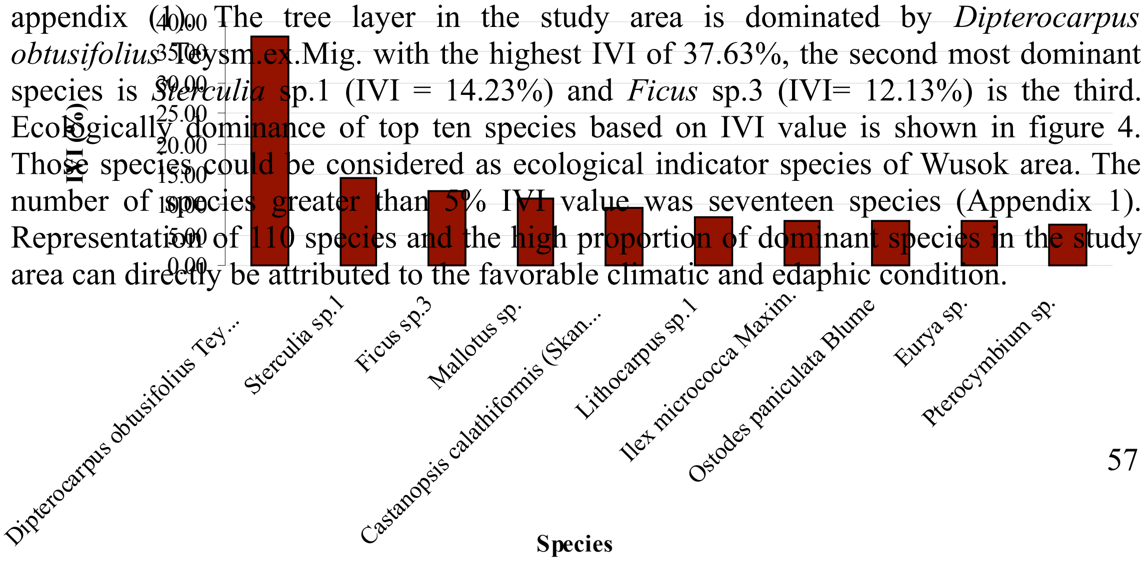


Figure (4) Important Value Index of top ten species in the Wusok Dam Site

4.2.4. Species distribution by frequency classes

In order to clarify the homogeneity or heterogeneity of the floristic distribution in the study area, species distribution by frequency classes was examined. According to the outcome of frequency chart, 87.28% of the total number of species was in lower frequency classes, A and B, while low value was observed only in higher frequency class C, D, and E (Table 1, Figure 5). It indicates that the forest in Wusok area is floristically heterogeneous, according to Lamprecht (1989). The species which fall in high frequency class E was *Ostodes paniculata* Blume and *Sterculia* sp.1 These species can be considered as the most common species in the Wusok area.

Table (1) Species distribution by frequency classes ≥3cm

Frequency Class	Frequency range	No. of species	% of total species frequency distribution
A	1-20 %	70	63.64
B	21-40 %	26	23.64
C	41-60 %	9	8.18
D	61-80 %	3	2.73
E	81-100 %	2	1.82

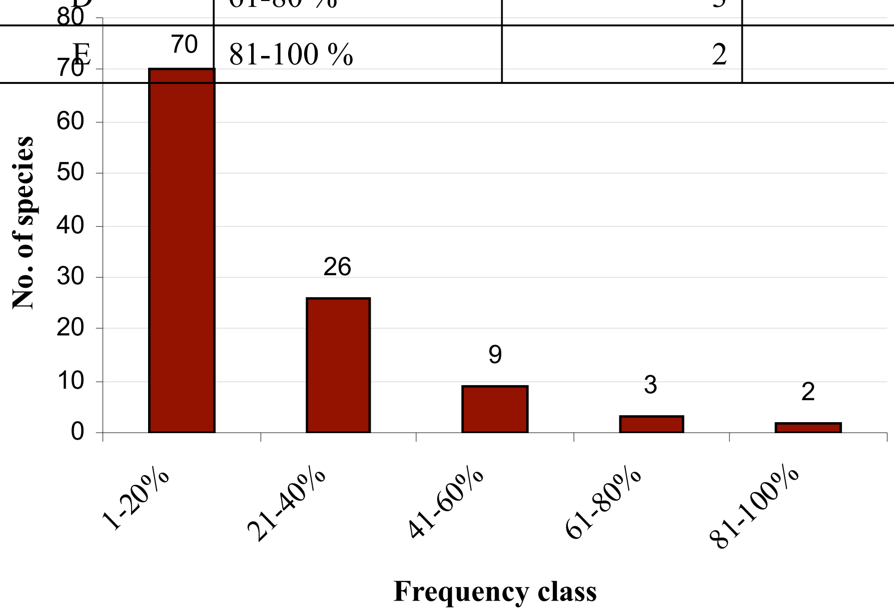


Figure (5) Species distribution by frequency classes ≥3cm

4.2.5 Diversity indices and evenness

Among the different measurement of species diversity indices, the floristic diversity of the Wusok area was analyzed using the Shannon Wiener index (H), Simpsons index (D), Brillouin (D), Shannon Maximum and minimum evenness (E), Brillouin (E) because these indices not only take taxa richness into account but also depend on the relative distribution of individuals. The value of diversity indices and evenness indices of individual sample plot and all sample indices are shown in table (2) and (3). According to the result, though the diversity indices of individual sample plot are low, all sample indexes are fairly high. Diversity value for all sample index of Shannon Wiener index (H) is 4.021, Simpsons index (D) is 37.160, Brillouin (D) is 3.849.

Table (3) Species diversity indices in the Wusok Dam site

Sample	Shannon Wiener H	Variance H	Simpsons Index (D)	Brillouin (D)
WS 1	2.666	0.021	14.440	2.152
WS 2	2.653	0.018	13.070	2.195
WS 3	2.869	0.013	18.800	2.388
WS 4	2.826	0.014	16.450	2.351
WS 5	3.156	0.009	26.960	2.644
WS 6	2.824	0.006	15.580	2.522
WS 7	2.679	0.009	12.720	2.352
WS 8	2.325	0.007	6.967	2.15
WS 9	2.746	0.009	9.677	2.481
WS 10	2.712	0.11	9.250	2.423
WS 11	2.969	0.88	13.910	2.645
All Sample Index	4.021		37.160	3.849
Jackknife Std Error	0.138		10.59	0.1206

Table (3) Evenness indices in the Wutsok Dam site

Sample	Shannon Maximum	Shannon Minimium	Simpson evenness (E)	Brillouin (E)
WS 1	2.944	1.989	0.7602	0.9066
WS 2	2.996	1.809	0.6533	0.89
WS 3	3.135	1.909	0.8173	0.9217
WS 4	3.091	1.852	0.7476	0.9192
WS 5	3.367	2.072	0.9298	0.9436
WS 6	3.135	1.144	0.6774	0.9025
WS 7	3.091	1.288	0.5784	0.8666
WS 8	3.258	0.7727	0.268	0.7114
WS 9	3.434	1.126	0.3122	0.7971
WS 10	3.296	1.174	0.3426	0.8201
WS 11	3.434	1.325	0.4486	0.864
All Sample Index	4.700	0.8025	0.3379	0.8567
Jackknife Std Error	0.041	0.1414	0.09503	0.02792

4.2.6. Forest structure

Stem density of ≥3cm was 2448 ha^{-1} and basal area was 67.3 m^2/ha in the Wusok dam site Table (4). Among the 11 sample plots studies, 110 tree species were recorded. Only one individual of 23 species were found only and these species were considered as unique species.

The 10 most abundance species in terms of basal area occupied 69.53% of the total, of which *Dipterocarpus obtusifolius* Teysm.ex.Mig. was the most dominant species in the study area with 33.11%, followed by *Ficus* sp.3 9.54%, *Elaeocarpus* sp. 5.23%, *Castanopsis calathiformis* (Skan) Resd &Wils 4.19%, *Caryota gigas* Hahn ex hodel 3.48%, *Sterculia* sp. 3.13%, *Lithocarpus* sp.1 2.98%, *Quercus* sp. 2.91%, *Pterocymbium* sp. 2.70%, and *Syzygium* sp.1 2.27% of the total basal area Figure (6).

Table (4) Consolidated detail of species inventory in the Wusok Dam site

Description	Results
No. of sample points	11
No. of tree species	110
Density (stem/ha)	2448
Basal area (m2/ha)	67.3
Total no. of unique species	23

The distribution of the basal area across DBH interval classes reveals the dominance of small stemmed individuals in the study area. The population structure by DBH class decreased from class to class with a steeper gradient in lower DBH classes and with a gentle slope in higher classes Figure (7) and Table (5). Out of total number of stems inventoried, 89.09% of stems were accumulated in the 3-60cm DBH class, 9.00% of stems in the 60-150cm, 2.78% in the 150-240cm, 0.55% in the 240-330cm and 330-480cm. The highest DBH was measured in the case of *Dipterocarpus obtusifolius* Teysm.ex.Mig. (460cm), *Ficus* sp.3 (345cm), *Elaeocarpus* sp. (340cm), *Castanopsis calathiformis* (Skan) Resd &Wils (290cm).

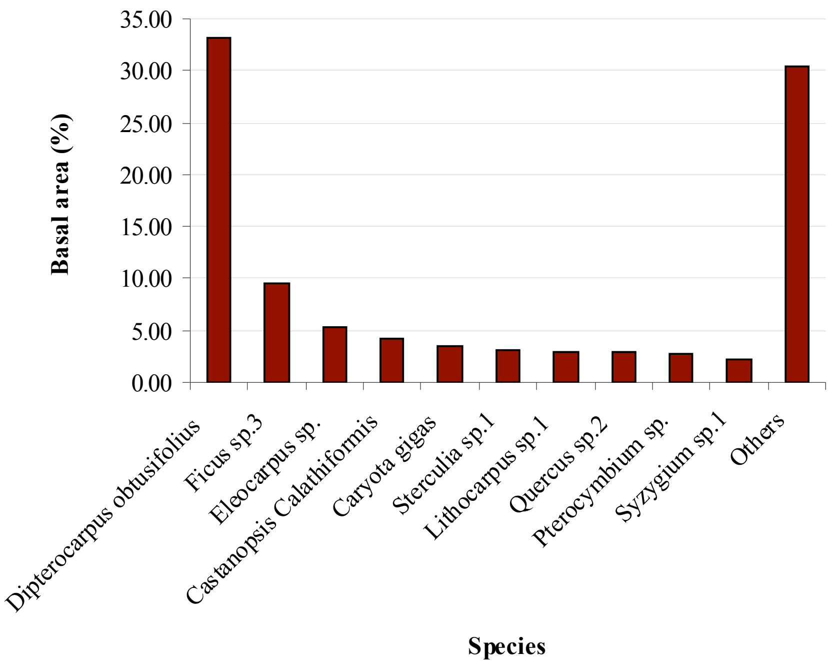


Figure (6) Ranking of relative basal area by species in the Wusok Dam site

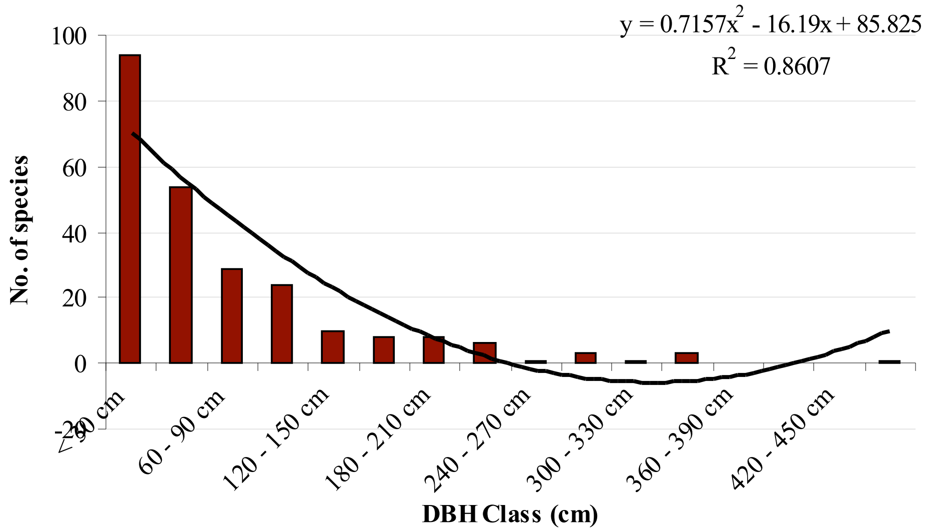


Figure (7) Species distribution by DBH classes

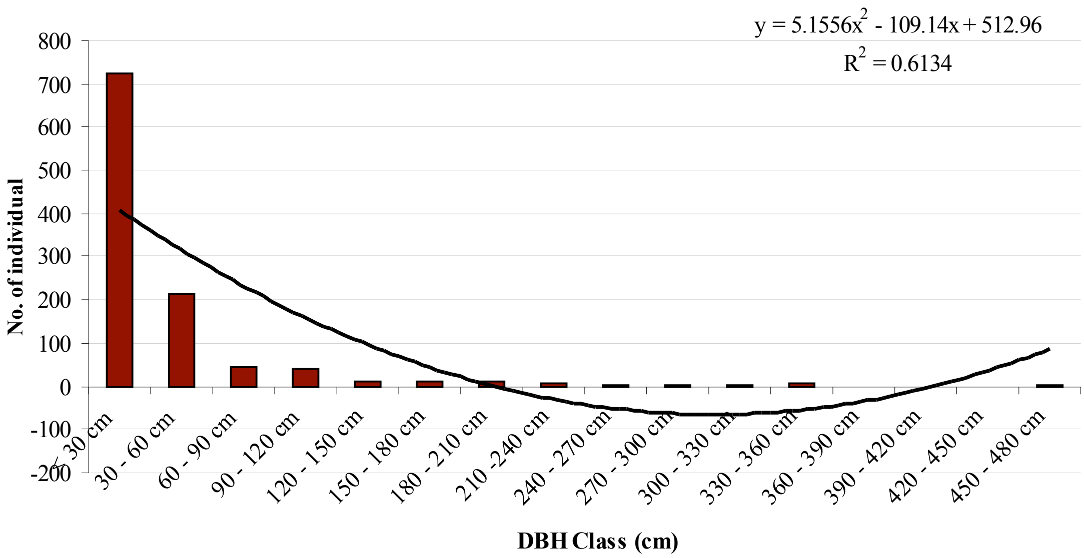


Figure (8) Population distribution by DBH classes

Table (5) Population density of tree species across DBH class interval

DBH Classes	No. of species	Total number of individual	% of total species	% of total individual
< 30 cm	94	726	38.84	67.41
30-60 cm	54	212	22.31	19.68
60-90 cm	29	45	11.98	4.18
90-120 cm	24	39	9.92	3.62
120-150 cm	10	13	4.13	1.21
150-180 cm	8	11	3.31	1.02
180-210 cm	8	13	3.31	1.21
210-240 cm	6	6	2.48	0.56
240-270 cm	1	2	0.41	0.19
270-300 cm	3	3	1.24	0.28
300-330 cm	1	1	0.41	0.09
330-360 cm	3	5	1.24	0.46
360-390 cm	-	-	0.00	0.00
390-420 cm	-	-	0.00	0.00
420-450 cm	-	-	0.00	0.00
450-480 cm	1	1	0.41	0.09
Total	**110**	**1077**	**100.00**	**100.00**

Tree distribution by height intervals shows that among the total number of 1077 individuals, 429 individuals (39.83%) belong to 3-10m category, followed by 425 individuals (39.46%) in 10-17m, 91 individuals (8.45%) in 17-24m, and 97 individuals (9.01%) in 24-31m, 1 individual (0.09%) in 31-38m. The height class of >38m includes (0.19%) of total individuals Table (6). <3m height trees of 32 individuals (2.97%) infer natural regeneration is poor or frequent disturbance on ground cover plant. The population structure by height classes in the Wusok area, 3-10m class is highest and gradually decreases to higher classes (Figure 9 and 10). The tallest individual trees were *Mallotus* sp. (43m), UN-6 (40m), *Ilex micrococca* Maxim. (34m), *Dipterocarpus obtusifolius* Teysm.ex.Mig. (30m), *Sterculia* sp.1 (30m), and *Ficus* sp.3 (30m),Total picture of height class shows that, 42.8% belong to <3-10m category, 47.91% in 10-24m, and 9.29% in 24->38m. The overall population structure indicates that study area represents mature stand.

Table (6) Population density of tree species across height class interval

Height Classes	No. of species	Total number of individual	% of total species	% of total individual
< 3 m	8	32	3.32	2.97
3-10 m	81	429	33.61	39.83
10-17 m	81	425	33.61	39.46
17-24 m	33	91	13.69	8.45
24-31 m	35	97	14.52	9.01
31-38 m	1	1	0.41	0.09
> 38 m	2	2	0.83	0.19
Total	110	1077	100.00	100.00

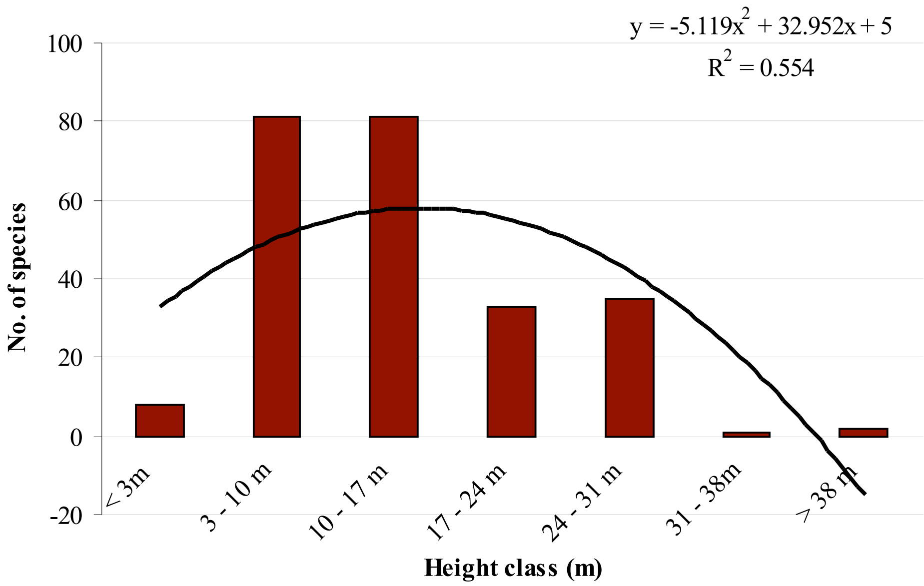


Figure (9) Species distribution by height classes

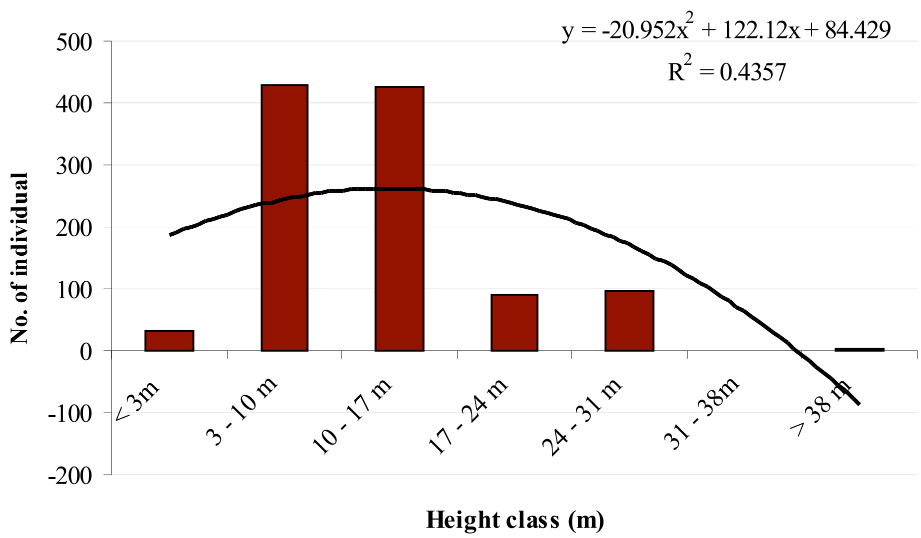


Figure (10) Population distribution by DBH classes

4.3. Discussion and Conclusion

A total of 110 tree species representing 79 genera and 43 families were analyzed in the study area. The main vegetation types discovered in Wusok and Pisa Dam sites can be grouped into four formations, i.e. low land evergreen forest, oak forest, lowland secondary forest, and bamboo forest. In some disturbed site, degraded forests are occurred.

The ten leading dominants by important value index in study area were *Dipterocarpus obtusifolius* Teysm.ex.Mig., *Sterculia* sp.1, *Ficus* sp.3, *Mallotus* sp., *Castanopsis calathiformis* (Skan) Resd &Wils, *Lithocarpus* sp.1, *Ilex micrococca* Maxim., *Ostodes paniculata* Blume, *Eurya* sp., and *Pterocymbium* sp. contributing highest IVI value (37.65, 14.23, 12.13, 11.01, 9.45, 7.96,7.37, 7.26, 7.21, 6.76) respectively. Those tree species could be considered as ecological indicator species of the study area.

In mature site, the largest trees can reach up to >31m in height while the main canopy is 24-31m with well developed understoreys. The canopy of the forest is more or less close, but in some disturbed site the canopy is open and the estimated height is probably not more than 15m, including stunted and cutover regrowth of the tree species.

Presence of high species diversity and richness indicates uniqueness and potentiality of Wusok area for conservation of ecosystem in totality.

The forest structures in the study area show all types of disturbance. The surrounding Wusok area has an insufficient protection status and so allows the exploitation of natural resources; such as firewood collection, logging, shifting cultivation, and hunting. Logging was the major destructive force and one of the influencing factors for forest structure.

4.4. Recommendation

4. The new access road to Wusok and Pisa should be implemented with great care and it should have minimal impacts on environment.

5. The socioeconomic development and community awareness on environment should be planned and implemented under the project. It may support the conservation and maintenance of remaining forest.

6. Reforestation project should be introduced and implemented in degraded area.

The flooded areas of dams are narrow and damage is minimal on terrestrial ecosystem since both dams are cascade, the cumulative impact assessment of hydrology should be carried out with special attention.

Appendix (1) Ranking of Important Value Index (IVI) in the Wusok Area

Ranking of Important Value Index (IVI) in the Wutsok Area

No.	Species Name	R.D. %	R.D.m %	R.F %	IVI %
1	*Dipterocarpus obtusifolius* Teysm.ex.Mig.	3.44	33.112	1.10	37.65
2	*Sterculia* sp.1	7.80	3.135	3.30	14.23
3	*Ficus* sp.3	1.49	9.544	1.10	12.13
4	*Mallotus* sp.	6.96	2.210	1.83	11.01
5	*Castanopsis calathiformis* (Skan) Resd &Wils	3.44	4.188	1.83	9.45
6	*Lithocarpus* sp.1	2.41	2.981	2.56	7.96
7	*Ilex micrococca* Maxim.	3.90	2.010	1.47	7.37
8	*Ostodes paniculata* Blume	2.79	1.182	3.30	7.26
9	*Eurya* sp.	4.18	1.567	1.47	7.21
10	*Pterocymbium* sp.	2.23	2.696	1.83	6.76
11	*Saurauia* sp.1	3.44	0.722	2.56	6.72
12	*Elaeocarpus* sp.	0.74	5.229	0.73	6.70
13	*Caryota gigas*Hahn ex hodel	0.84	3.480	2.20	6.51
14	*Quercus* sp.2	1.95	2.908	1.47	6.32
15	*Saurauia* sp.2	4.18	0.467	1.10	5.74
16	*Quercus* sp.1	1.67	1.755	2.20	5.62
17	*Syzygium* sp.1	1.39	2.266	1.47	5.12
18	*Callicarpa* sp.	2.41	0.715	1.47	4.59
19	*Diphanimorpha* sp.	3.16	0.166	1.10	4.42
20	*Canthium* sp.	1.67	0.141	2.56	4.38
21	*Ficus* sp.1	1.21	0.766	2.20	4.17
22	*Chisocheton siamensis* Craib	0.93	0.889	1.83	3.65
23	*Litsea* sp.1	0.84	0.562	2.20	3.60
24	*Boehmeria* sp.	1.49	0.151	1.83	3.47
25	*Maesa*sp.	2.41	0.038	0.73	3.18
26	*Knema furfuracea* (HK. F.et Th.) Warb.	1.39	0.682	1.10	3.17
27	*Bischofia* sp.	1.21	0.327	1.47	3.00
28	*Macaranga* sp.	1.30	0.216	1.10	2.61
29	*Saurauia napaulensis* DC.	1.30	0.557	0.73	2.59
30	*Castanopsis tribuloides* A.DC.	0.46	0.611	1.47	2.54
31	*Ficus semicordata* Buch.- Ham ex. J. E. Sm.	0.74	0.609	1.10	2.45
32	*Sterculia* sp.2	1.02	0.316	1.10	2.44
33	UN-9	0.65	0.207	1.47	2.32
34	*Lasianthus* sp.	0.74	0.015	1.47	2.22
35	*Myrica* sp.	0.37	1.099	0.73	2.20
No.	**Species Name**	**R.D. %**	**R.D.m %**	**R.F %**	**IVI %**

No.	Species Name	R.D. %	R.D.m %	R.F %	IVI %
36	*Mitrephora* sp.	0.19	1.586	0.37	2.14
37	*Oxyspara paniculata* (D.Don.) DC.	1.30	0.090	0.73	2.12
38	*Nothaphoeba* sp.1	0.19	1.179	0.73	2.10
39	*Leea* sp.	1.30	0.056	0.73	2.09
40	*Pterospermum cinnamonemum* Kurz	0.46	0.138	1.47	2.07
41	*Ficus hispida* Forsk.	1.11	0.138	0.73	1.98
42	*Polyalthia* sp.	0.74	0.022	1.10	1.86
43	*Castanopsis* sp1	0.37	0.370	1.10	1.84
44	*Arenga triandra* Roxb.	1.02	0.018	0.73	1.77
45	*Engelhardtia spicata* Blume	0.09	1.302	0.37	1.76
46	*Schefflera* sp.	0.56	0.062	1.10	1.72
47	*Ficus roxburghii* Wall.	0.19	0.799	0.73	1.72
48	*Phoebe* sp.2	0.56	0.045	1.10	1.70
49	UN-12	0.19	1.143	0.37	1.70
50	*Cinnamomum*sp.1	0.56	0.008	1.10	1.66
51	*Machilus* sp.	0.46	0.055	1.10	1.62
52	*Aralia* sp.	0.46	0.054	1.10	1.62
53	*Ilex* sp.	0.65	0.139	0.73	1.52
54	*Litsea* sp.2	0.28	0.072	1.10	1.45
55	*Diospyros* sp.	0.46	0.236	0.73	1.43
56	*Symplocos* sp.	0.65	0.018	0.73	1.40
57	*Ardisia* sp.	0.84	0.144	0.37	1.35
58	UN-4	0.46	0.095	0.73	1.29
59	*Symplocos microphylla* Wight.	0.46	0.048	0.73	1.24
60	*Wendlandia* sp.	0.28	0.229	0.73	1.24
61	*Agalia* sp.	0.46	0.015	0.73	1.21
62	*Litsea cubeba* (Lour.) Pers.	0.19	0.232	0.73	1.15
63	*Pteris* sp.	0.09	0.689	0.37	1.15
64	*Betula* sp.	0.28	0.074	0.73	1.09
65	*Cyathea gigantea* (Wall. Ex Hook.) Holttum	0.28	0.072	0.73	1.08
66	UN-11	0.19	0.527	0.37	1.08
67	*Callicarpa arborea* Roxb.	0.65	0.045	0.37	1.06
68	*Cinnamomum* sp.2	0.09	0.597	0.37	1.06
69	*Myristica angustifolia* Roxb.	0.19	0.128	0.73	1.05
70	UN-8	0.28	0.027	0.73	1.04
71	*Maesa montana* A.DC.	0.65	0.021	0.37	1.04
72	*Garcinia* sp.	0.28	0.020	0.73	1.03
73	*Alnus nepalensis* D. Don	0.19	0.457	0.37	1.01
74	*Eurya* sp.1	0.19	0.045	0.73	0.96

75	*Castanopsis argyrophylla* King.	0.37	0.213	0.37	0.95
76	*Meliosma* sp.	0.19	0.030	0.73	0.95
77	*Glochidion* sp.	0.19	0.030	0.73	0.95
78	*Phoebe* sp.1	0.19	0.017	0.73	0.94
79	*Gmelina* sp.	0.46	0.034	0.37	0.86
80	UN-2	0.46	0.032	0.37	0.86
81	*Lithocarpus* sp.2	0.09	0.331	0.37	0.79
82	*Indigofera* sp.	0.19	0.147	0.37	0.70
83	*Lannea* sp.	0.28	0.043	0.37	0.69
84	*Bischofia javanica* Blume	0.28	0.027	0.37	0.67
85	UN-7	0.28	0.008	0.37	0.65
86	*Clerodendrum* sp.	0.28	0.002	0.37	0.65
87	*Limnophila* sp.	0.19	0.081	0.37	0.63
88	*Flacourtia* sp.	0.09	0.143	0.37	0.60
89	*Archidendron clypearia* (Jack) Nielsen	0.19	0.024	0.37	0.58
90	*Ziziphus* sp.	0.19	0.015	0.37	0.57
91	UN-5	0.19	0.013	0.37	0.56
92	*Nothaphoebe* sp.2	0.19	0.005	0.37	0.56
93	*Dichroa* sp.	0.19	0.002	0.37	0.55
94	*Meliosma* sp.2	0.09	0.073	0.37	0.53
95	UN-3	0.09	0.041	0.37	0.50
96	*Saurauia benghalensis*	0.09	0.031	0.37	0.49
97	*Streblus* sp.	0.09	0.031	0.37	0.49
98	UN-6	0.09	0.029	0.37	0.49
99	*Chesocheton* sp.	0.09	0.024	0.37	0.48
100	*Ficus* sp.2	0.09	0.011	0.37	0.47
101	*Syzygium* sp.2	0.09	0.011	0.37	0.47
102	*Litsea monopetala* (Roxb.) Pers.	0.09	0.009	0.37	0.47
103	UN-10	0.09	0.007	0.37	0.47
104	*Arenga saccharifera* Labill.	0.09	0.004	0.37	0.46
105	*Dolichandron* sp.	0.09	0.004	0.37	0.46
106	*Schima* sp.	0.09	0.003	0.37	0.46
107	UN-1	0.09	0.003	0.37	0.46
108	*Maesa chisia* Godayari	0.09	0.002	0.37	0.46
109	*Morus* sp.	0.09	0.002	0.37	0.46
110	*Sterculia* sp.3	0.09	0.002	0.37	0.46
	Total	56.36	27.94	74.73	159.03

Chapter V

5. Khaunglanhpu Dam

5.1. Study area

The location of Khaunglanphu area is between 26º30´N, 98º 00´E and 27º30´N, 98º 40 ´E near Sangn hkun Hkyet village on downstream confluence mouth of Mayhka River and Achanhti stream. The dam site lies between high mountains and riverine. From biodiversity standpoint, the study area lies WWF Eco-region of Northern Triangle Temperate forest. It is also located within the priority site for conservation investment of Northern mountain forest complex. The Hkakaborizi NP, Hponganrazi W.S and Emawbum mountain forest are its watershed area. So the area is the biodiversity hot-spot area and globally outstanding for conservation. A detailed map of the study area is given in figure (1.4).

5.1.1. Participants

Dr Win Myint, Daw Khin Swe Lwin, Daw Ei Ei Phyo, and U Nay Phyo Aung.

5.2. Results

5.2.1. Forest composition

To clarify the tree species composition and their distribution, fourteen quadrats (20x20 m each) were set up and observed in the flooded area of Khaunglanhpu dam site. In the fourteen sampling plots (.56ha), total number of species with DBH ≥3cm was 56 species; of which 7 species are under identification. The dominant families of tree species were Fagaceae (8 species), Euphorbiaceae (6 species), Lauraceae (5 species), Verbenaceae (3 species) Figure (3). The main vegetation types encountered in Khaunglanhpu Dam site can be grouped into four formations; high land evergreen forest, oak forest, highland secondary forest, and bamboo forest. Due to the human impact, degraded forest occurs in most of the places. In some disturbed sites, wild banana and bushes can be seen in patches. Highland evergreen forests can be typically distinguished by *Saurauia* sp., *Spondias* sp., *Cinnamomum* sp., *Litsea cubeba., Macaranga diversifolia,* associated with *Ficus* sp*., Elaeocarpus* sp. are found in tree layer. Shrub layer is dominated by *Maesa* sp., *Polygonum* sp*., Phlogacanthus pubinervius,* and *Buddleja* sp.. Herb layer is dominated by *Oxalis* sp., *Begonia* sp., *Commelina* sp., and *Viola* sp.. Oak forest can be typically distinguished by *Castanopsis tribuloides, Castanopsis diversiflia, Castanopsis* sp., *Lithocarpus* sp. associated with *Macaranga denticulata, Spondias* sp. and *Cinnamomum* sp. are found in tree layer. Shrub layer is dominated by *Osbeckia* sp., and *Rubus* sp.. The ground cover of dominated by *Commelina* sp., *Polygonum* sp., and *Plantago* sp.. In the high land secondary forest, *Michelia champaca., Schefflera* sp*., Cinnamomum* sp. and *Saurauia napaulensis* are found in tree layer. Herb layer is dominated by *Begonia semperflorens., Adiantum* sp. and *Polygonum* sp.. In the bamboo forest *Dendrocalamus hamiltonii* Ness (Wabo Myatsan), *D. giganteus* Munro(Wabowa), and *Melocalamus compactiflorus* (Kurz) Benth.(Wa-nwe) mainly occur.

The species area curves of the investigated stands are shown in the figure (4). The species area curves, which express the number of species in relation to change in area of habitat, not only consider the minimum representative area but also detect the habitat diversity within the survey area (Fangliang He and Pierre Legendre, 1996). The trend of species area curve shows tendency towards flattening. Therefore the sample areas can be said to be sufficient as a minimum representative area for the study.

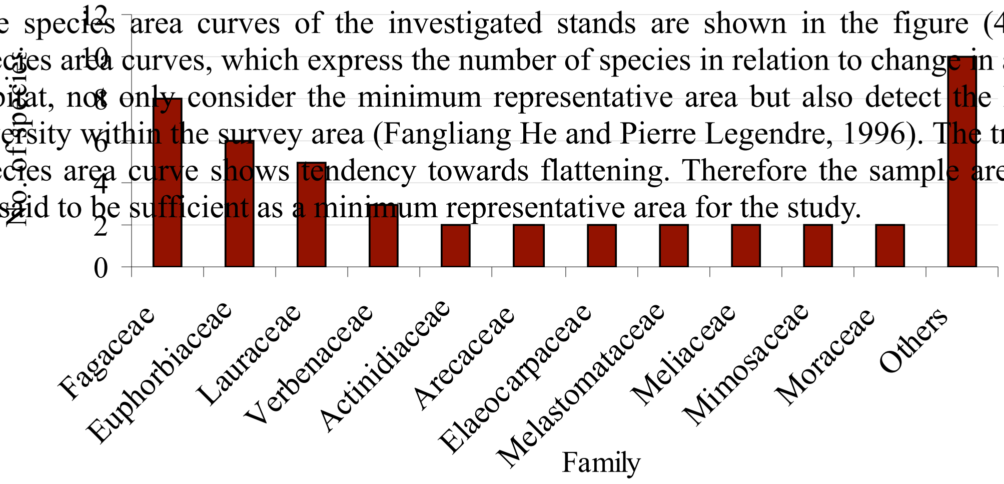


Figure (2) Ranking of dominant family by number of species composition

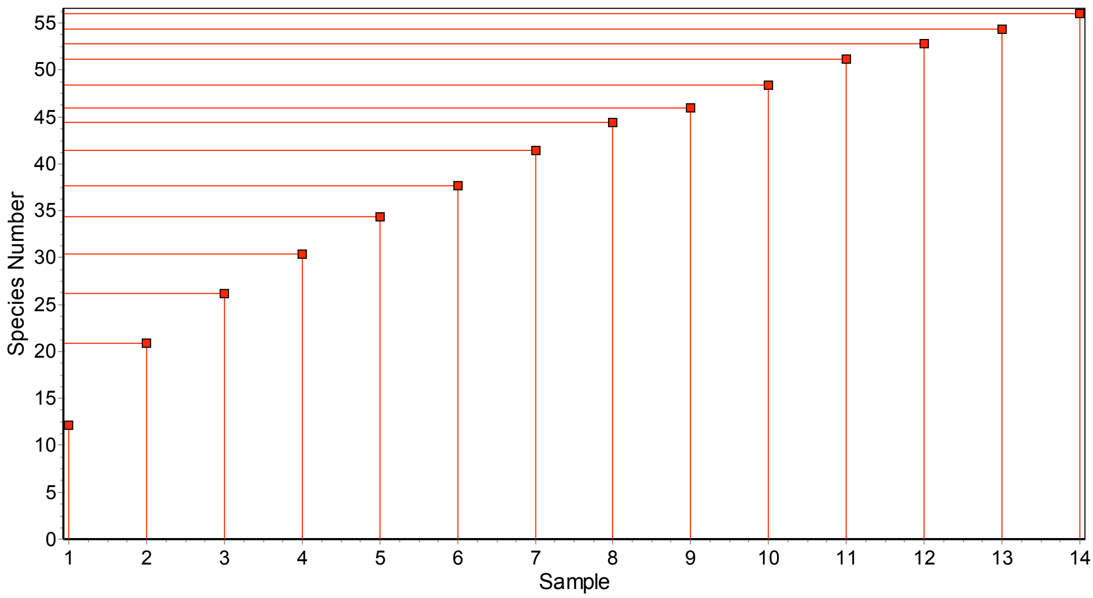


Figure (3) Plot of species accumulation in the Khaunglanhpu Dam Site

5.2.2. Important Value Index (IVI)

Ranking of ecological significance by IVI of tree species in the study area is given in appendix (1). The tree layer in the study area is dominated by *Alnus nepalensis* D. Don with the highest IVI of 33.76 %, the second most dominant species is *Castanopsis diversifolia* (Kurz) King (IVI = 21.51%) and *Castanopsis acuminatissima* (Bl.) A. DC. (IVI= 19.57 %) is the third. Ecologically dominance of top ten species based on IVI value is shown in figure 4. Those species could be considered as ecological indicator species of Khaunglanhpu area. The number of species greater than 5% IVI value was only sixteen species (Appendix 1).

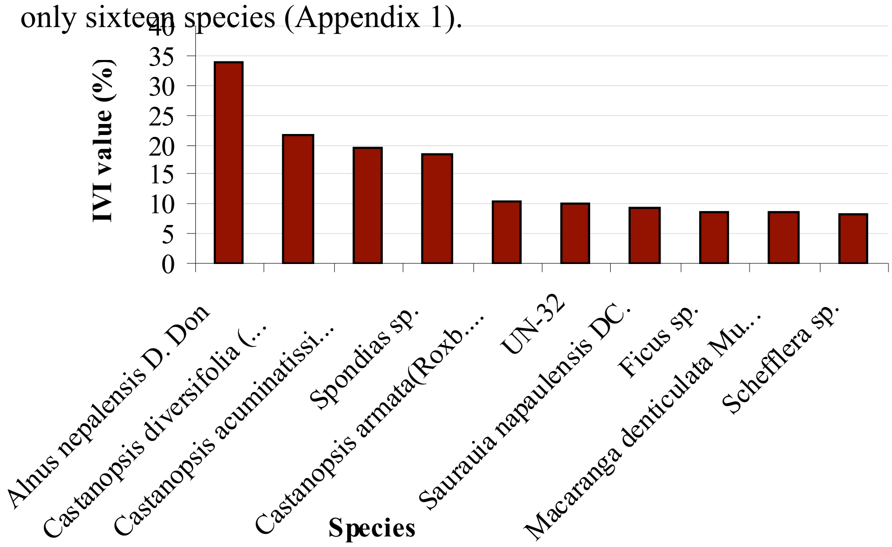


Figure (4) Important Value Index of top ten species in the Khaunglanhpu Dam Site

5.2.3. Species distribution by frequency classes

In order to clarify the homogeneity or heterogeneity of the floristic distribution in the study area, species distribution by frequency classes was examined. According to the outcome of frequency chart, 82.14 % of the total number of species was in lower frequency classes, A and B, while low value was observed only in higher frequency class D (Table 1, Figure 5). It indicates that the forest in Khaunglanhpu area is floristically heterogeneous, according to Lamprecht (1989). The species which fall in high frequency class D was *Castanopsis acuminatissima* (Bl.) A. DC. *Macaranga diversifolia* and *Castanopsis diversifolia* (Kurz) King,. These species can be considered as the most common species in the Khaunglanhpu area.

Table (1) Species distribution by frequency classes ≥3cm

Frequency Class	Frequency range	No. of species	% of total species frequency distribution
A	1-20 %	35	62.50
B	21-40 %	11	19.64
C	41-60 %	7	12.50
D	61-80 %	3	5.36
E	81-100 %	-	-

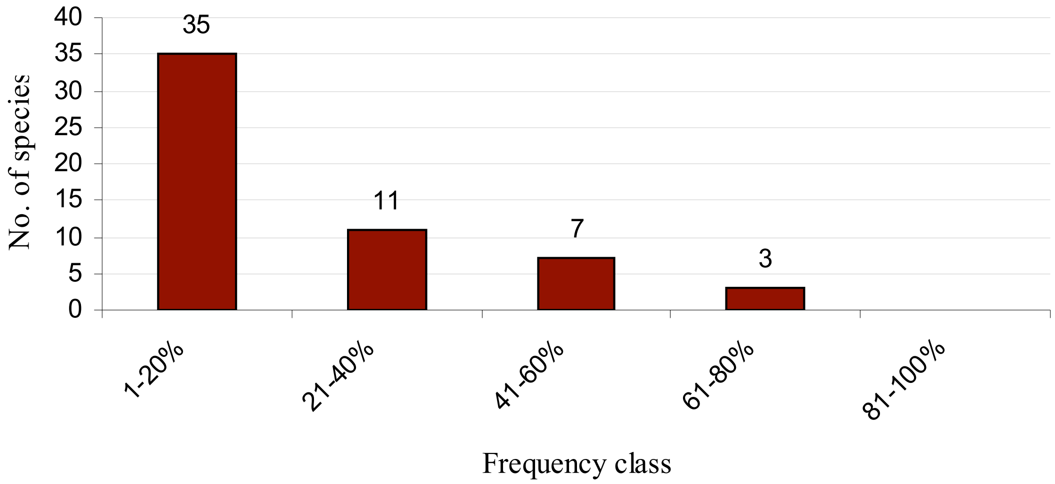


Figure (5) Species distribution by frequency classes ≥3cm

5.2.4. Diversity indices and evenness

Among the different measurement of species diversity indices, the floristic diversity of the Khaunglanhpu area was analyzed using the Shannon Wiener index (H), Simpsons index (D), Brillouin (D), Shannon Maximum and minimum evenness (E), Brillouin (E) because these indices not only take taxa richness into account but also depend on the relative distribution of individuals. The value of diversity indices and evenness indices of individual sample plot and all sample indices are shown in table (2) and (3). According to the result, the diversity indices of individual sample plot and all sample indexes are relatively low. Diversity value for all sample index of Shannon Wiener index (H) is 3.527, Simpsons index (D) is 25.5, Brillouin (D) is 3.318.

Table (2) Species diversity indices in the Khaunglanhpu Dam site

Sample	Shannon Wiener H	Variance H	Simpsons Index (D)	Brillouin (D)
KLP 1	2.463	0.019	18.400	1.902
KLP 2	2.602	0.016	20.300	2.047
KLP 3	2.719	0.012	27.190	2.138
KLP 4	2.372	0.007	15.540	1.932
KLP 5	2.076	0.022	7.808	1.687
KLP 6	2.306	0.008	12.350	1.926
KLP 7	1.746	0.015	5.293	1.499
KLP 8	1.942	0.028	6.522	1.554
KLP 9	2.397	0.016	13.680	1.932
KLP 10	2.372	0.007	15.540	1.932
KLP 11	2.023	0.027	7.131	1.639
KLP 12	1.701	0.012	4.598	1.507
KLP 13	2.315	0.023	13.14	1.801
KLP 14	2.362	0.01645	14.04	1.876
All Sample Index	3.527		25.5	3.318
Jackknife Std Error	0.08919		3.092	0.07386

Table (3) Evenness indices in the Khaunglanhpu Dam site

Sample	Shannon Maximum	Shannon Minimium	Simpson Evenness (E)	Brillouin (E)
KLP 1	2.565	1.936	1.415	0.9681
KLP 2	2.708	1.967	1.353	0.9643
KLP 3	2.773	2.047	1.699	0.9875
KLP 4	2.398	1.404	1.412	0.9951
KLP 5	2.303	1.301	0.7808	0.8987
KLP 6	2.398	1.23	1.123	0.965
KLP 7	2.079	0.8199	0.6616	0.8357
KLP 8	2.197	1.292	0.7246	0.8814
KLP 9	2.565	1.629	1.052	0.942
KLP 10	2.398	1.404	1.412	0.9951
KLP 11	2.398	1.404	0.6483	0.8442
KLP 12	2.079	0.6288	0.5747	0.812
KLP 13	2.485	1.789	1.095	0.9305
KLP 14	2.485	1.653	1.17	0.9565
All Sample Index	4.025	0.8794	0.4554	0.8769
Jackknife Std Error	0.094	0.1089	0.06093	0.01819

5.2.5. Forest structure

Stem density of ≥3cm was 784 ha^{-1} and basal area was 53.3 m^2/ha in the Khaunglanhpu dam site Table (4). Among the 14 sample plots studies, 56 tree species were recorded, only one individual of 9 species were found and these species were considered as unique species. The 10 most abundance species in terms of basal area occupied 72.17% of the total, of which *Alnus nepalensis* D. Don was the most dominant species in the study area with 20.50%, followed by UN-5 9.25%, *Castanopsis diversifolia* (Kurz) King 8.14%, *Castanopsis acuminatissima* (Bl.) A. DC. 8.02%, *Spondias* sp. 5.81%, *Alseodaphne nigrescens* (Gamble) Kosterm. 5.29%, *Castanopsis armata* Spach 4.84%, *Osbeckia* sp. 4.14%, *Castanopsis argyrophylla* King. 3.22%, and *Ficus* sp.2.96% of the total basal area Figure (6).

Table (4) Consolidated detail of species inventory in the Khaunglanhpu Dam site

Description	Results
No. of sample points	14
No. of tree species	56
Density (stem/ha)	784
Basal area (m^2/ha)	55.3
Total No. of unique species	9

The distribution of the basal area across DBH interval classes reveals the dominance of small stemmed individuals in the study area. The population structure by DBH class decreased from class to class with a steeper gradient in lower DBH classes and with a gentle slope in higher classes Figure (7) and Table (5). Out of total number of stems inventoried, 44.87% of stems were accumulated in the 3-60cm DBH class, 44.88% of stems in the 60-150cm, 9.34% in the 150-240cm, 0.68% in the 240-330cm, only 0.23% occurs in >570cm. The highest DBH was measured in the case of UN-5 (600cm), *Alseodaphne nigrescens* (Gamble) Kosterm (250cm), *Alnus nepalensis* D. Don (250cm), *Spondias* sp. (230cm).

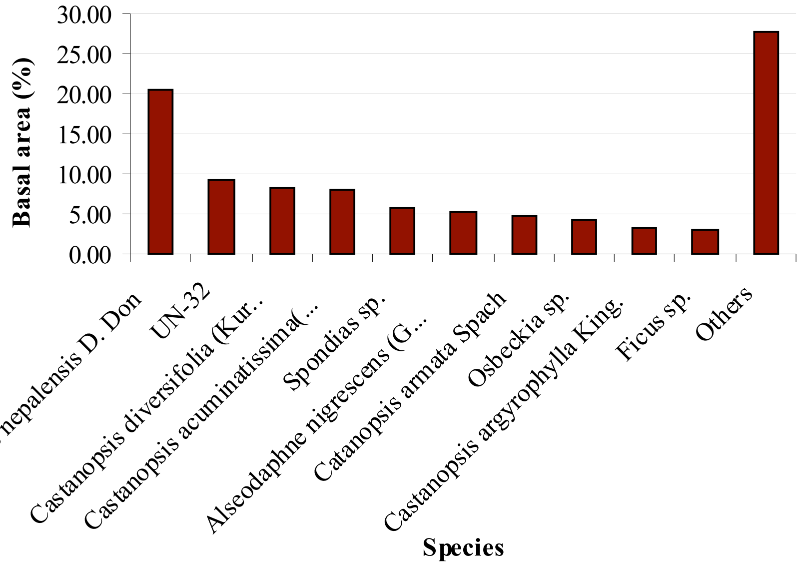


Figure (6) Ranking of relative basal area by species in the Khaunglanhpu Dam site

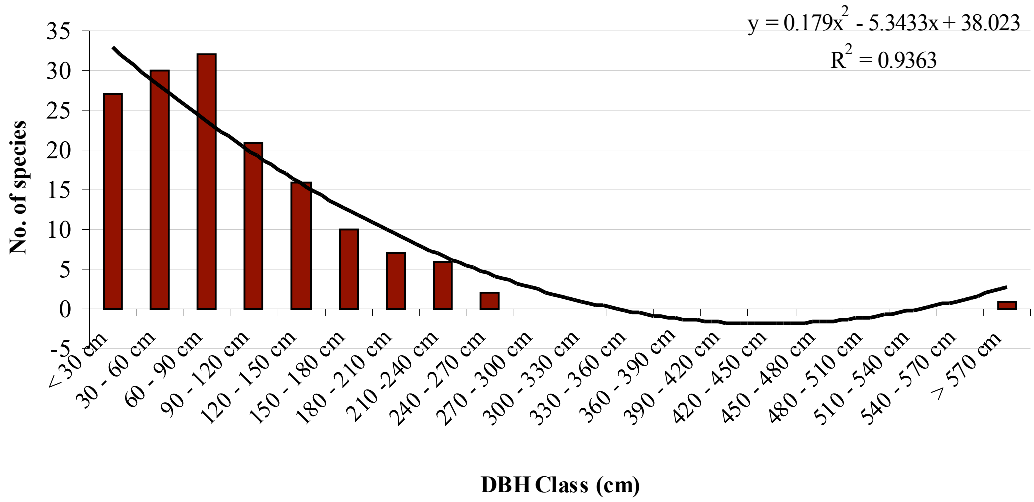


Figure (7) Species distribution by DBH classes

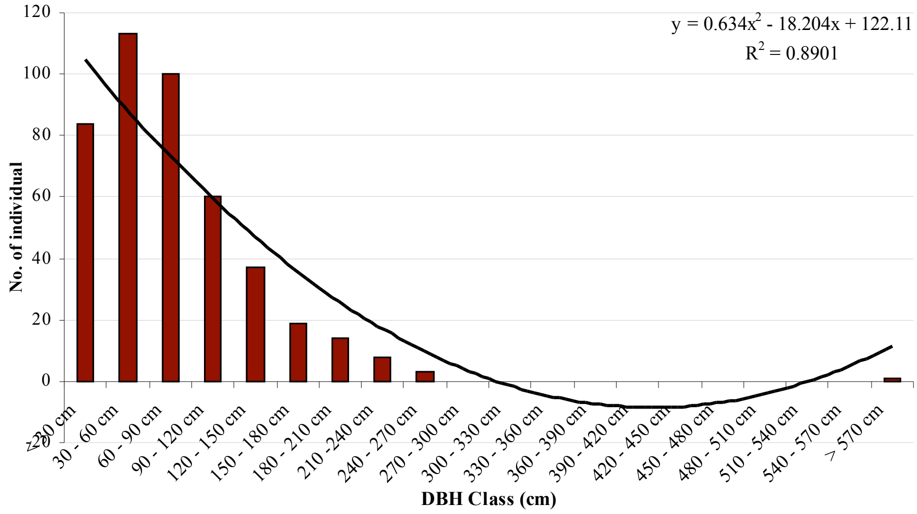


Figure (8) Population distribution by DBH classes

Table (5) Population density of tree species across DBH class interval

DBH Classes	No. of species	Total number of individual	% of total species	% of total individual
< 30 cm	27	84	17.76	19.13
30-60 cm	30	113	19.74	25.74
60-90 cm	32	100	21.05	22.78
90-120 cm	21	60	13.82	13.67
120-150 cm	16	37	10.53	8.43
150-180 cm	10	19	6.58	4.33
180-210 cm	7	14	4.61	3.19
210-240 cm	6	8	3.95	1.82
240-270 cm	2	3	1.32	0.68
270-300 cm	-	0	0.00	0.00
300-330 cm	-	0	0.00	0.00
330-360 cm	-	0	0.00	0.00
360-390 cm	-	0	0.00	0.00
390-420 cm	-	0	0.00	0.00
420-450 cm	-	0	0.00	0.00
450-480 cm	-	0	0.00	0.00
480-510 cm	-	0	0.00	0.00
510-540 cm	-	0	0.00	0.00
540-570 cm	-	0	0.00	0.00
> 570 cm	1	1	0.66	0.23
Total	56	439	100.00	100.00

Tree distribution by height intervals shows that among the 439 total number of individual, 151 individuals (34.40%) belong to 3-10m category, followed by 158 individuals (35.99%) in 10-17m, 97 individuals (22.10%) in 17-24m, 31 individuals (7.06%) in 24-31m. The height class of 31-38m includes only (0.46%) of total individuals Table (6). The population structure by height classes in the Khaunglanhpu area, 3-10m class is the highest and gradually decreases to higher classes (Figure 10 and 11). The tallest individual trees were UN-5 (36m), *Alnus nepalensis* D. Don (35m), *Osbeckia* sp. (30m), *Spondias* sp. (30m), *Lithocarpus* sp. (30m), and *Castanopsis argyrophylla King.* (30m). Total picture of height class shows that, 34.40% belong to <3-10m category, 58.09% in 10-24m, and 7.52% in 24->31m. The overall population structure indicates that study area represents mature stand.

Table (6) Population density of tree species across height class interval

Height Classes	No. of species	Total number of individual	% of total species	% of total individual
< 3 m	0	0	0.0	0.0
3-10 m	38	151	36.2	34.40
10-17 m	35	158	33.3	35.99
17-24 m	19	97	18.1	22.10
24-31 m	11	31	10.5	7.06
31-38 m	2	2	1.9	0.46
Total	56	439	100.00	100.00

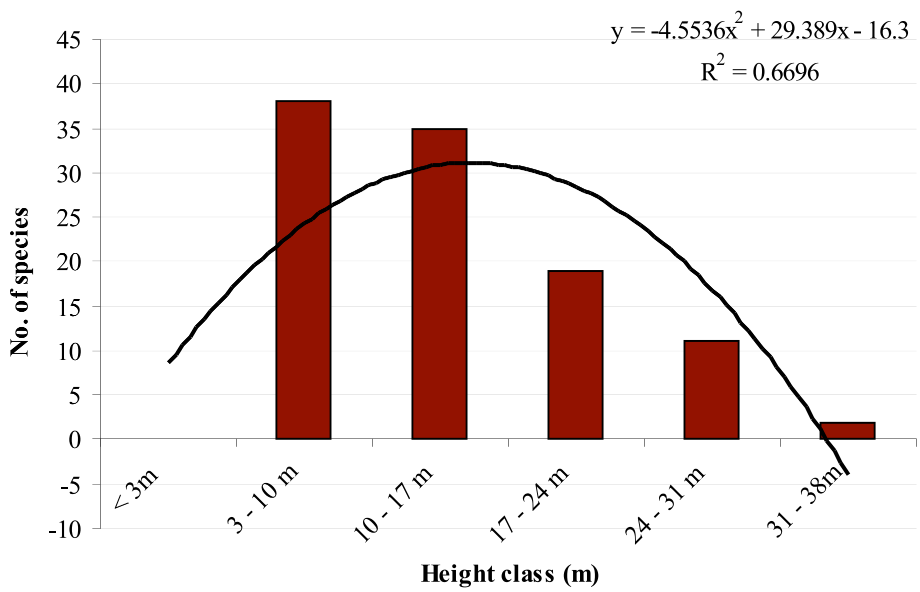


Figure (9) Species distribution by height classes

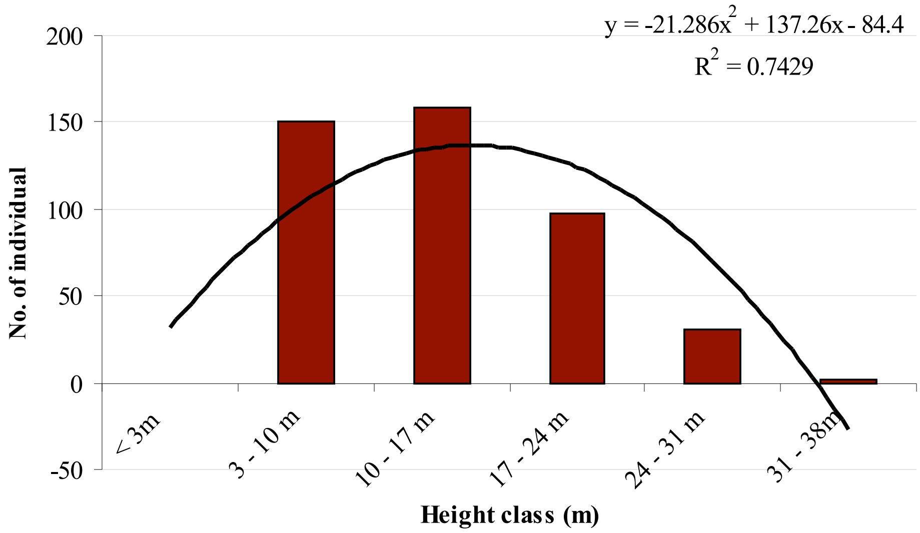


Figure (10) Population distribution by DBH classes

5.3. Discussion and Conclusion

A total of 56 tree species representing 41 genera and 25 families were analyzed in the study area. The main vegetation types discovered in Khaunglanphu Dam sites can be grouped into four formations, i.e. highland evergreen forest, highland secondary forest, oak forest, and bamboo forest. In some disturbed sites, degraded forests occur.

The ten leading dominants by important value index in study area were *Alnus nepalensis* D. Don, *Castanopsis diversifolia* (Kurz) King, *Castanopsis acuminatissima* (Bl.) A. DC., *Spondias* sp., *Castanopsis armata* (Roxb.) Spach. Prodr., UN-5, *Saurauia napaulensis* DC., *Ficus* sp., *Macaranga denticulata* Muell. Arg., and *Schefflera* sp. contributing highest IVI value (33.76, 21.51, 19.57, 18.38, 10.47, 10.11, 9.38, 8.76, 8.56, 8.16) respectively. Those tree species could be considered as ecological indicator species of the study area.

In some sites, the largest trees can reach up to >31m in height while the main canopy is 17-24m. The canopy of the forest is more or less sparse and in some disturbed site the canopy is open and the estimated height is probably 12 m and ground cover is dominated by *Oxalis* sp., *Begonia* sp., *Commelina* sp., and *Viola* sp..

The forest structure in the study area illustrates some types of disturbance. The surrounding of Khaunglanphu area has insufficient protection status and so shifting cultivation, firewood collection and hunting occur as common practices. Shifting cultivation is one of the main factors for habitat loss and deforestation. So the species diversity in the area is low.

The following species that recorded in the study area is assessing in IUCN Red list as follows;

No.	Botanical Name	Family	Red Lists	Year
1.	*Taiwania cryptomeriodes* Hayata	Taxodiaceae	VU Ald	IUCN-2000

Recommendation

1. The flooded areas of dams are narrow and damage is minimal on terrestrial ecosystem since both dams are cascade, the cumulative impact assessment of hydrology should be carried out with special attention.

2. The socioeconomic development and community awareness on environment should be planned and implemented under the project. It may support the conservation and maintenance of remaining forest.

3. To substitute the inundated forest cover by dam construction, reforestation project should be implemented.

4. Resettlement area for inundated villages should be selected in environmentally least impact area.

Appendix (1) Ranking of Important Value Index (IVI) in the Khaunglanhpu Area

No.	Species Name	R.D. %	R.D.m %	R.F %	IVI %
1	*Alnus nepalensis* D. Don	8.88	20.50	4.38	33.76
2	*Castanopsis diversifolia* (Kurz) King	7.74	8.14	5.63	21.51
3	*Castanopsis acuminatissima*(Bl.) A. DC.	5.92	8.02	5.63	19.57
4	*Spondias* sp.	8.20	5.81	4.38	18.38
5	*Castanopsis armata*(Roxb.) Spach. Prodr.	2.51	4.84	3.13	10.47
6	UN-5	0.23	9.25	0.63	10.11
7	*Saurauia napaulensis* DC.	2.96	2.67	3.75	9.38
8	*Ficus* sp.	4.56	2.96	1.25	8.76
9	*Macaranga denticulata* Muell. Arg.	5.92	1.38	1.25	8.56
10	*Schefflera* sp.	3.64	0.77	3.75	8.16
11	*Ficus roxburghii* Wall.	2.05	1.05	5.00	8.10
12	*Alseodaphne nigrescens* (Gamble) Kosterm.	1.37	5.29	1.25	7.91
13	*Osbeckia* sp.1	2.73	4.14	0.63	7.50
14	*Saurauia roxburghii* Wall.	2.28	2.71	2.50	7.48
15	*Chisocheton siamensis* Craib	1.37	1.81	3.75	6.93
16	*Grewia* sp.	4.56	0.45	1.25	6.25
17	*Macaranga diversifolia*	0.46	0.15	5.63	6.23
18	*Castanopsis argyrophylla* King.	1.37	3.22	1.25	5.84
19	*Lithocarpus* sp.	2.05	2.38	0.63	5.06
20	*Engelhardtia spicata* Blume	0.68	1.06	3.13	4.86
21	*Caryota gigas*Hahn ex hodel	0.91	1.96	1.88	4.74
22	*Glochidion* sp.	0.91	0.06	3.75	4.72
23	*Lithocarpus craibianus* barn.	0.46	1.58	2.50	4.53
24	*Macaranga kurzii* (O.k.) Pax & Hoffm.	3.19	0.55	0.63	4.36
25	*Litsea cubeba* (Lour.) Pers.	1.82	0.64	1.88	4.34
26	*Albizia odoratissima* (L.f.) Benth.	0.91	2.10	1.25	4.26

No.	Species Name	R.D. %	R.D.m %	R.F %	IVI %
27	UN-2	1.82	0.27	1.88	3.97
28	*Amoora rohituka* W.& A.	1.37	0.52	1.88	3.77
29	*Cinnamomum* sp.	1.82	0.45	1.25	3.53
30	*Trema orientalis* (L.) Blume	1.14	0.28	1.88	3.29
31	*Callicarpa* sp.	0.91	0.23	1.88	3.02
32	*Cinnamomum* sp.2	1.82	0.23	0.63	2.68
33	*Elaeocarpus* sp.1	1.14	0.21	1.25	2.60
34	*Caryota urens*L.	1.14	0.15	1.25	2.54
35	*Symplocos macrophylla* Wight.	1.14	0.02	1.25	2.41
36	*Hydrangea aspera* D. Don	0.91	0.07	1.25	2.23
37	*Macaranga* sp.	0.23	0.13	1.88	2.23
38	*Michelia champaca* L.	0.91	0.61	0.63	2.15
39	UN-6	0.68	0.70	0.63	2.01
40	*Elaeagnus montana* Makino	0.68	0.02	1.25	1.96
41	*Albizia* sp.	0.68	0.63	0.63	1.94
42	*Quarcus* sp.	0.68	0.58	0.63	1.89
43	*Machilus* sp.	0.68	0.45	0.63	1.76
44	UN-7	0.46	0.02	1.25	1.73
45	*Elaeocarpus* sp.2	0.46	0.33	0.63	1.41
46	UN-3	0.68	0.03	0.63	1.34
47	*Agave sisalana* Perr.	0.46	0.15	0.63	1.23
48	UN-1	0.46	0.10	0.63	1.18
49	*Alstonia angustifolia* Wall.	0.46	0.00	0.63	1.08
50	*Vitex* sp.	0.23	0.13	0.63	0.98
51	*Antidesma* sp.	0.23	0.05	0.63	0.90
52	*Cordia myxa* L.	0.23	0.04	0.63	0.89
53	*Castanopsis calathiformis* (Skan) Resd &Wils	0.23	0.04	0.63	0.89
54	UN-4	0.23	0.02	0.63	0.87
55	*Osbeckia* sp.2	0.23	0.01	0.63	0.86
56	*Clerodendrum* sp.	0.23	0.00	0.63	0.85
	Total	100.00	100.00	100.00	300.00

Chapter VI

6. Lasa Dam

6.1. Study area

The location of Lasa area is 26º 28´N and 97º 49´ E and 144.2 km away from the confluence at Myitsone. From biodiversity standpoint, the study area lies in WWF Eco-regions of Mizoram-Manipur-Kachin moist evergreen forest and Northern Triangle Subtropical forest-Myanmar. The watershed areas of Lasa Dam are Hukaung Valley W.S and its extension and Bumphabum W.S., which are biodiversity hotspot and outstanding area of conservation. A detailed map of the study area is given in figure (1.5).

6.1.1. Participants: Dr Win Myint, Daw Khin Swe Lwin, and Daw Ei Ei Phyo, and U Nay Phyo Aung.

6.2. Results

6.2.1. Forest composition

To clarify the tree species composition and their distribution, eight quadrats (20x20 m each) were set up and observed in the flooded area of Lasa dam site. In the eight sampling plots (.32ha), total number of species with DBH ≥3cm was 77 species; of which 26 species are under identification. The dominant families of tree species were Euphorbiaceae (11 species), Fagaceae (5 species), Dipterocarpaceae (4 species), Moraceae (4 species) Figure (3). The main vegetation types discovered in Lasa Dam site can be grouped into four formations; low land evergreen forest, oak forest, low land secondary forest, and bamboo forest. Due to the human impact degraded forest occurs in most of the places. In some disturbed sites, wild banana and bushes can be seen in patches. Low land evergreen forests typically distinguished by *Itea macrophyll., Dipterocarpus sp., Litsea sp., Mallotus paniculatus, Spondias sp.* are mainly found in tree layer. Ground layer is dominated by *Urena* sp., *Commelina* sp. *Gnetum* sp., *Molineria capitulata., Begonia sp., Phrynium capitatum*. Oak forest mainly composed of *Lithocarpus* sp., *Quercus* sp., *Castanopsis* sp., *associate with Garcinia sp., Chisocheton siamensis* are found in tree layer. Ground layer is dominated by *Melastoma* sp., *Smilax* sp., *Lepidagathis* sp., and *Urena* sp. In the low land secondary forest, *Cinnamomum* sp., *Myristica angustifolia, Chisocheton siamensis* and *Macaranga kurzii, Mallotus* sp. are mainly found in tree layer. Ground layer is dominated by *Dracaena* sp., *Wallichia siamensis* , *Clerodendrum* sp., *Piper* sp., and *Commelina* sp. In the bamboo forest *Dendrocalamus hamiltonii* Ness (Wabo Myatsan), *D. giganteus* Munro (Wabowa), and *Bambusa* sp. mainly occur.

The species area curves of the investigated stands are shown in the figure (4). The species area curves, which express the number of species in relation to change in area of habitat, not only to consider the minimum representative area but also to detect the habitat diversity within the survey area (Fangliang He and Pierre Legendre, 1996). The trend of species area curve shows tendency towards flattening. Therefore the sample areas can be said to be sufficient as a minimum representative area for the study.

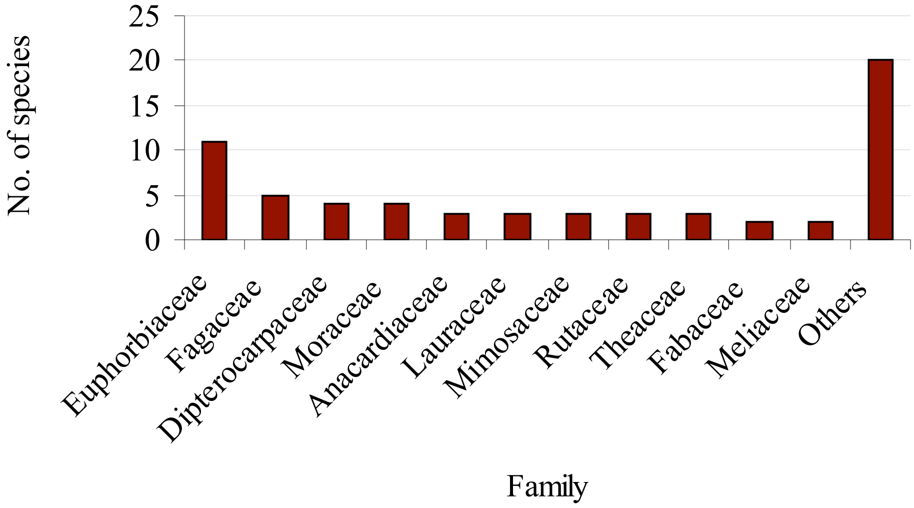


Figure (2) Ranking of dominant family by number of species composition

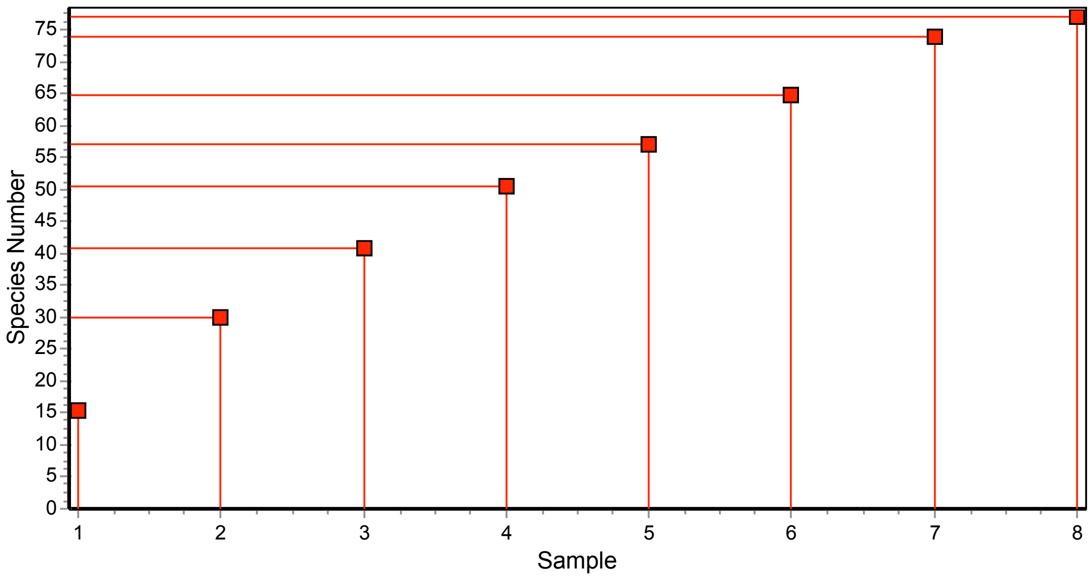


Figure (3) Plot of species accumulation in the Lasar Dam Site

6.2.2. Important Value Index (IVI)

Ranking of ecological significance by IVI of tree species in the study area are given in appendix (1). The tree layer in the study area is dominated by *Castanopsis* sp. with the highest IVI of 25.88%, the second most dominant species is *Schima wallichii* (DC.) Korth. (IVI = 16.21%) and *Cinnamomum* sp. (IVI= 14.88%) is third. Ecologically dominance of top ten species based on IVI value is shown in figure 4. Those species could be considered as ecological indicator species of Lasa area. The number of species greater than 5% IVI value was only sixteen species (Appendix 1).

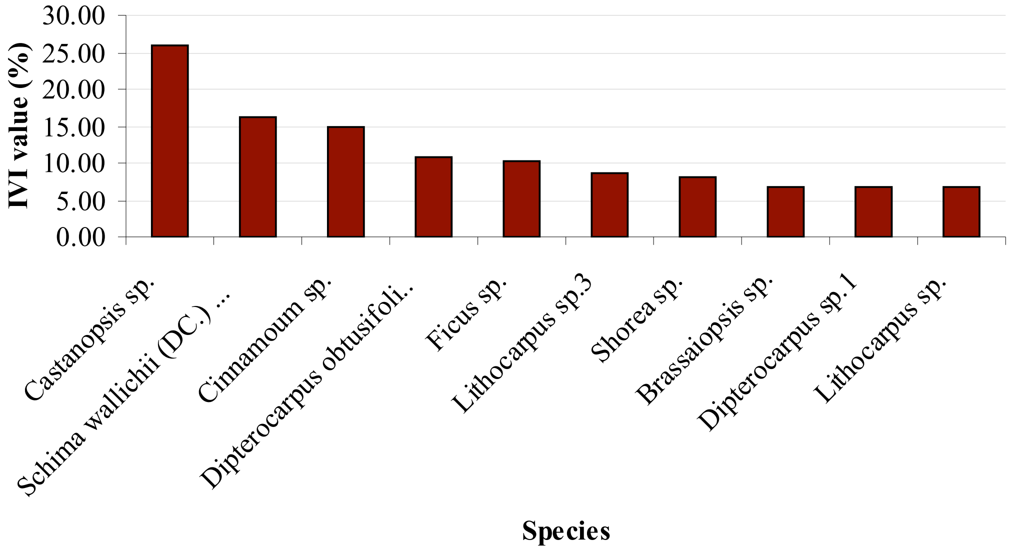


Figure (4) Important Value Index of top ten species in the Lasar Dam Site

6.2.3. Species distribution by frequency classes

In order to clarify the homogeneity or heterogeneity of the floristic distribution in the study area, species distribution by frequency classes was examined. According to the outcome of frequency chart, 94.8% of the total number of species was in lower frequency classes, A and B, while low value was observed only in higher frequency classes C and D (Table 1, Figure 5). It indicates that the forest in Lasa area is floristically heterogeneous, according to Lamprecht (1989). The species which fall in high frequency class D was *Ficus* sp., *Castanopsis* sp., and *Cinnamomum* sp.. These species can be considered as the most common species in the Lasa area.

Table (1) Species distribution by frequency classes ≥3cm

Frequency Class	Frequency range	No. of species	% of total species frequency distribution
A	1 – 20 %	43	55.84
B	21 – 40 $	30	38.96
C	41 – 60 %	1	1.30
D	61 – 80 %	3	3.90
E	81 – 100 %	0	0.00

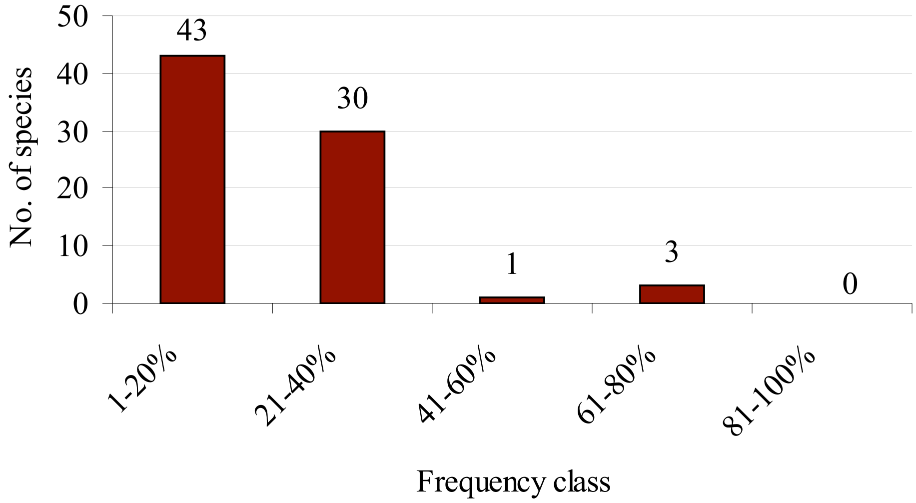


Figure (5) Species distribution by frequency classes ≥3cm

6.2.4. Diversity indices and evenness

Among the different measurement of species diversity indices, the floristic diversity of the Lasa area was analyzed using the Shannon Wiener index (H), Simpsons index (D), Brillouin (D), Shannon Maximum and minimum evenness (E), Brillouin (E) because these indices not only take taxa richness into account but also depend on the relative distribution of individuals. The value of diversity indices and evenness indices of individual sample plot and all sample indices are shown in table (2) and (3). According to the result, though the diversity indices of individual sample plot are not too high, all sample index are relatively high. Diversity value for all sample index of Shannon Wiener index (H) is 4.049, Simpsons index (D) is 51.95, and Brillouin (D) is 3.687.

Table (2) Species diversity indices in the Lasa Dam site

Sample	Shannon Wiener H	Variance H	Simpsons Index (D)	Brillouin (D)
LSR 1	2.631	0.011	21.57	2.104
LSR 2	2.770	0.013	23.33	2.217
LSR 3	2.526	0.008	13.67	2.157
LSR 4	2.654	0.007	20.58	2.186
LSR 5	1.791	0.013	6.407	1.495
LSR 6	2.770	0.010	25.2	2.229
LSR 7	3.102	0.012	37.43	2.466
LSR 8	2.881	0.010	25.08	2.345
All Sample Index	4.049		51.95	3.687
Jackknife Std Error	0.146		9.377	0.1127

Table (3) Evenness indices in the Lasa Dam site

Sample	Shannon Maximum	Shannon Minimium	Simpson Evenness (E)	Brillouin (E)
LSR 1	2.708	1.84	1.438	0.9765
LSR 2	2.89	2.03	1.296	0.959
LSR 3	2.708	1.293	0.9113	0.9364
LSR 4	2.708	1.6	1.372	0.9873
LSR 5	1.946	0.9035	0.9153	0.9172
LSR 6	2.833	1.919	1.482	0.9816
LSR 7	3.219	2.499	1.497	0.977
LSR 8	2.996	1.987	1.254	0.9663
All Sample Index	4.344	1.627	0.6747	0.9338
Jackknife Std Error	0.133	0.217	0.0742	0.013

6.2.5. Forest structure

Stem density of ≥3cm was 963ha^{-1} and basal area was 44.5 m^2/ha in the Lasa dam site Table (4). Among the 8 sample plots studies, 77 tree species were recorded. Only one individual of 15 species were found and these species were considered as unique species.

The 10 most abundance species in terms of basal area occupied 62.15% of the total, of which *Castanopsis* sp. was the most dominant species in the study area with 15.81%, followed by *Schima wallichii* (DC.) Korth 11.66 %, *Dipterocarpus obtusifolius* Teysm.ex.Mig. 8.03%, *Dipterocarpus* sp.1 5.43%, *Cinnamomum* sp. 4.81%, *Lithocarpus* sp.3 4.13%, *Lithocarpus* sp. 2.76%, *Lithocarpus* sp.1 2.47%, and *Dipterocarpus* sp.2 2.36%, of the total basal area (Figure (6)).

Table (4) Consolidated detail of species inventory in the Lasa Dam site

Description	Results
No. of sample points	8
No. of tree species	77
Density (stem/ha)	963
Basal area (m^2/ha)	44.5
Total No. of unique species	15

The distribution of the basal area across DBH interval classes reveals the dominance of small stemmed individuals in the study area. The population structure by DBH class decreased from class to class with a steeper gradient in lower DBH classes and with a gentle slope in higher classes Figure (8) and Table (5). Out of total number of stems inventoried, 52.92% of stems were accumulated in the 3-60cm DBH class, 39.28% of stems in the 60-150cm, and 7.8% in the 150-240cm. The highest DBH was measured in the case of *Dipterocarpus* sp.1 (230cm), *Knema* sp. (200cm), *Dipterocarpus obtusifolius* Teysm.ex.Mig. (200cm), *Castanopsis* sp. (200cm).

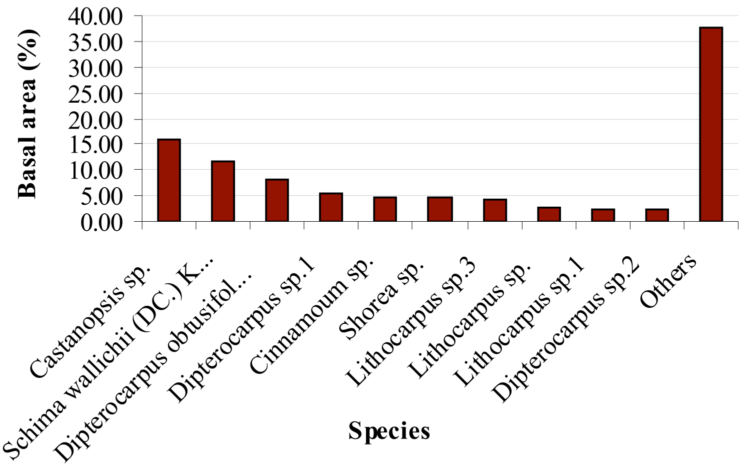


Figure (6) Ranking of relative basal area by species in the Lasa Dam site

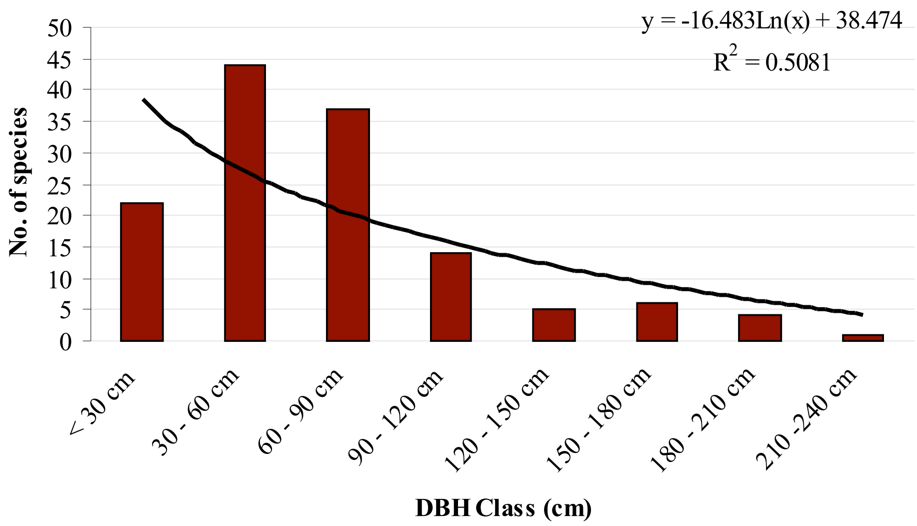


Figure (7) Species distribution by DBH classes

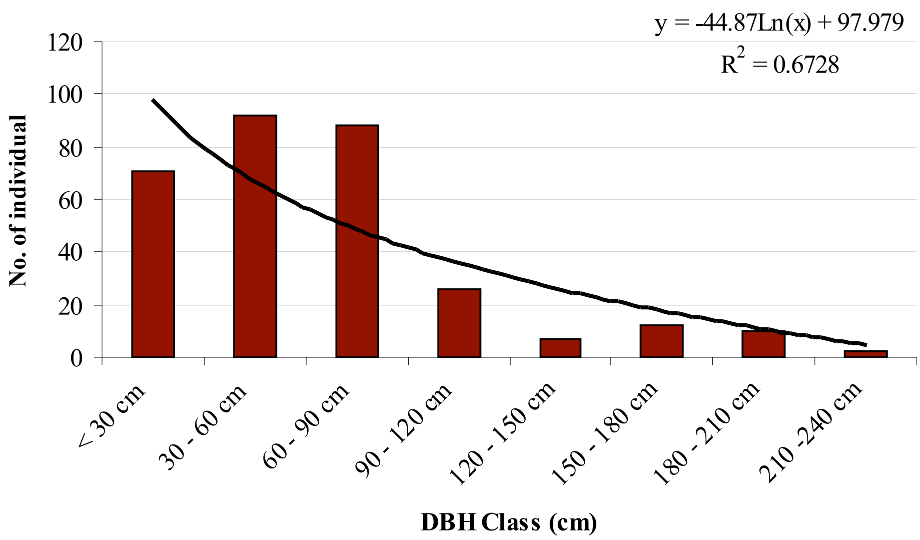


Figure (8) Population distribution by DBH classes

Table (5) Population density of tree species across DBH class interval

DBH Classes	No. of species	Total number of individual	% of total species	% of total individual
< 30 cm	22	71	16.54	23.05
30-60 cm	44	92	33.08	29.87
60-90 cm	37	88	27.82	28.57
90-120 cm	14	26	10.53	8.44
120-150 cm	5	7	3.76	2.27
150-180 cm	6	12	4.51	3.90
180-210 cm	4	10	3.01	3.25
210-240 cm	1	2	0.75	0.65
Total	77	308	100.00	100.00

Tree distribution by height intervals shows that among the total number of 308 individualS, 160 individuals (51.30%) belong to 3-10m category, followed by 89 individuals (28.90%) in 10-17m, and 52 individuals (16.88%) in 17-24m. The height class of 24-31m includes only (2.27%) of total individuals (Table (6)). <3m hight trees of 2 individuals (0.65%) infer natural regeneration is poor or frequent disturbance on ground cover plant. The population structure by height classes in the Lasa area is highest in 3-10m class and gradually decreases to higher classes (Figure 9 and 10). The tallest individual trees were *Schima wallichii* (DC.) Korth. (25m), *Lithocarpus* sp. (25m), *Dipterocarpus* sp.1(25m), *Dipterocarpus* sp.2 (25m), *Castanopsis* sp. (25m), and *terminalia* sp. (20m). Total picture of height class shows that, 51.95% belong to <3-10m category, 45.78% in 10-24m, and 0.65% in 24-31m. The overall population structure indicates that study area was strongly influenced by human impact.

Table (6) Population density of tree species across height class interval

Height Classes	No. of species	Total number of individual	% of total species	% of total individual
< 3 m	1	2	0.85	0.65
3-10 m	55	158	47.01	51.30
10-17 m	38	89	32.48	28.90
17-24 m	18	52	15.38	16.88
24-31 m	5	7	4.27	2.27
Total	77	308	100.00	100.00

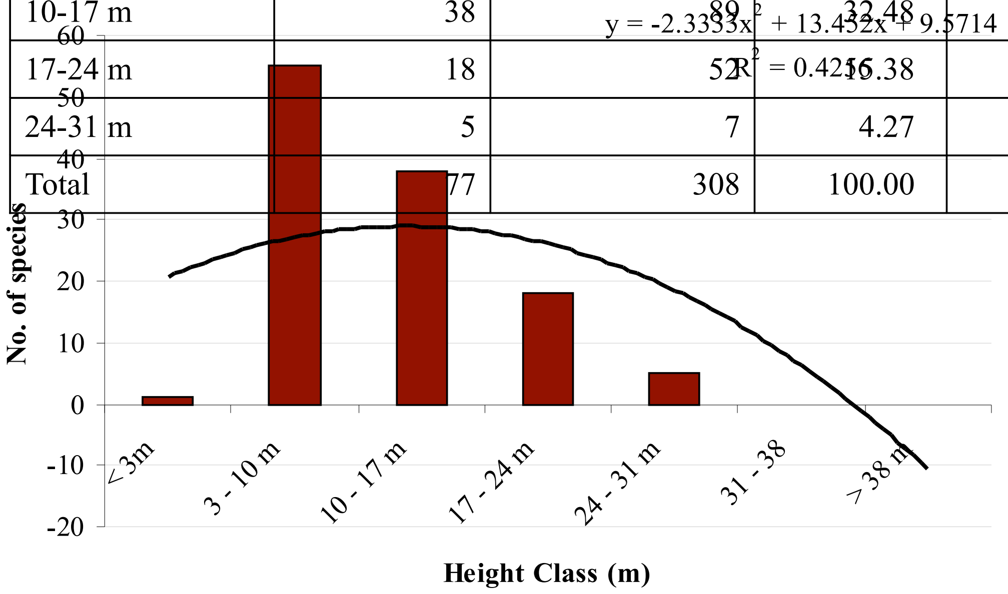


Figure (9) Species distribution by height classes

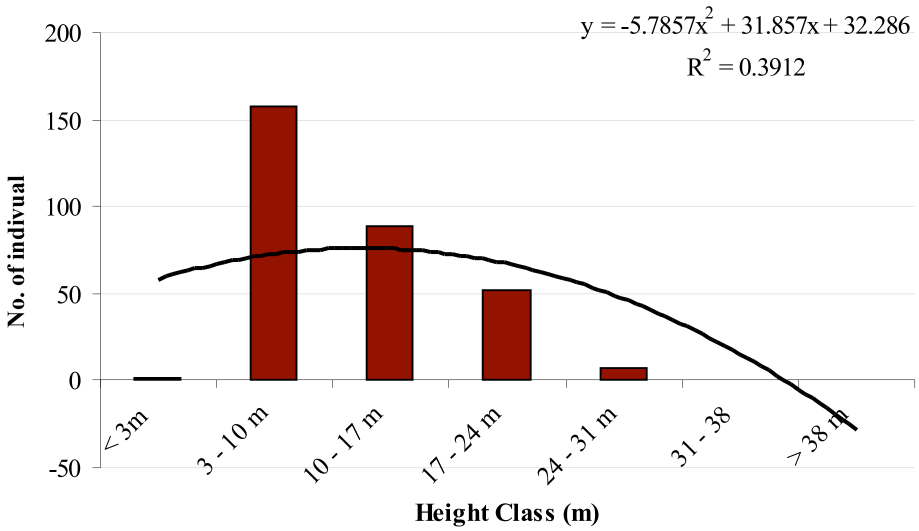


Figure (10) Population distribution by DBH classes

6.3. Discussion and Conclusion

A total of 77 tree species representing 64 genera and 28 families were analyzed in the study area. The main vegetation types discovered in Lasa Dam site can be grouped into four formations, i.e. low land evergreen forest, oak forest, lowland secondary forest, and bamboo forest. In some disturbed sites, degraded forests which generally composed of *Solanum* sp., *Melastoma* sp., *Clerodendron fragrans* and wild banana can be seen as patches.

The important value index indicates the extent of dominance of a species in the structure of a forest stand (Curtis and McIntosh, 1950). It is stated that species with the greatest important value are the leading dominants of the forest. Accordingly, the ten leading dominants in study area were *Castanopsis* sp, *Schima wallichii* (DC.) Korth., *Cinnamomum* sp., *Dipterocarpus obtusifolius* Teysm.ex.Mig., *Ficus* sp., *Lithocarpus* sp.3, *Shorea* sp., *Brassaiopsis* sp., *Dipterocarpus* sp.1, and *Lithocarpus* sp., contributing highest IVI value (25.88, 16.21, 14.88, 10.84, 10.31, 8.68, 8.04, 6.83, 6.83, 6.66) respectively. Those tree species could be considered as ecological indicator species of the study area.

In mature site, the largest trees can reach up to 25m in height while the main canopy is 17-24m with poor ground cover. The canopy of the forest is more or less close, but in some disturbed sites, the canopy is open and the estimated height was probably not more than 10m with stunted tree species.

The forest structures in the study area show all types of disturbance. The surrounding of Lasa area has an insufficient protection status that allows the exploitation of natural resources; such as logging, hunting, gold mining, and shifting cultivation. The major crops cultivated in shifting cultivation are *Canna* sp., *Brassica* sp., *Zea mays*, *Oryza indicum*. Gold mining is the chief destructive force and one of the influencing factors for ecosystem.

The following species that recorded in the study area assessed in IUCN Red list as follows;

No.	Botanical Name	Family	Red Lists	Year
1.	*Aquilaria malaccensis* Lam.	Thymeliaceae	VU Alcd	IUCN-2000
2.	*Dipterocarpus turbinatus* Gaertn.f.	Dipterocarpaceae	CR Alcd+2cd	IUCN-2000
3.	*Shorea assamica* Dyer	Dipterocarpaceae	CR Alcd, B1+2c	IUCN-2000

6.4. Recommendation

1. The socioeconomic development and community awareness on environment should be planned and implemented under the project. It may support the conservation and maintenance of remaining forest.
2. Reforestation project should be implemented to substitute the inundated forest cover and to balance the forest ecosystem services lost by dam construction.
3. Resettlement area for inundated villages should be selected in environmentally least impact area.
4. Infrastructure development as well as new access road from Myitkyina to Putao should be carried out with great care and it should have minimal impacts on environment, social and cultural aspects of the indigenous people.

One or more compensatory protected area should be established and managed under the project. The remaining forest cover should be systematically managed and conserved since the action not only maintain the watershed area but also support the biodiversity rich ecosystem.

Appendix (1) Ranking of Important Value Index (IVI) in the Lasa Area

No.	Species Name	**R.D. %**	**R.D.m %**	**R.F %**	**IVI %**
1	*Castanopsis* sp.	5.52	15.81	4.55	25.88
2	*Schima wallichii* (DC.) Korth.	2.27	11.66	2.27	16.21
3	*Cinnamomum* sp.	5.52	4.81	4.55	14.88
4	*Dipterocarpus obtusifolius* Teysm.ex.Mig.	1.30	8.03	1.52	10.84
5	*Ficus* sp.	4.55	1.98	3.79	10.31
6	*Lithocarpus* sp.3	2.27	4.13	2.27	8.68
7	*Shorea* sp.	2.60	4.68	0.76	8.04
8	*Brassaiopsis* sp.	3.57	0.23	3.03	6.83
9	*Dipterocarpus* sp.1	0.65	5.43	0.76	6.83
10	*Lithocarpus* sp.	1.62	2.76	2.27	6.66
11	*Spondias* sp.	2.60	1.72	2.27	6.59
12	*Erythrina* sp.	2.27	1.69	2.27	6.24
13	*Mallotus* sp.	2.92	1.47	1.52	5.90
14	*Vernonia arborea* Buch-Ham.	1.95	2.34	1.52	5.80
15	*Macaranga kurzii* (O.k.) Pax & Hoffm.	2.27	1.14	2.27	5.69
16	*Osbeckia* sp.	2.92	0.06	2.27	5.25
17	UN-12	2.92	0.26	1.52	4.70
18	UN-2	1.95	1.23	1.52	4.70
19	*Mallotus paniculatus* Muell. Arg.	2.27	0.89	1.52	4.68
20	*Bischofia* sp.	1.62	1.47	1.52	4.61
21	*Dipterocarpus* sp.2	0.97	2.36	0.76	4.10
22	UN-10	2.27	0.22	1.52	4.01
23	*Lithocarpus* sp.1	0.65	2.47	0.76	3.88
24	UN-1	1.62	0.67	1.52	3.80
25	*Actinodaphne* sp.	1.95	0.34	1.52	3.80
26	UN-19	1.62	0.59	1.52	3.73
27	*Knema* sp.	0.65	2.25	0.76	3.66
28	*Macaranga denticulata* Muell. Arg.	0.97	0.36	2.27	3.61
29	UN-8	1.30	1.55	0.76	3.61
30	*Chisocheton siamensis* Craib	1.30	0.72	1.52	3.54
31	UN-18	1.62	0.32	1.52	3.46
32	*Dalbergia* sp.	1.30	0.43	1.52	3.25
33	*Lithocarpus* sp.2	0.97	1.50	0.76	3.23
34	UN-15	1.30	0.30	1.52	3.11
35	*Glochidion* sp.	0.97	0.47	1.52	2.96
36	UN-13	1.30	0.07	1.52	2.88
37	*Cordia myxa* L.	0.65	1.27	0.76	2.68
38	*Phoebe* sp.	0.65	0.42	1.52	2.58
39	*Gordonia* sp.	1.62	0.20	0.76	2.58
40	*Albizia* sp.	0.65	0.40	1.52	2.57
No.	Species Name	**R.D. %**	**R.D.m %**	**R.F %**	**IVI %**

41	*Ardisia* sp.	0.97	0.05	1.52	2.54
42	*Syzygium* sp.	0.65	0.35	1.52	2.52
43	*Saurauia* sp.	0.65	0.33	1.52	2.49
44	UN-9	1.30	0.38	0.76	2.44
45	*Itea macrophylla* Wall.	0.97	0.68	0.76	2.41
46	*Terminalia* sp.	0.65	1.00	0.76	2.41
47	*Ficus* sp.1	0.97	0.62	0.76	2.36
48	UN-23	0.65	0.76	0.76	2.16
49	UN-14	0.65	0.68	0.76	2.09
50	UN-11	0.97	0.30	0.76	2.03
51	UN-6	0.97	0.26	0.76	1.99
52	UN-16	0.97	0.19	0.76	1.92
53	UN-7	0.97	0.15	0.76	1.88
54	*Phyllanthus* sp**.**	0.65	0.46	0.76	1.87
55	*Macaranga gigantea* (Rchb. F. & Zoll.)	0.65	0.35	0.76	1.76
56	*Sterculia macrophylla* Vent.	0.65	0.34	0.76	1.74
57	*Sloanea* sp.	0.65	0.26	0.76	1.67
58	UN-5	0.65	0.19	0.76	1.60
59	*Alangium* sp.	0.32	0.50	0.76	1.59
60	UN-17	0.65	0.16	0.76	1.57
61	*Zanthoxylum* sp.	0.65	0.12	0.76	1.53
62	UN-22	0.65	0.12	0.76	1.53
63	*Calusena* sp.	0.65	0.11	0.76	1.52
64	*Saurauia* sp.4	0.32	0.41	0.76	1.50
65	UN-20	0.32	0.40	0.76	1.49
66	*Cedrela sinensis* (Juss.) Roem	0.32	0.36	0.76	1.44
67	UN-4	0.32	0.31	0.76	1.40
68	*Limonia* sp.	0.32	0.26	0.76	1.34
69	*Bredelia* sp.	0.32	0.22	0.76	1.30
70	UN-24	0.32	0.21	0.76	1.29
71	UN-21	0.32	0.16	0.76	1.25
72	UN-26	0.32	0.15	0.76	1.23
73	*Ficus roxburghii* Wall.	0.32	0.14	0.76	1.22
74	*Ficus hirta* Vahl.	0.32	0.11	0.76	1.20
75	UN-3	0.32	0.09	0.76	1.17
76	UN-25	0.32	0.06	0.76	1.14
77	*Albizia* sp.2	0.32	0.02	0.76	1.10
	Total	100.00	100.00	100.00	300.00

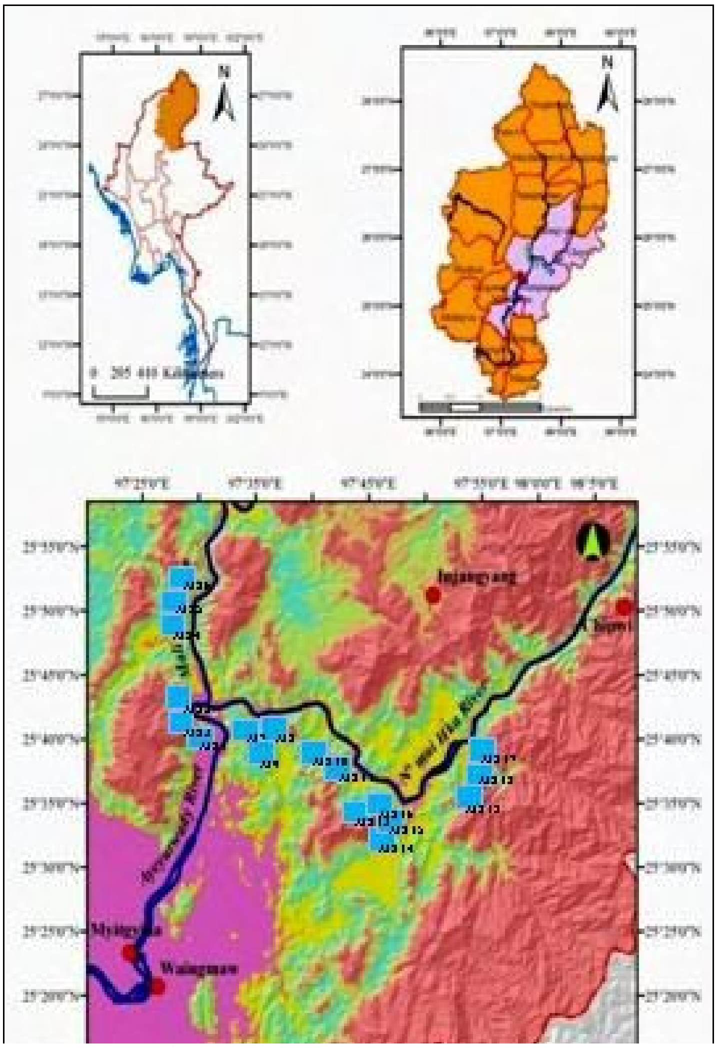
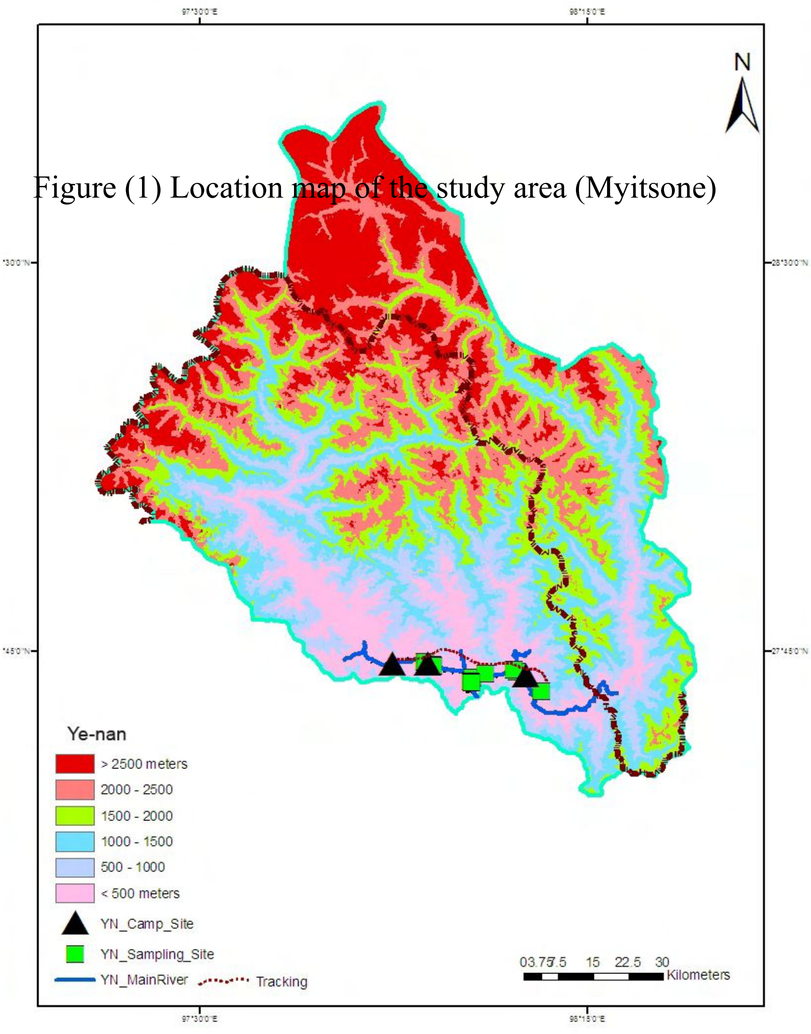


Figure (1) Location map of the study area (Myitsone)



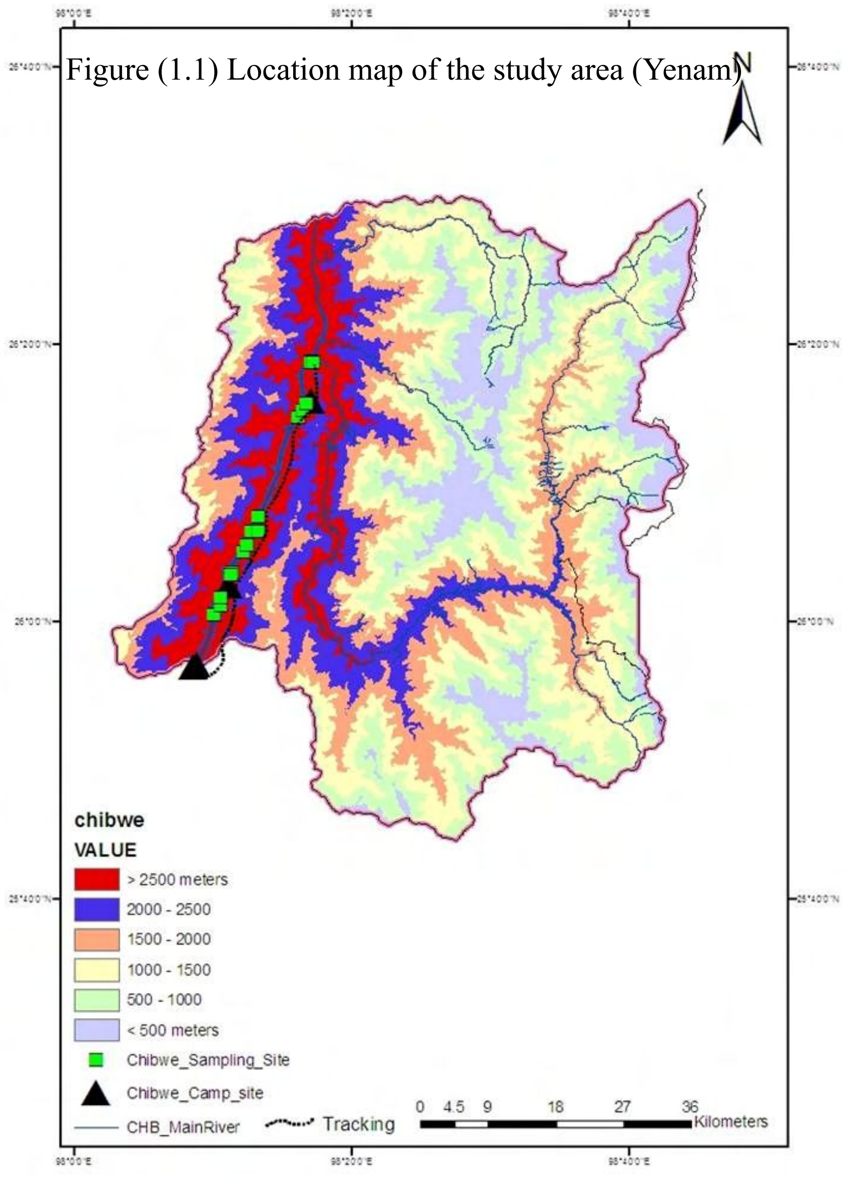


Figure (1.1) Location map of the study area (Yenam)

Figure (1.2) Location map of the study area (Chibwe)

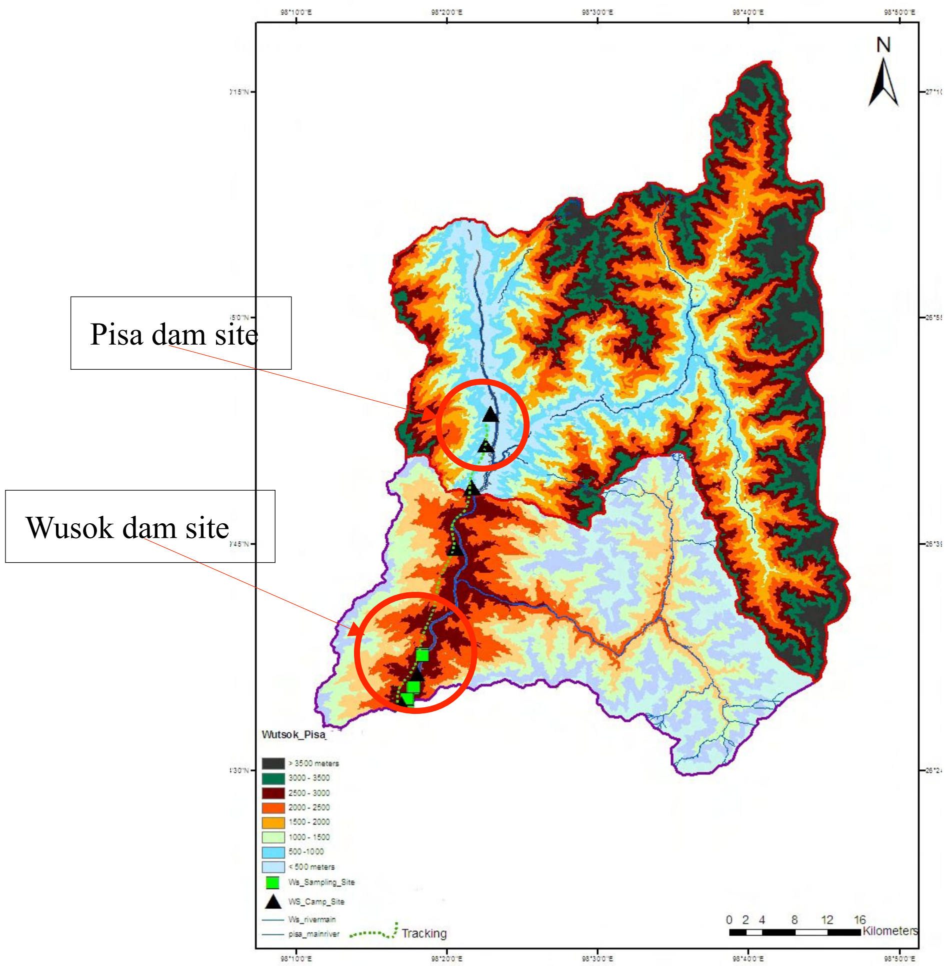


Figure (1.3) Location map of the study area (Pisa & Wusok)

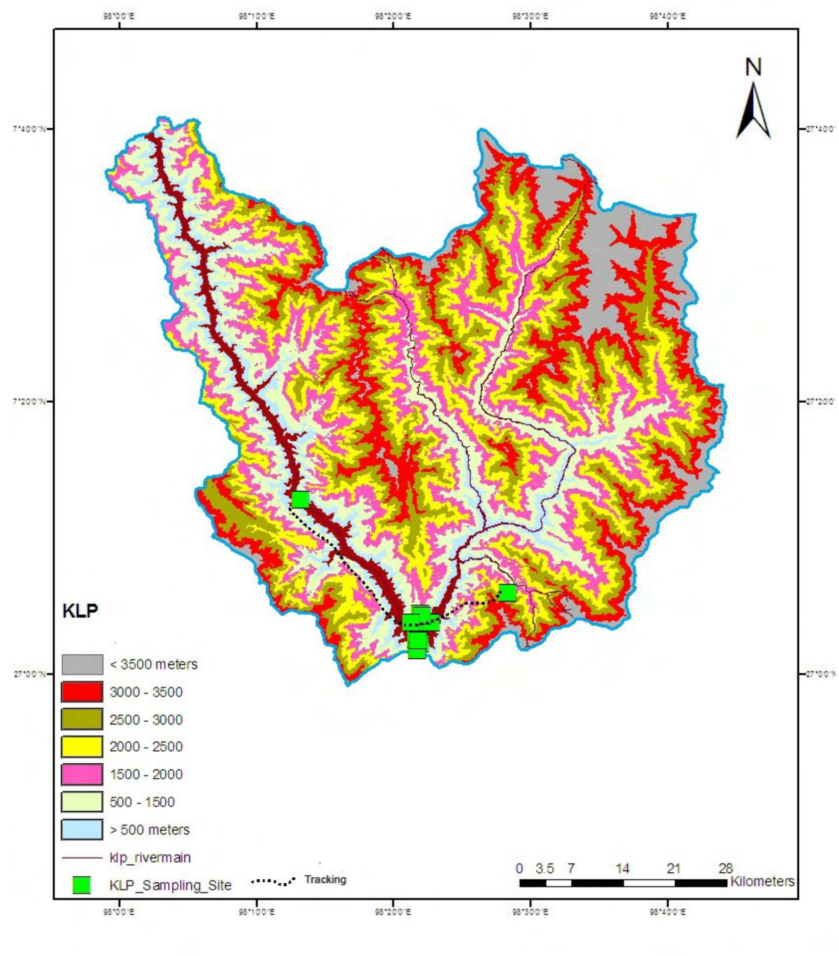


Figure (1.4) Location map of the study area (Khaunglanhpu)

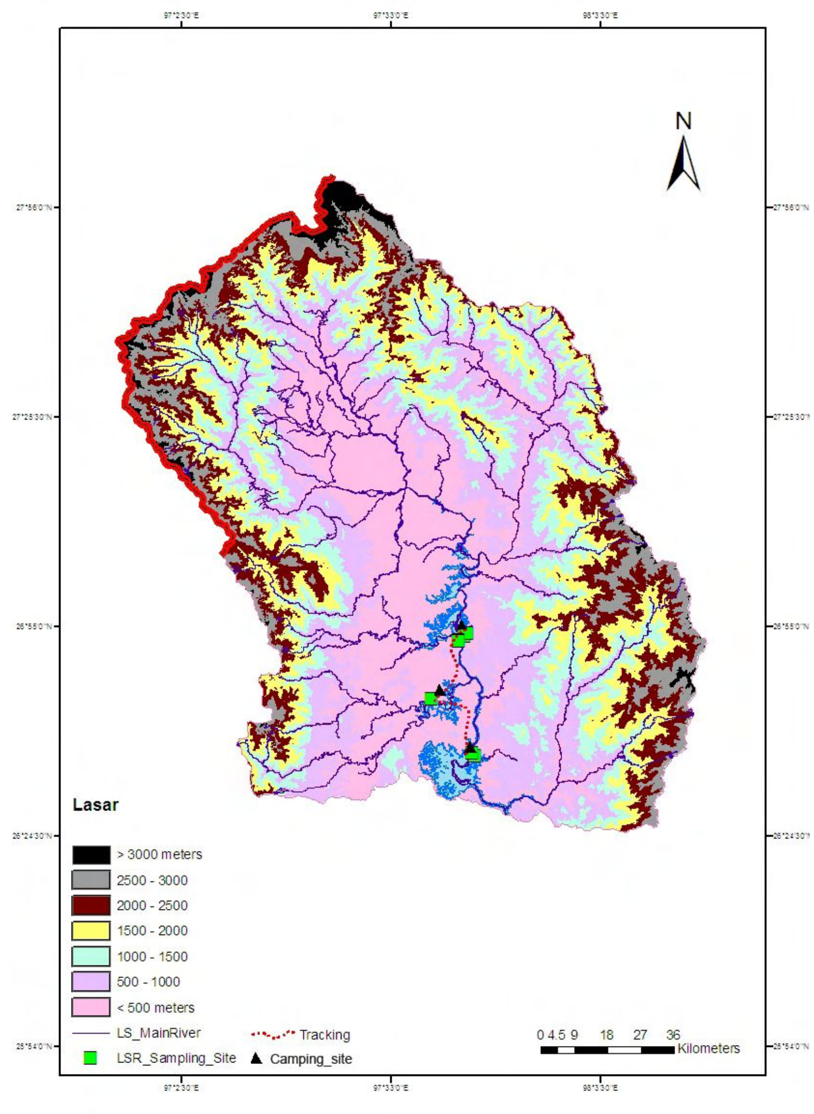


Figure (1.5) Location map of the study area (Lasa)

List of Plates (Myitsone)


Plate – 1 Primary forest in Myitsone

Plate – 2 Secondary forest in Myitsone

Plate – 3 Degraded secondary forest in Myitsone

Plate – 4 Dipterocarpus forest in Myitsone

Plate – 5 Oak forest in Myitsone

Plate - 6 Bamboo forest in Myitsone

Plate – 7 Banana forest beside Mayhka River

Plate – 8 Shifting Cultivation in Myitsone

Plate - 9 Logging in Myitsone

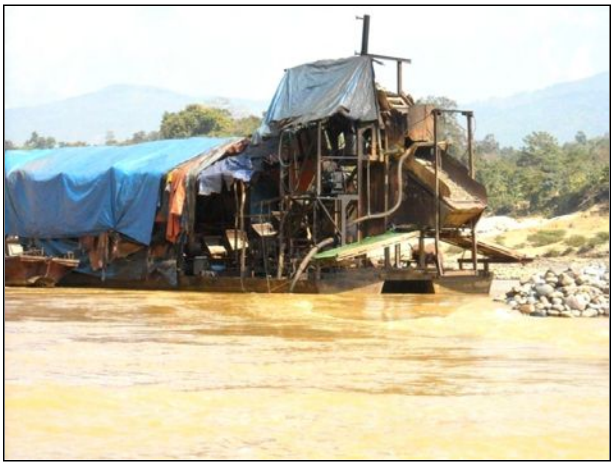


Plate - 10 Gold mining in Myitsone

List of Plates (Yenam)

Plate - 1 Primary forest in Yenam

Plate - 2 Secondary forest in Yenam

Plate - 3 Degraded secondary forest in Yenam

Plate - 4 Oak forest in Yenam

Plate - 5Bamboo forest in Yenam

Plate -6 Grass land in Yenam

Plate – 7 Shifting cultivation in Yenam

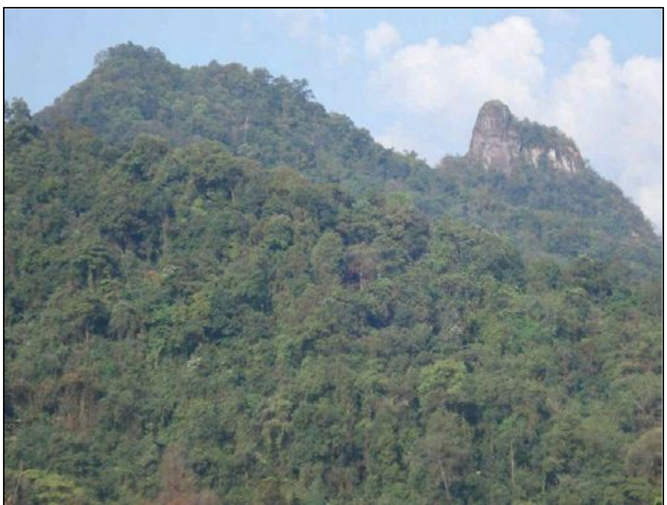


Plate - 1 Primary forest in Chibwe

Plate - 2 Secondary forest in Chibwe

Plate - 3 Degraded secondary forest in Chibwe

Plate – 4 Bamboo forest in Chibwe

Plate – 5 Banana forest in Chibwe

List of Plates (Wusok)

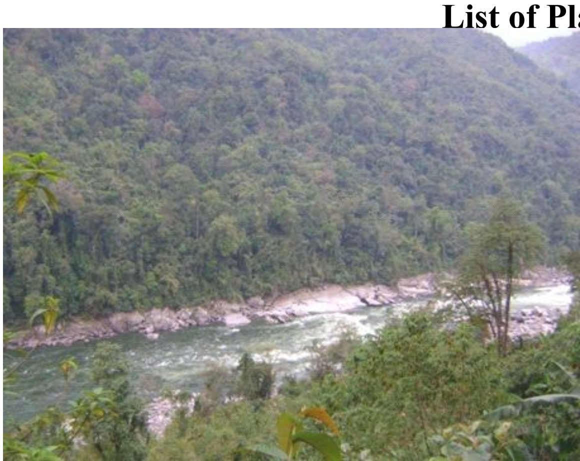


Plate - 1 Primary forest in Wusok

Plate - 6 Citrus cultivation in Wusok

Plate - 3 Degraded secondary forest in Wusok

Plate - 4 Oak forest in Wusok

Plate - 5 Shifting cultivation in Wusok

List of Plates (Khaunglanhpu)

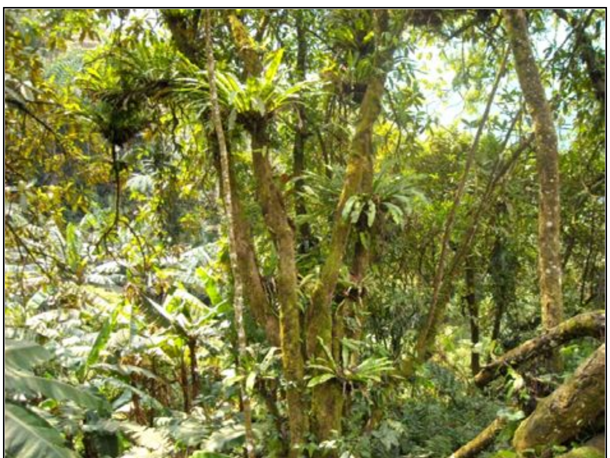


Plate - 1 Primary forest in Khaunglanhpu

Plate - 2 Secondary forest in Khaunglanhpu

Plate - 3 Degraded secondary Forest in Khaunglanphu

Plate -4 Alnus forest in Khaunglanhpu

Plate - 5 Bamboo forest in Khaunglanhpu

Plate–6 Shifting cultivation in Khaunglanhpu

List of Plates (I

Plate - 1 Lowland evergreen in Lasa

Plate - 2 Oak forest in Lasa

Plate - 3 Degraded Secondary Forest in Lasa

Plate - 4 Bamboo forest in Lasa

Plate - 5 Grass land in Lasa

Plate - 6 Gold mining in Lasa

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Glossary

DBH	Diametre breast Height
Relative density (RD)	No. of individuals of the species / No. of individuals of all the species x 100
Relative frequency (RF)	No. of occurrences of the species / No. of occurrences of all the species x 100

Relative dominance (R.Dm)	Total basal area of the species / Total basal area of all the species x 100
Important Value Index (IVI)	Sum of relative density + relative frequency + relative dominance
Species Diversity	The number and relative abundance of species in defined area
Diversity Indices	Combine both richness and abundance

Part - III

Report on Survey of

Aquatic Ecological Conditions and Mitigation Measures of Hydropower Development of Ayeyarwaddy River Basin above Myitkyina.

Aquatic Team

Biodiversity and Nature Conservation Association

(BANCA)

2009

ABSTRACT

A survey on aquatic ecological conditions in the EIA (Environmental Impact Assessment) for the project of hydropower development in Ayeyarwaddy River basins above Myitkyina, Kachin State was carried out from January 2009 to June 2009. The surveyed areas were Lasa on Mali Hka River, Yenam, Kaunglanghpu, Pisa, Wusok and Chibwe on May Hka River and 5.4 kilometers downstream from the confluence of May Hka River and Mali Hka River, locally known as Myitsone, on Ayeyarwaddy River. The data were collected from the main rivers and its' tributaries within 10 kilometers range upstream and downstream from the dam sites. Data of the lowest dam, Myitsone and the farthest dams, Lasa and Yenam covered more than 20 kilometers range from the dam sites to find out suitable habitats for the migratory fish. Preliminary survey results of the aquatic ecological conditions, aquatic organisms and fish species check list are described. The possible impacts on the aquatic ecosystem including economically important fish species, aquatic organisms and aquatic environmental conditions are predicted. Because of the dams, the aquatic ecosystem of the flooded areas will change and some of the economically important migratory fish will be lost in some parts of the main rivers. On the other hand, valuable benefits of regional aquaculture after dam construction are discussed in general. Due to the essential of dam construction for the development of the region, mitigation measures and recommendations are also described to reduce the impact on the environment and biodiversity. The prioritized action of mitigation measures on the aquatic biodiversity of this region needs to be undertaken immediately in collaboration with international institutions.

1. INTRODUCTION

Dams have been constructed on the rivers for the benefit of saving the people since ancient times. They generally serve the primary purpose of retaining water, while other structures such as floodgate or dikes are used to manage or prevent water flow into specific land regions. Water resources can be profitably utilized for power generation, irrigation, flood control, domestic uses, aquaculture and recreational fisheries. Among them, hydropower development has become the most attractive as a reliable, cheap, green and safe energy source. Hydropower and hydroelectricity are often used in conjunction with dams to provide clean electricity for development of the regions and millions of consumers. Conversely, many people have suffered and a lot of environmental damage has occurred as a consequence of dam construction.

Reservoirs of the dams permanently flood extensive natural habitats, with local and even global extinctions of aquatic organism, terrestrial animal and plant species. One occasional exception to this rule is that shallow reservoirs in dry zones can provide a permanent oasis, sometimes important for migratory waterfowl and other terrestrial and aquatic fauna.

Storage dams alter the natural distribution and timing of stream-flow. They compromise the dynamic aspects of rivers that are fundamental in maintaining the character of riverine aquatic ecosystems. Richness of species in the rivers depends on the function of the flow, the quantity of the sediment in the river, and the character or composition of the materials that composed the bed and banks of the river. The river discharge includes both high- and low-flow elements. These dynamics determine a river's physical foundation, which in turn ensures ecosystem integrity. The extent of impacts will also depend on whether water is extracted or diverted for consumption, or left in-stream. Loss of system dynamics, loss of the ability to maintain continuity of an ecosystem, introduction of non-native species and modified water quality (temperature, pH, oxygen and chemical composition) result in ecological modification in the river systems. The establishment of a new dynamic has positive effects on some species and negative effects on others.

As a physical barrier, the dam disrupts the movement of species leading to changes in composition of upstream and downstream species and even loss of the species. River-dwelling species have several migratory patterns. These include anadromous fish such as salmon and catadromous fish such as eels. Adults of the anadromous fish migrate upstream of the rivers to spawn and the young descend to the sea. Catadromous fish spawn in the sea and the youngs migrate upstream of the rivers. Many freshwater fish species move upstream of rivers or tributaries to spawn**.** Dams block these migrations to varying degrees. Migratory fish require different environments for the main phases of their life cycle such as reproduction, production of juveniles, growth, and sexual maturation.

The blockage of sediment and nutrients, the re-regulation of stream-flow, and elimination of the natural flood regime can all have significant, negative effects on downstream fisheries. Substantial losses in downstream fishery production as a result of dam construction have been reported globally. Along with subsistence agriculture, fisheries constitute an important livelihood activity among large rural populations in the developing countries. Many of these households depend on fisheries either as a primary or supplementary source of livelihood.

Dams can enhance some riverine fisheries, particularly tail-water fisheries immediately below dams that benefit from discharge of nutrients from the upstream reservoir. Productive reservoir fisheries often follow from dam construction, although they are not always anticipated as a part of project design proposals. Mitigation or compensation measures have been used to reduce the impacts of changes in fisheries. Compensation measures must be implemented such as establishing fish hatcheries and stocking programs to reproduce the productivity of the fishery.

The dominant aquatic ecosystem of the rivers of surveyed area is lotic ecosystem (rapidly moving water). Damming any specific area along the river will change from lotic to lentic aquatic ecosystem (slow moving water). The ecosystem of a river is governed by many factors such as rainfall, melting of snow and ice, soil characteristics, vegetation and land use. These factors influence ecological parameters of aquatic ecosystem such as temperature, pH, conductivity, turbidity, chemical compositions of the water as well as composition and distribution of aquatic organisms.

Rainfall and melting waters from snow and ice govern water depth, soil erosion, water transparency, water temperature and even flow rate of the water. The rainfall of study area is high because of receiving south west monsoon wind and the wind from South China Sea. The surveyed areas are situated in Kachin State where the mean rainfall within 10 years (1999-2008 in Putao, Machanbaw and Myitkyina) was approximately 3347.88 mm. The highest rainfall was in Putao, 4696.69 mm., and the lowest was in Myitkyina, 2143.98 mm. In Putao, there is rain every month and mean rainy days are about 168 days/annum. The mean of rainy days in Myitkyina is about 106 days and there is rain every month except in December and January.

The environments of surveyed areas are covered with mountains of various heights, folded ranges and valleys. Most of the mountains and valleys are covered with various forest type especially secondary forests a result of long term shifting cultivation by local people. Some areas near the villages have terrace farms where permanent cultivation of rice and vegetables is found. Land slides have been observed near shifting cultivation along the rivers.

The surveyed areas are situated in the mountainous regions of the far eastern Himalaya mountain range. The prominent physical characteristic of the river in the region is high velocity flow in most parts of the river. Most of the parts of surveyed areas are characterized by a multitude of small streams and rills to large tributaries, with a very steep gradient. The fast-flowing water transports a considerable amount of eroded material downstream, where it is deposited on floodplains in the form of an alluvial.

The river bank is also steep where boulder and gravel are common environments for most of the parts. Gravel and pebble bottoms are also common. In some parts of the rivers where there is low flow areas with sandy bottoms are found. The speed of fast flowing river water is a key factor in the development of biological organisms. Fast flowing water sweeps the plankton population continuously which is an important food for aquatic organisms. In addition to lower temperature, water velocity constitutes an important factor for composition and distribution of fish species in the survey areas. The damming of the rivers will change this species composition and distribution.

The chemical and physical parameters also depend on the characteristics of water and bank condition. The concentration of the chemical constituents and the physical properties of water depend on the flow of water. The river basin of surveyed areas has low population density, with low irrigation intensity. Therefore, there are no major sources of organic pollution from agricultural farms. Most of the residents in the area use water from adjacent rivers and streams without disinfecting.

Colour of water of Mali Hka is more turbid than May Hka and Ayeyarwaddy. In the regions of May Hka above Chibwe, the upstream water is very clear compared to the downstream. The most prominent feature of the region is the various forms of gold mining from the river bed and banks. This is found from Putao to Myitsone confluence (local name for the confluence of May Hka and Mali Hka) in Mali Hka, from Chibwe to Myitsone confluence in May Hka and down stream from the Myitsone confluence to Myitkyina. This is the most important business and employment for the local people in this region. Because of this business, coloration of the river water is turbid with heavy concentration of sand especially in Mali Hka. Local people say that mercury is the main chemical used in the gold purification process.

A significant turbidity was found in Ngawchang Hka, one of the major tributaries of May Hka at Chibwe dam area, which has been caused by heavy concentration of silt in the water. Due to the information from local people, this problem has started 3 years ago probably caused by the discharge of factory effluents upstream of the tributary. The problem of the water from this tributary starts in the region of agricultural farms and farmed animals such as cows.

The fundamental requirement of aquatic organisms is composition of nutrients in the water. Nutrients are taken up by primary producers such as phytoplankton, phytobenthos and algae. Important autotrophic organisms in aquatic environment are primary producers that generate organic compounds from inorganic materials or nutrients contained in the water. They use solar energy to generate biomass from carbon dioxide and nutrients in the water. Primary consumers such as zooplankton and herbivores, heterotrophic organisms, consume autotrophic organisms and use the organic compounds in their bodies as energy sources and raw materials to create their own biomass. The biomass created by these primary producers is important for the community because it is transferred to higher trophic levels such as secondary consumers (carnivores and omnivores) and tertiary consumers (higher rank carnivores and omnivores) via consumption. Therefore, any changing of nutrient composition in the aquatic ecosystem will severely effect the composition and distribution of aquatic organisms in any areas. In the aquatic food web or food cycle, changing or destruction of any steps along the linkage will affect the successive steps distinctly.

Aquatic organisms are highly dependent upon the characteristics of their aquatic habitat which supports all their biological functions. Any change of their environment will affect their biological responses to the environment prominently. This dependence is most marked in migratory fish which requires different environments for the main phases of their life cycle such as reproduction, production of juveniles, growth and sexual maturation. The migrants have to move or migrate from one environment to another regularly in order to survive in their life span. Damming will change the ecosystem and affect not only the aquatic organisms but also serve as a major obstacle for the migrants along the river, fish biodiversity and local fishing communities.

The building of a dam generally has a major impact on the density and distribution of fish population. Fish migrations and other fish movements can be stopped or delayed. The quantity and accessibility of their habitat, which plays an important role in population sustainability, can be affected. Fishes can suffer physical trauma during their transit through hydraulic turbines or over spillways. Changes in discharge regime or water quality can also have indirect effects upon fish species. Increased upstream and downstream predation on migratory fish is also linked to dams. Because of the dam, fish movement slows down and concentrates below and above the dam making them easier prey to certain predatory species.

Capture fishery is not a major profession and culture fishery is also not developed in this region. Due to increasing population and poverty, most of the local people living in this area undertake seasonal works such as shifting cultivation in the paddy season and fishing and hunting in the other seasons. Most of the families in these areas possess various tools such as farming and hunting apparatus and fishing gears for their livelihood. Major threat for fishery found in the region is uncontrolled dynamite fishing along the rivers and tributaries. Although dynamite fishing is banned by fisheries regulation and laws, the local people use this method extensively because it is easy in fast flowing water. Using small mesh size nets and fishing even in the banned season are common in this area. All of these due to poor knowledge of the local people on the importance of environmental conservation.

No record is available on the aquatic ecology of surveyed areas except for a few fish identification list from Myitkyina, Putao fish markets and nearby townships along the Ayeyarwaddy River. There is no record on snow trout which is distinct cold water species in sueveyed areas, until now. These fishes are very important in Trans-Himalayan countries as a game fish for recreational fishery as they fetch a good price for their excellent taste. WWF (World Wildlife Foundation) considered the eastern Himalayan region as a global biodiversity hotpot, where many species groups have been inadequately studied due to its remote location. New records of fish species and aquatic organisms along this project are very valuable not only locally but also internationally from the biodiversity point of view.

2. BRIEF LITERATURE REVIEWS OF DAM IMPACT ON AQUATIC ECOSYSTEM

The only one literature available on EIA on aquatic ecological condition on dam project in Myanmar is Tamanthi Dam, Hydropower and Multipurpose Project, Statement of Biodiversity Impact (2006) (A Rapid Assessment). The report pointed out that dams usually cause fragmentation of ecosystems. Dams not only alter the pattern of downstream flow (i.e. intensity, timing and frequency) they also change sediment and nutrient regimes and alter water temperature and chemistry. Dams disrupt dynamic processes and so have an impact on the ecological integrity of natural systems.

Human started to build dams and canals a long time ago and this influenced the natural flow regime. In 2600 BC, the first large dam (14 meters height, 113 meters crest length) was build at Sadd et Kafara in Egypt in the Garawi ravine facing Memphis (Schnitter, 1994). Dam construction and reservoir itself has variable impacts such as social, economical, geophysical as well as impacts on water quality, climate, flora and fauna. These impacts are related closely to each other. From all these, impacts on fish should be observed in more detail. Fish is important to our society not only as a living being but also as a basic food for thousands of years and fishing is a sport or recreational activity for a lot of people (Horvath et. al., 1998).

Human population growth and increased water usage are placing greater demands on the world's freshwater supplies (Postel, 2000). Consequently, alterations in the hydrologic regime due to structural and operational measures such as dam construction and associated water diversion, exploitation of groundwater aquifers, stream channelization and inter-catchment water transfer are producing global-scale effects on the environment (Rosenberg et al., 2000).

Dams represent a major cause of disruption in natural river flows which are built to store water, to compensate the water level fluctuation, or to raise the level of water upstream, either to increase hydraulic head or to divert water into a channel. The storage capacity allows dams to generate electricity, to supply water for agriculture, industries and municipalities, to mitigate flooding and to assist river navigation (Rosenberg et al., 2000).

Large dams and river diversions have proven to be primary destroyers of aquatic habitat, contributing substantially to fisheries destruction, the extinction of species and the overall loss of ecosystem services on which human economy depends (Postel, 1998).

Some effects after the dam construction are immediate and obvious, for example dams obstruct migration pathways for fish, and reservoirs act as a sediment trap. Other effects are gradual and subtle, making them difficult to predict (Nilsson and Berggren, 2000).

The biodiversity of aquatic fauna is affected after dam construction because the natural seasonal flow patterns to which it is adapted are altered, normal seasonal migration paths are blocked and populations are therefore fragmented (Dudgen 2000). Although dams with spillways allow the passage of migratory biota, macrofauna abundance upstream of the dams is lower than in river reaches downstream of dams or in comparable reaches without dams (Conception and Nelson, 1999). Sometimes, low-head dams may act as a bottleneck, increasing the density of upstream migrating animals below the dam, attracting a large number of predators and, therefore, resulting in increased mortality among the migratory species (Benstead et al., 1999).

As riverine landscapes depend to a high extent of natural disturbances, the seasonal hydrological dynamics are crucial for maintaining ecological integrity (Junkwirth et al. 2002). Flood control by levees, land drainage, river bed dredging, river regulation by dams and various alterations of the natural hydrological regimes isolate rivers from their floodplains and have been the major factors in physical habitat degradation (Petts 1996). Flood-dependent fishes migrate regularly between the river channel and the inundated floodplain for spawning and feeding (Welcomme, 1979) and some invertebrates also exhibit movements between the channel and floodplain water bodies as part of their life cycles (Sodetstrom, 1987).

Anthropogenic impacts on riverine landscapes such as damming, dredging, channelization, disrupt natural disturbances regimes and truncate environmental gradients will effect severly on the migratory species (Ward and Stanford, 1989). Environmental gradients lead to high levels of spatio-temporal heterogeneity such as movements and migration also contribute to high biodiversity levels over an annual cycle (Ward, 1998). Ecosystem management, therefore, becomes a problem of re-establishing the environmental gradients, re-establishing the ecological connectivity between landscape elements and reconstitutes some semblance of natural dynamics (Ward, 1998).

Many morphological and hydrological alterations in the river resulted in irreversible damage of riverine ecosystems (Bloesch and Sieber, 2002). Therefore, when evaluating the effects of dams or other anthropogenic disturbances, it is important for managers to have a good understanding of the ecology of the specific rivers they are managing. Collaboration with biologists, which can provide information about river flora and fauna (e.g. life-cycle, reproduction, feeding patterns, migration, habitat requirements), can offer useful tools for mitigation of negative effects of dams or reservoirs construction.

Larinier (2000) discussed that the construction of a dam on a river can block or delay upstream fish migration and thus contribute to the decline and even the extinction of species that depend on longitudinal movements along the stream continuum during certain phases of their life cycle. Mortality resulting from fish passage through hydraulic turbines or over spillways during their downstream migration can be significant. Experience gained shows that problems associated with downstream migration can also be a major factor affecting anadromous or catadromous fish stocks. Habitat loss or alteration, discharge modifications, changes in water quality and temperature, increased predation pressure as well as delays in migration caused by dams are significant issues.

Adams (2000) proposed that dams impact fish in three ways. Firstly, dams can affect the physical stability of river channels. River bed degradation downstream of dams can also lead to the loss of important in-stream spawning grounds for fish. Secondly, dams can affect fisheries through impacts on water quality. Declines in water quality can have significance for human health, and for the economies dependent on the natural resources of the river. Water released from low outlets in a dam (e.g. turbines) tends to be cold and may be deoxygenated, or rich in hydrogen sulphide. Thirdly, and most importantly, dams affect fishing communities by changing natural flooding patterns. In temperate rivers there is a relatively detailed understanding of the impacts of dams on migratory game fish, and the development of responses in dam design (e.g. fish ladders), dam operation (the release of artificial floods) and downstream river management (e.g. in-stream, flow diversion structures) to minimize adverse impacts of control on fish stocks. Knowledge of the impacts of dams on fisheries in tropical rivers is not complete.

In the dams, fish such as snow trout, catfish and loaches may be pulled into the intakes and get killed. Even riverine fish adapted to fast current may be lost. Fish food organisms will be highly affected by reduced flow rates and new species will invade areas with a slow current. Golden and copper mahaseer are known to be affected directly by the changes in their habitat, which leads to stunted growth, diseases and parasite infestation and increased mortality (Petr and Swar, 2002).

Reduced winter flows after damming would probably have impacts on aquatic ecology and water quality in large part because the river's pollutant load would be less diluted and thus more concentrated. This could result in widespread die-off of species and long-term replacement of desirable species with less desirable but more pollution tolerant organisms (Kondolf and Hou, 1998).

Gubhaju (2002) discussed that cold water fish of Nepal are facing problems due to an increasing number of hydropower projects. Abundant indigenous fish stocks have been declining due to overfishing, harmful fishing practices (electrofishing, dynamiting, chemical usage), pollution and developmental works. Developmental works such as river damming have a major impact on river ecology, aquatic flora and fauna, including fish. Cold water fish of Nepal are affected by the increasing number of hydropower dams in the country.

Petr (2003) noted that there are a large number of obstructions on rivers and streams for developmental projects. The ever increasing numbers of weirs, barrages and dams have a harmful effect on the ecological well-being of the native fish populations, preventing many fish species from reaching their traditional areas of spawning and feeding. As a result of such disturbances, many fish species have declined in numbers, and in the worst situations, some species have become extinct in some rivers. Fishways (or fish passes) are an important means of redressing parts of the detrimental effects of obstructions. They assist in allowing fish to move over a dam or a weir to reach their breeding and feeding areas, or to reach the lower stretches of the river or the sea. Ensuring the free passage of fish protects stocks for future generations. To design the right type of fishway, one has to understand the requirements of the individual fish species, and these vary from species to species. Designing fishways requires skill in the fields of both biology and hydraulics, such as the swimming ability of migrators, and also their behaviour when faced with obstruction. Hydraulic and civil engineering must fully guarantee that the facilities will work throughout the usual range of river discharge experienced during the migration season. A recent visit to several dam sites in Nepal has shown that most of the existing fish passes require modification to be effectively used by the native migratory fish species. This will also require a better knowledge of the biology and the behaviour of the indigenous species, especially of the behaviour in relation to obstacles and the fish's capacity to negotiate them. While this knowledge is available for salmonid stocks frequenting temperate waters of the northern hemisphere, little is known on such behaviour of non-salmonids inhabiting rivers of the Himalayas, Karakoram, Hindu Kush and some other mountains of Asia. As a result, valuable fish stocks are being lost.

Dams constitute obstacles for longitudinal exchanges along fluvial systems and as such result in the fragmentation (i.e. reduced connectivity) of ecosystems (Ward and Stanford, 1995). Dams not only alter the pattern of downstream flow (i.e. intensity, timing and frequency) they also change sediment and nutrient regimes and alter water temperature and chemistry. Dams may be viewed as anthropogenic alterations that disrupt dynamic processes and so they have impact on the ecological integrity of natural systems (McCarthy, 2000).

Dams may be good for some species such as water fowl and pelagophilic fish and in some areas in a dry desert like areas, where a reservoir may be beneficial to terrestrial as well as aquatic biota, because it constitutes a permanent water resource. However, because a river and its tributaries represent a more varied habitat than a large lake (particularly in the tropics) there is usually a decline in the total number of species (Bardach and Dussart, 1973).

The most common downstream effect of large dams is that variability in water discharge over the year is reduced such as high flows are decreased and low flows are increased. Reduction of flood peaks reduces the frequency, extent and duration of floodplain inundation. Reduction of channel-forming flows reduces channel migration. Truncated sediment transport (i.e. sedimentation within the reservoir) results in complex changes in degradation and aggregation below the dam. The temporal pattern of flooding is altered by regulation, one effect of which is to desynchronise annual flow and temperature regimes (Sparks et. al., 1990). These changes and others directly or indirectly influence a myriad of dynamic factors that affect habitat heterogeneity and successional trajectories and, ultimately the ecological integrity of river ecosystems (Ward and Stanford, 1995).

A dam will fragment and isolate upstream resident fish such as stone carp and catfish from downstream. The resident species may congregate in the tail-water release site. Fish from upstream will occasionally sweep downstream during the monsoon, stay in the tail-water or swim further downstream. A dam will obstruct the route of the long and mid-distance migratory fish. Upstream migrants will arrive at the dam site during the flow phase. Long distant migrants such as *Tor* sp., *Bagarius, Pseudeutropius, Clupisoma* and *Anguilla*, and mid-distance migrants *N. hexagonolepis* and *Labeo* species are most affected by a dam. These species will abandon the original pool and colonize deep pool regions downstream or upstream. Populations of snow trouts are less affected, as they make a small-scale migration to tributaries to breed in clear and cool water during the monsoon and return to the main stream during the low flow period (Shrestha, 1997).

Fish are affected directly by physical barrier of migration routes and movement of fish such as inundation of spawning grounds within the reservoirs, irregular releases of dam and periodic inundation or drying out of spawning grounds and refuge area downstream of the dam. Fish are affected indirectly to different level, depending on species, by modification of velocity, temperature and quality of water. The change in habitat caused by construction of a dam modified the fish community, population densities and areas utilized by a particular species (Horvath et. al., 1998).

The impoundments after damming the rivers adversely impact both fish biodiversity and local fishing communities. Ecosystem change destroys feeding as well as breeding grounds, with a resultant loss of fish species. Where the movement of migratory fish up and down river is affected by hydropower development, fish hatcheries near the dam sites or fish ladders for fish movement should be considered as mitigation options. Local user groups and other stakeholders should be involved in decision-making, to keep good relations concerning peoples' livelihoods and the sustainability of aquatic resources. Migratory fish species are vulnerable during their life cycle due to river damming, and about 20% of the world's fresh water fishes are estimated near extinction or in urgent need of conservation. Therefore, to sustain biodiversity and fisheries in rivers requires sustainable management both of habitats and systems of exploitation. River systems should be thoroughly studied jointly with concerned agencies (e.g., electricity, irrigation and fisheries authorities; and local authorities) during formulation and application stages of hydroelectric power development projects (Rai, 2008).

Gleick (2009) reported that ecological problems have been projected to occur as a result of the construction of the dam and modification of the watershed, including impacts on the fisheries of the Yangtze River basin. This basin has 36 percent of all freshwater fish species in China, with more than 360 fish species belonging to 29 families and 131 genera. Twenty-seven percent of all of China's endangered freshwater fish are in the Yangtze basin, and there are as many as 177 endemic fish species. Major changes in fish populations have been anticipated because the project is altering the dynamics of the river, the chemical and temperature composition of the water, and the character of the natural habitat and food resources available for these fish species. The dam itself blocks migration of fish and access to spawning grounds, and these impacts will be imposed on top of other significant modifications to the Yangtze that have already caused declines in fisheries. In 1981, the Chinese completed the construction of the Gezhou Dam 40 kilometers downstream from the Three Gorges Dam site. That was followed by rapid and sharp declines in the populations of three of China's famous ancient fish species, the Chinese Sturgeon, River Sturgeon, and Chinese Paddlefish, each of which is now listed as endangered. Of special concern is the Chinese Freshwater Dolphin, which may already be extinct. Fisheries in the upper watershed are also at risk. A study in 2003 identified six species at high risk of complete extinction, another 14 with an uncertain future, and two dozen more that may only survive in tributaries to the Yangtze. Fisheries are already beginning to show the effects of altered river ecology below the dam. Data released to a Three Gorges Dam monitoring program website indicate that commercial harvests of four species of carp are well below pre-dam levels. Annual harvest of these commercial fish below the dam from 2003 to 2005 was 50–70% below a 2002 pre-dam baseline and even more dramatic declines are being seen on larvae and eggs below the dam.

3. PARTICIPANTS

2 teams from Myanmar and Chinese scientists were carried out collaboratively along the surveyed period (Fig. 3.1.). The member scientists are as follows:

1. U Zau Lunn — BANCA, Myanmar
2. U Myint Pe
3. U Tint Wai
4. U Than Htay Oo
5. U L. Tue Nann

6. U Thaung Htut
7. U Aung Kyaw Win
8. U De Mo Tun
9. Professor Qiao Ye IHE, Wuhan, China
10. Mr. Zheng Haitao
11. Mr. Wang Xiang
12. Dr. Zhang Yichao
13. Dr. Zhao Xianfu
14. Mr. Wang Hongjun
15. Mr. Ma Peiming
16. Mr. Wan Li
17. Mr. Cai Yupeng

4. PROJECT LOCATIONS AND SURVEYED AREAS

There are 7 dams for construction in the project areas in Kachin State. 1 dam on Mali Hka River is Lasa Dam, 5 dams on May Hka River are Yenam Dam, Kaunglanghpu Dam, Pisa Dam, Wusok Dam and Chibwe Dam and 1 dam on Ayeyarwaddy River is Myitsone Dam. The investigation on physicochemical parameters covered from below the reservoir heads of Lasa Hydropower Station on Mali Hka and Yenam Hydropower Station on May Hka to 20 kilometers downstream from Myitsone dam site on Ayeyawady River. Investigation on major branch tributaries covered 10 km above the estuaries of various branch tributaries.

Investigation on fish resource survey was focused on regional investigation, without fixed sections for investigation and monitoring. This investigation was set up along the trip in the main rivers, major branch tributaries and the villages near the camps for spot sampling. Interview surveys were also conducted along the trip for information on fisheries and water quality conditions.

4.1. Myitsone:

The Myitsone dam site is situated on the Ayeyarwaddy River in Myitkyina Township, 5.4 kilometers downstream from the confluence of May Hka and Mali Hka. The estimated GPS location of dam site is N 25° 41’ 48.2” and E 97° 29’ 39.4”. The estimate elevation is about 138 m. There were 23 stations surveyed in January and February, 2009 and 8 stations in May, 2009. The positions are shown in Fig. (4.1).

4.2. Lasa (Laza):

Lasa dam, the one and only dam on Mali Hka River, located in Sumprabum Township, is situated in the middle part of Mali Hka River and the estimated GPS locations are N 26° 27’ 21.7” and E 97° 48’ 5.9”. The estimated elevation of the dam site is about 214 m. Fig. (4.1) illustrates the 6 stations surveyed.

4.3. Yenam (Renam):

Yenam is the farthest on May Hka and located in Naungmung Township, 315 kilometers far from May Hka and Mali Hka confluence, the estimated GPS locations of which are N 27° 41’ 16.0” and E 98° 01’ 29.3” and elevation about 852 m. The 6 stations of which aquatic ecological conditions are carried out are shown in Fig. (4.1).

4.4. Kaunglanghpu:

The smallest catchment area of the dams, Kaunglanghpu which is 14655 kilometer square in area, Kaunglanghpu is located 1.6 kilometers down stream from Mekh Rame Tributary and May Hka River confluence and situated in Kaunglanghpu Township. The estimated elevation is about 670 m. and estimated GPS locations are N 27° 01’ 26.8” and E 98° 21’ 28.9”. Aquatic ecological conditions were studied for 8 stations in Khaunglangphu dam environment and the locations are as shown in Fig. (4.1).

4.5. Pisa:

This dam, of which the information was difficult to get, because of road accessibility, is situated about 1.6 kilometers downstream from the confluence of Mekh Rame Tributary and May Hka River and located in Tsawlaw Township. The estimated GPS locations are N 26° 43’ 54.2” and E 98° 22’ 34.6” and estimated elevation is about 533 m. Environmental Impact Assessment for 5 stations were undertaken for this dam environment and the locations are as shown in Fig. (4.1).

4.6. Wusok:

The second smallest installed capacity, 1800 kilowatts, of the dams of Wusot is situated on May Hka River. This dam is located in Tsawlaw Township, and the estimate values of GPS points are N 26° 25’ 59.0” and E 98° 17’ 27.1”, and estimate elevation is about 430 m. From the main river and the major tributaries along the dam environment, 7 stations were surveyed and illustrations are as shown in Fig. (4.1).

4.7. Chibwe:

Chibwe dam, the second largest catchments area of the dams, is situated on May Hka River and located in Chibwe Township. The estimated GPS locations are N 26° 00’ 04.1” and E 98° 10’ 59.2” and 270 m. is estimated elevation. 5 sites were undertaken for environmental conditions of aquatic ecology and the positions are as shown in Fig. (4.1).

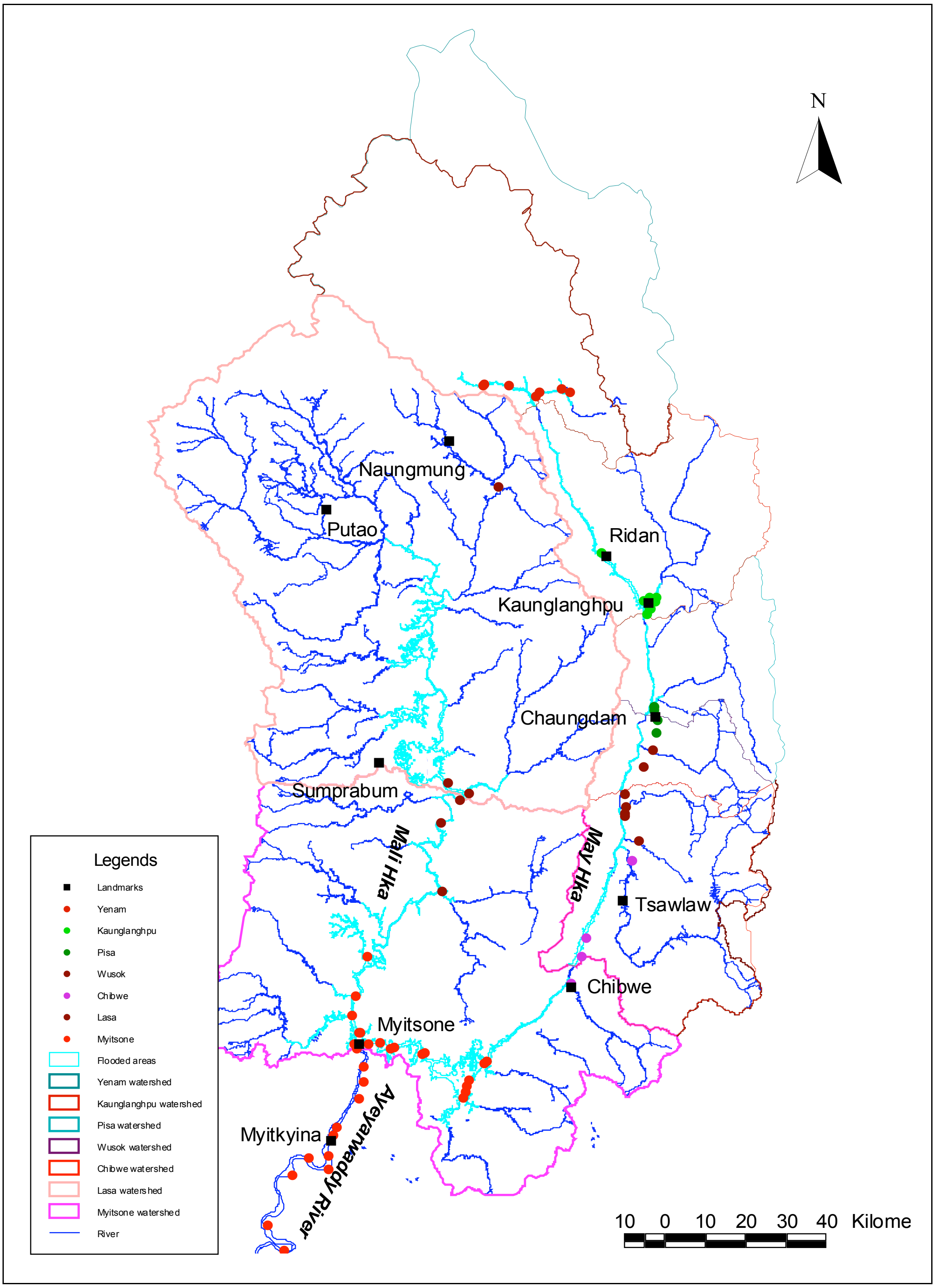

Fig. 4.1 (a). Sampling stations in the flood areas along May Hka, Mali Hka and Ayeyarwaddy Rivers.

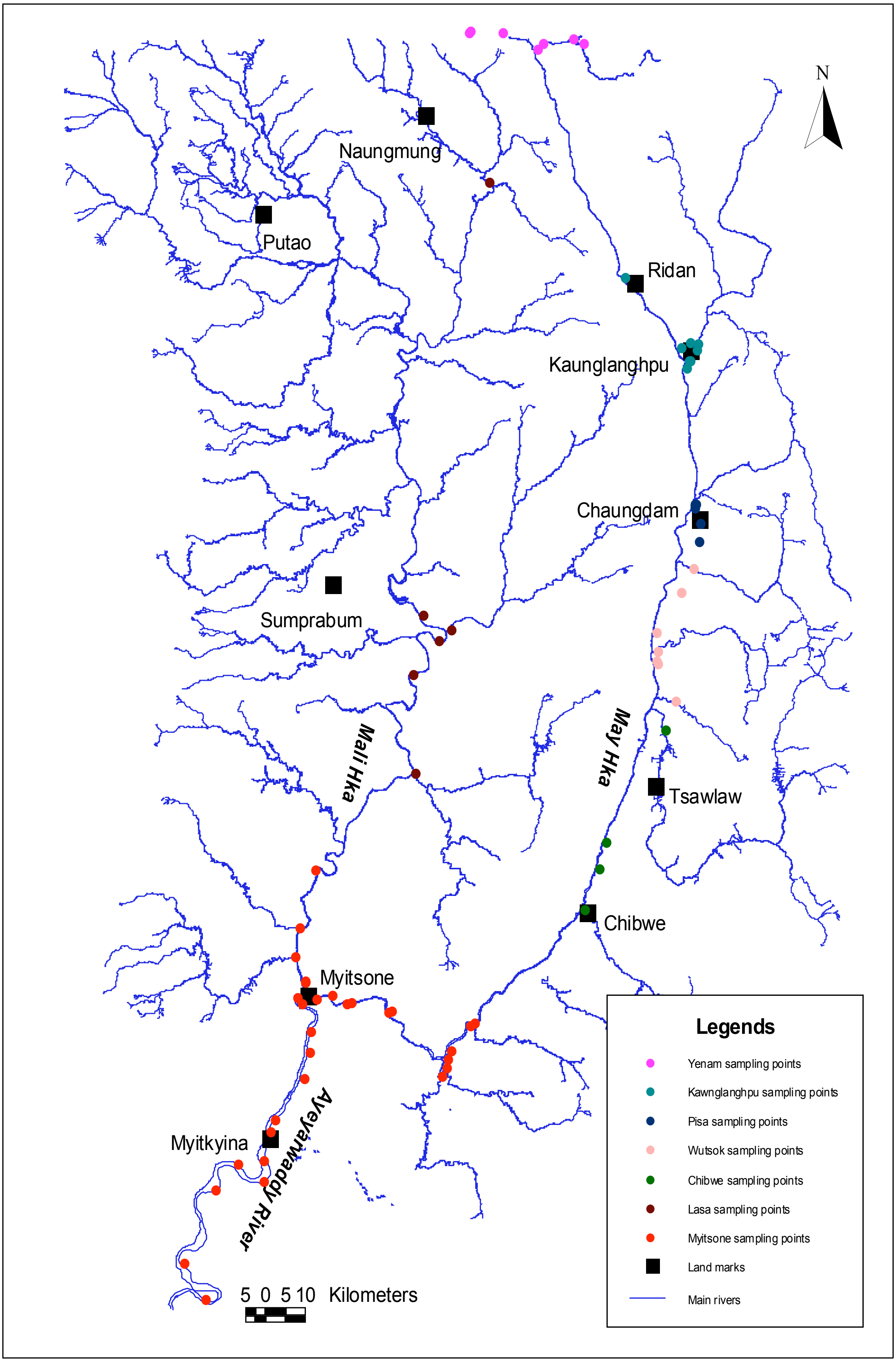

Fig. 4.1 (b) Sampling stations along May Hka, Mali Hka and Ayeyarwaddy Rivers.

5. MATERIALS AND METHODS

The data for physicochemical parameters, aquatic organisms composition and distribution and fisheries conditions were studied according to the “Terms of Reference of EIA on Hydropower Development of Ayeyarwaddy River above Myitkyina, Myanmar” for prediction of environmental impacts before and after dam construction on the aquatic ecosystem. Due to the difficulties of assessment to the dam sites and weather condition, surveyed stations were set up as close as possible to the guide lines.

Physical properties of water quality such as air temperature (degree celcius), water temperature (degree celcius), pH, water transparency (cm) and turbidity (NTU) were measured. Measured chemical properties were conductivity (mS/cm), Total Dissolved solids-TDS (mg/l), salty (g/l), Dissolved Oxygen (DO) (ppm and percentage), ORP (Oxydative Redox Potential) and nutrients of ammonia, nitrite, nitrate, total nitrogen and total phosphate in parts per million (ppm).

Water temperature, air temperature, pH, turbidity, conductivity, TDS, salty, ORP, DO were measured in situ using YSI (Yellow Spring Instrument) multipurpose model no. 6600 and TROLL multi-parameter series no. 9500 (Fig. 5.1). Temperature values were counter checked using mercury thermometer. pH was counter checked by INDEX model ID 1000. TDS and conductivity were checked using INDEX model ID 1020 (Fig. 5.2). The rest of the chemical properties were analyzed in the Institute of Hydroecology, Ministry of Water Resources and Chinese Academy of Science, Wuhan, Peoples Republic of China. The analytical procedures are followed in accordance with the Pollution Prevention Manual published by the World Bank.

Exact location of the surveyed sites was found using GARMIN GPS models etrex-Legend Cx and GPSmap 60CSx (Fig. 5.3). Environmental conditions of the surveyed areas were recorded by Nikon COOLPIX L18 and SONY Cyber-shot DSC-S730 digital cameras. Weather conditions were determined by overall naked eye view surveys (Fig. 5.4).

Phytoplankton was collected using 25# mesh and zooplankton was collected using 13# mesh plankton nets and preserved with formalin. Quantitative samples were collected with 25# mesh plankton net and fixed with lugol’s solution for further calculation (Fig.5.5). Benthos was collected using D-shape kick-net and preserved with formalin (Fig. 5.6). Periphyton samples were taken from the submerged stones and preserved using formalin for further identification (Fig. 5.7). All of the samples are identified and analyzed at the Wuhan Institute of Hydroecology, Peoples Republic of China (Fig. 5.8).

Fish samples were bought from the local fishermen and markets (Fig. 5.9). The samples were preserved with formalin for further identification. Information on fisheries was taken by interviewed surveys from every place as a spot sampling method from the local fishermen and scholars. Frequent visit to Kachin State Fisheries Office, Myitkyina University and some local authority places were also made and collected secondary information about fish biodiversity and fisheries status. Fish samples are counter checked by Myanmar team members in the Fisheries Department, Ministry of Livestock and Fisheries, Union of Myanmar.

6. RESULTS

6.1. Water quality and environmental condition

6.1.1. Myitsone

The measured water quality values and environmental conditions are as shown in Table (6.1.1) and Fig (6.1.1.1 to 6.1.1.6). The recorded lowest water temperatures in January were about 12.5°C in May Hka, 16.0°C in Mali Hka and 15.3°C at the confluence to more than 20°C in the downstream of Ayeyarwaddy River. Water temperature of May Hka River is about 4 degrees celsius lower than the other rivers. Transparency of Mali Hka River is lower than the tributaries and other rivers.

Higher values of electrical conductivity were recorded from Mali Hka River and some tributaries along Ayeyarwaddy River. Oxygen concentration of all surveyed areas is very close to concentrated values.

River width of May Hka River is narrower and bank is steeper than the other rivers. Sandy banks are more common in the downstream of Ayeyarwaddy River. Gravel and pebble bottoms are common in Mali Hka and May Hka Rivers. Terrace and agricultural farms are common in the riparian areas of Mali Hka and Ayayarwaddy Rivers, and secondary forests are more common in May Hka. Most of the banks are occupied by ye-ne plants (*Homonia riparia* Lour.) in this region. Gold mining is abundant in Mali Hka River and different forms of small scale to mechanized scales were observed along the river.

Table 6.1.1. Water quality and environmental conditions of Myitsone Dam area.

Station (January)	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
GPS	N 25° 22' 13.9" E 97°24' 32.5"	N 25° 44' 38.9" E 97°30' 11.6"	N 25° 44' 38.8" E 97°30' 11.6"	N 25° 42' 32.9" E 97°31' 44.6"	N 25° 42' 06.0" E 97°36' 23.6"	N 25° 25' 51.0" E 97°25' 26.3"	N 25° 47' 46.5" E 97°28' 46.1"	N 25° 51' 19.8" E 97°29' 25.3"	N 25° 58' 40.2" E 97°31' 30.6"	N 25° 04' 49.1" E 97°16' 39.2"	N 25° 09' 21.2" E 97°13' 48.6"
Elevation (m)	138	126	153	137	157	125	149	129	151	118	129
Date	15/1/2009	16/1/2009	16/1/2009	17/1/2009	17/1/2009	17/1/2009	22/1/2009	23/1/2009	24/1/2009	31/1/2009	31/1/2009
Time	15:00	11:00	13:50	10:00	12:10	17:15	10:32	10:47	12:08	10:58	14:02
Locations **Parameters**	I	III	III	II	II	I	IV (III)	IV (III)	IV (III)	IV (I)	I
Air Temperature (°C)	19	19	19	14.5	19	18	18	20	19.5	25	25
Water Temperature (°C)	15.3	16.8	16.07	12.5	12.5	16.51	16	18	16.5	21.5	20.5
pH	7.74	7.89	7.75	7.57	7.4	8.02	7.8	8	8.2	7.1	8.4
Transparency (cm)	65	37	27	-	-	55	55	-	-	90	60
Electrical Conductivity (mS/cm)	0.074	0.105	0.103	0.082	0.006	0.101	0.106	0.029	0.016	0.029	0.067
Dissolved Oxygen (ppm)	9.38	8.56	9.25	8.34	9.56	8.76	9.25	9.36	9.45	8.78	9.63
Dissolved Oxygen (%)	94.2	85.9	92.9	83.7	96.0	88.0	92.9	94.0	94.9	88.2	96.7
Total Nitrogen (ppm)	0.22	0.546	0.242	0.1516	0.2873	0.2524	0.3541	0.641	0.1195	0.1706	0.1463
NH_3-N (ppm)	0.011	0.036	0.089	0.001	0.002	0.008	0.006	0.065	0.006	0.003	0.001
NO_2-N (ppm)	0.006	0.007	0.001	0.005	0.001	0.006	0.004	0.002	0.002	0.001	0.006
NO_3-N (ppm)	0.054	0.211	0.004	0.005	0.007	0.024	0.036	0.088	0.003	0.033	0.014
Total Phosphorous (ppm)	0.0681	0.0419	0.0494	0.0805	0.0547	0.0373	0.0709	0.04335	0.058	0.0598	0.0423
Total Dissolved	.074	.081	.081	.067	.07	.05	.04	.06	.09	.08	.05

Solids TDS (mg/L)												
Turbidity (NTU)												
Oxidative Redox Potential ORP (mV)		-9.5	-13	103	45.3	452	54.8	436	-13	116	-20	145
Salty		0.05	0.06	0.06								
Weather		S	S	S	S	S	S	S	S	½ C	S	S
Water Clarity		CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
Water Coloration		LG	G	LG	G	G	LG	LG	LG	LG	DG	LG
River Width (m) (estimate)		100-150	200-250	100	100-150	300	500	25	20	10	300	600
Bank Condition	Left	Sd. & Rc.	Rc. & Sd.	Sd. & Rc.	Sd.	Sd.	Sd.	Sd. & Rc.	Sd. & Rc.	Rc.	Sd.	Rc.
	Right	Rc.	Sd. & Rc.	Sd.	Sd.	Rc. & Sd.	Gv.	Sd. & Rc.	Sd. & Rc.	Rc.	Sd.	Gv. & Rc.
Bank Height (m) (estimate)	Left	30	5	5	10	5	10	10	15	10	7	7
	Right	30	5	5	10	5	10	10	15	10	7	7
Bank Width (m) (estimate)	Left	10	50	200	50	500	50	5	3	0	20	300
	Right	4	50	50	900	75	100	5	3	0	300	300
Bank Gradient (°) (estimate)	Left	60-70	10-15	70	10-15	5-7	5	50	50	50	40	20
	Right	80	5-10	5-10	5-10	10-15	5-10	50	50	45	30	20
Bottom Condition		Rc.	Gv.	Sd.	Gv. & Sd.	Sd. & Gv.	Gv.	Gv. & Sd.	Gv. & Sd.	Gv., Sd. & Md.	Sd.	Gv.
Biological Condition in the Water		-	-	-	-	-		Td. Larv.	Bent. & Alg.	Bent.	Pt. & Mp.	-
Biological Env. on the Banks	Left	-	-	-		-	-	-	-	Mos.	-	-
	Right	Bent.	-	-		-	Alg.	-	-	Mos.	-	-
Riparian Area Condition	Left	Sec.	Sec.	Sec.	Sec.	GM & Vil.	Sec.	Bam.	Sec.	Sec.	Vil.	Vil.
	Right	Camp.	Sec.	Vil.	Sec.	GM & Sec.	Vil.	Bam.	Sec.	Sec.	Vil.	Agr.

XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI	XXII	XXIII
N 25° 18’ 39.4” E 97°18’04.5”	N 25° 21’ 45.2” E 97°21’01.9”	N 25° 19’ 40.1” E 97°24’34.0”	N 25° 32’ 33.1” E 97°30’00.9”	N 25° 35’ 50.0” E 97°30’48.3”	N 25° 38’ 27.4” E 97°30’52.9”	N 25° 42’ 37.7” E 97°29’06.7”	N 25° 34’ 52.4” E 97°49’15.9”	N 25° 35’ 57.7” E 97°49’44.9”	N 25° 40’ 54.3” E 97°41’45.1 ”	N 25° 40’ 48.1” E 97°41’18.4”	N 25° 41’ 50.2” E 97°35’41.2”
113	113	103	148	130	136	135	166	180	177	177	146
1/2/2009	1/2/2009	2/2/2009	5/2/2009	5/2/2009	6/2/2009	7/2/2009	9/2/2009	9/2/2009	9/2/2009	10/2/2009	11/2/2009
10:00	11:20	9:30	9:00	12:07	13:56	12:26	10:45	12:58	14:38	11:38	9:58
I	I	I	IV (I)	I	I	IV (I)	IV (II)	II	II	IV (II)	IV (II)
21	24	19	15.5	18.5	28	26.5	21	20.5	20.5	22	22
17.5	18	16	16.5	22	17	19.5	16	14	14.5	19	19
7.4	7.5	7.2	7.8	7.5	7.5	8.3	7.5	7.4	7.4	8	7.5
-	-	-	-	50	70	-	-	-	-	-	-
0.047	0.066	0.106	0.026	0.009	0.006	0.22	0.006	0.005	0.007	0.008	0.010
9.89	8.65	7.54	10.02	8.99	7.76	10.1	7.65	8.63	10.63	9.12	7.65
99.3	86.8	75.7	100.6	90.3	77.9	101.4	76.8	86.6	106.7	91.6	76.8
0.323	0.592	0.1089	0.2375	0.111	0.608	0.265	1.2143	1.9187			
0.006	0.045	0.003	0.005	0.001	0.069	0.067	0.321	0.226			
0.007	0.008	0.007	0.005	0.007	0.008	0.008	0.009	0.008			
0.033	0.16	0.004	0.006	0.003	0.32	0.068	0.563	0.885			
0.0558	0.0457	0.0371	0.0475	0.0912	0.1537	0.1193	0.1106	0.081			

.04	.04	.04	.06	.06	.04	.15	.04	.04	.04	.07	.06
179	112	-423	-132	75.2	46.5	112	188	143	147	-46	46.9
S	S	S	S	S	S	S	S	S	S	S	S
CL	TB	TB	TB	CL	CL	CL	CL	CL	CL	CL	CL
LG	G	G	G	LG	G	LG	LG	G	G	LG	LG
300	500	300	4	500	400	15	30	300	400	7	2
Gv.	Sd.	Sd.	Gv. & St.	Gv. & Sd.	Gv. & Sd.	Gv. & Sd.	Gv.	Gv. & Sd.	Gv. & Sd.	Rc.	Rc.
Sd.	Gv.	Gv.	Gv. & St.	Gv. & Sd.	Rc. & Sd.	Gv. & Sd.	GV.	Gv. & Sd.	Gv. & Sd.	Rc.	Rc.
7	7	7	8	8	8	2	1.5	7	7	3	3
7	7	7	8	8	8	2	1.5	7	7	3	3
200	50	400	5	30	50	0	0	100	20	0	20
200	50	100	5	100	50	0	0	200	10	0	0
15	15	70	90	40	25	70	80	45	45	70	70
10	10	5	80	25	15	50	70	60	60	70	70
Gv.	Gv.	Gv.	Gv. & St.	Gv. & Sd.	Gv.	Gv.	Gv.	Sd.	Gv.	GV. & Sd.	Sd. & St.
Alg.	Bent.	Bent.	-	-	-	-	Bent. & Alg.	-	-	Alg.	Alg.
Bent.	Bent.	-	-	-	-	-	-	-	-	-	-
-	Bent.	Bent.	-	-	-	-	-	-	-	-	-
Agr.	Bus.	Vil.	Bam.	Vil.	Sec.	Vil.	Org.	Org.	Is.	Bam.	Bam.
Agr.	Bus.	Agr.	Bam.	Sec.	Sec.	Vil.	Org.	Sec.	Bam.	Bam.	Bam.

Station	XXIV	XXV	XXVI	XXVII	XXVIII (M1)	XXIX (M2)	XXX (M3)	XXXI (M4)
GPS	N 25° 39' 06.1" E 97° 52' 25.4"	N 25° 39' 24.6" E 97° 52' 53.5"	N 25° 33' 50.1" E 97° 49' 06.8"	N 25° 32' 49.2" E 97° 48' 35.0"	N 25° 44' 42.7" E 97° 30' 06.8"	N 25° 42' 54.6" E 97° 33' 45.7"	N 25° 41' 48.2" E 97° 29' 39.4"	N 25° 27' 25.6" E 97° 26' 04.7"
Elevation (m)	177	178	178	179	132	142	138	121
Date	7/5/2009	7/5/2009	7/5/2009	7/5/2009	8/5/2009	8/5/2009	9/5/2009	9/5/2009
Time	8:01	9:16	12:55	14:09	15:45	17:15	8:49	10:50
Locations **Parameters**	II	IV (II)	IV (II)	IV (II)	III	II	I	I
Air Temperature (°C)	24	27	28.5	29	33	30	21	29.5
Water Temperature (°C)	19.94	24.35	24.49	24.7	26	19.3	18.3	25.5
pH	7.43	7.37	7.71	7.72	7.5	7.56	7.45	8.49
Transparency (cm)	-	-	-	-	-	-	-	-
Electrical Conductivity (mS/cm)	0.034	0.031	0.039	0.047	0.05	0.034	0.057	0.039
Dissolved Oxygen (mg/L)	10.7	8.72	9.31	10.3	9.2	11.36	8.32	11.53
Dissolved Oxygen (%)	107.43	87.55	93.5	103.4	92.4	114.1	83.5	115.8
Total Nitrogen (ppm)	0.4446	0.2811	0.9422	0.1293	0.166	0.1903	0.5892	0.3523
NH_3-N (ppm)	0.006	0.001	0.122	0.003	0.003	0.003	0.005	0.004
NO_2-N (ppm)	0.007	0.007	0.005	0.006	0.002	0.003	0.007	0.008
NO_3-N (ppm)	0.123	0.004	0.356	0.008	0.009	0.06	0.552	0.078
Total Phosphorous (ppm)	0.0976	0.1032	0.0816	0.0737	0.1361	0.0812	0.0922	0.111
Total Dissolved Solids TDS (gm/L)								

Turbidity (NTU)		1.2	-1.8	0.3	7	12.1	5.3	9.5	3.7
Oxidative Redox Potential ORP (mV)		-180	155	-111	125	-154	85	87	80
Salty									
Weather		½ C	¾ C	C	C	S	S	S	S
Water Clarity		CL	CL	CL	TB	CL	CL	TB	CL
Water Coloration		LG	LG	LG	G	G	G	DG	LG
River Width (m) (estimate)		200	15	20	15	100	100	150	200
Bank Condition	Left	Sd.	Gv. & Pb.	Ert. & Rc.	Ert. & Bd.	Pb.	Sd.	Sd. & Bd.	Gv.
	Right	Sd.	Gv. & Sd.	Ert.	Ert.	Pb.	Gv. & Sd.	Gv.	Sd. & Gv.
Bank Height (m) (estimate)	Left	10	10	5	5	10	10	10	10
	Right	10	10	5	5	10	10	10	10
Bank Width (m) (estimate)	Left	200	50	0	10	30	50	10	200
	Right	10	35	20	0	100	30	5	50
Bank Gradient (°) (estimate)	Left	80	80	80	80	45	60	45	5
	Right	80	70	80	45	45	45	70	30
Bottom Condition		Pb. & Sd.	Pb. & Sd.	Pb. & Sd.	Bd.	Pb.	Sd.	Sd.	Gv.
Biological Condition in the Water		-	Per.	-	Bent.	-	-	-	-
Biological Env. on the Banks	Left	-	-	-	-	-	-	-	-
	Right	-	-	-	-	-	-	-	-
Riparian Area Condition	Left	Vil.	Agr.	Vil. & Agr.	Agr. & Rd.	Bam.	Bam.	Bam.	Vil.
	Right	Sec.	Agr.	Vil. & Agr.	Sec.	Sec.	Bam.	Camp	Vil.

6.1.2. Lasa

The measured water quality values and environmental conditions are as shown in Table (6.1.2) and Fig. (6.1.2.1 to 6.1.2.5). Water temperatures are higher than May Hka in the rivers recorded in the same period. Electrical conductivity is higher compared to the other dam sites.

River width is wider in most part of the surveyed stations. Secondary forests are common in riparian areas except Sumpian. Sandy bottoms can be found in some areas especially in wider rivers and areas of low flow rate. Gold mining is common in this area.

Table 6.1.2. Water quality and environmental conditions of Lasa Dam area.

Station	I	II	III	IV	V	VI

GPS		N 27° 24' 42.5" E 97° 54' 59.5"	N 26° 23' 09.5" E 97° 44' 41.6"	N 26° 10' 39.7" E 97° 44' 56.5"	N 26° 28' 40.7" E 97° 49' 45.2"	N 26° 30' 33.4" E 97° 46' 00.0"	N 26° 27' 21.7" E 97° 48' 05.9"
Elevation (m)		504	229		214	223	221
Date		24/3/2009			12/4/2009	13/4/2009	12/4/2009
Time		7:06			9:05	8:44	15:45
Location / **Parameter**		IV (III)	IV (III)	III	III	IV (III)	III
Air Temperature (°C)		20			24		
Water Temperature (°C)		20.5			17.17	20.62	20.58
pH		7.69			7.79	7.73	7.71
Transparency (cm)		-			-	-	-
Electrical Conductivity (mS/cm)		0.067			0.007	0.105	0.093
Dissolved Oxygen (ppm)		6.93			13.11		
Dissolved Oxygen (%)		77			120.7		
Total Nitrogen (ppm)		0.2409	0.7946	0.8549	0.395	0.8301	0.7025
NH_3-N (ppm)		0.006	0.156	0.189	0.039	0.078	0.067
NO_2-N (ppm)		0.007	0.008	0.005	0.006	0.006	0.009
NO_3-N (ppm)		0.011	0.19	0.65	0.07	0.037	0.34
Total Phosphorous (ppm)		0.121	0.08002	0.08	0.042	0.0464	0.02265
Total Dissolved Solids TDS (gm/L)		0.043			0.04	0.068	0.06
Turbidity (NTU)							
Oxidative Redox Potential ORP (mV)		-84			-139.3	-117	-131.2
Salty		0.03					
Weather		S					
Water Clarity		CL					
Water Coloration		G					
River Width (m) (estimate)		50			60	90	80
Bank Condition	Left	Gv. & Sd.					
	Right	Gv. & Sd.					
Bank Height (m) (estimate)	Left	3					
	Right	3					
Bank Width (m) (estimate)	Left	50			30	30	30
	Right	0			30	30	35
Bank Gradient (°) (estimate)	Left	10					
	Right	80					
Bottom Condition		Gv. & Sd.			Gv. & Bd.	Sd & Bd	Sd., Gv. & Bd.
Biological Condition in the Water		-					
Biological Env. on the Banks	Left	-					
	Right	-					
Riparian Area Condition	Left	Sec.			Sec.	Sec.	Sec.
	Right	Sec.			Sec.	Sec.	Sec.

6.1.3. Yenam

The measured water quality values are as shown in Table (6.1.3) and Fig. (6.1.3.1 to 6.1.3.5). Water temperature is the lowest compared to other surveyed dam environments. Every temperature records were lower than 10°C. Water is also well oxygenated because of high flow rate along the river. Bank gradient is also steep and rocky banks are common. Gravel and rocky bottoms are the most dominant along the river.

River width is narrow in most parts of the surveyed areas. Secondary forests are common along the river bank. No gold mining is observed in this region.

Table 6.1.3. Water quality and environmental conditions of Yenam Dam area.

Station		I	II	III	IV	V	VI
GPS		N 27° 43’ 23.1” E 97° 52’ 12.3”	N 27° 43’ 29.1” E 97° 56’ 40.2”	N 27° 42’ 08.0” E 98° 02’ 10.5”	N 27° 41’ 15.4” E 98° 01’ 28.7”	N 27° 42’ 06.5” E 98° 07’ 40.3”	N 27° 42’ 42.2” E 98° 06’ 14.9”
Elevation (m)		904	911	952	852	962	927
Date		28/2/2009	2/3/2009	8/3/2009	9/3/2009	11/3/2009	12/3/2009
Time		9:09	10:34	10:24	10:31	9:59	12:10
Parameter / **Location**		II	II	IV (II)	II	IV (II)	IV (II)
Air Temperature (°C)		12	14	11	14.5	10	15
Water Temperature (°C)		9	9	10	10	9	9
pH		7.5	7.5	6.8	7.4	7.4	7.2
Transparency (cm)		40	260	-	-	-	-
Electrical Conductivity (mS/cm)		0.005	0.005	0.001	0.004	0.004	0.003
Dissolved Oxygen (ppm)		10.2	9.12	8.65	10.1	10.5	9.86
Dissolved Oxygen (%)		102.41	91.57	86.85	101.41	105.42	99.00
Total Nitrogen (ppm)		0.1941	0.1193	0.1302	1.0516	0.1695	0.562
NH_3-N (ppm)		0.004	0.006	0.003	0.087	0.006	0.078
NO_2-N (ppm)		0.007	0.008	0.006	0.003	0.005	0.007
NO_3-N (ppm)		0.063	0.021	0.009	0.65	0.009	0.232
Total Phosphorous (ppm)		0.0948	0.0596	0.0378	0.0837	0.0853	0.045
Total Dissolved Solids TDS (gm/L)		0.04	0.03	0.01	0.02	0.03	0.02
Turbidity (NTU)							
Oxidative Redox Potential ORP (mV)		45.9	66.7	112.6	115.6	265.4	126.1
Salty							
Weather		C & Sh.	C & Sh.	C & Sh.	C & Sh.	C & Sh.	C
Water Clarity		CL	CL.	CL	CL	CL	CL
Water Coloration		LG	LG	LG	LG	G	LG
River Width (m) (estimate)		30	30	5	30	50	100
Bank Condition	Left	Rc.	Rc.	Rc.	Rc.	Rc.	Rc.
	Right	Rc.	Rc.	Rc.	Rc.	Rc.	Rc.
Bank Height (m) (estimate)	Left	10	5	5	10	5	5
	Right	10	5	5	10	5	5
Bank Width (m) (estimate)	Left	0	5	0	0	8	0
	Right	15	3	0	0	0	0
Bank Gradient (°) (estimate)	Left	80	80	70	90	50	90
	Right	70	80	90	90	80	90
Bottom Condition		Sd. & Rc.	Rc., Gv. & Sd.	Gv. & Rc.	Rc. & Sd.	Rc.	Sd. & Rc.
Biological Condition in the		-	-	-	-	-	-

Water							
Biological Env. on the Banks	Left	-	-	-	-	-	-
	Right	-	-	-	-	-	-
Riparian Area Condition	Left	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.
	Right	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.

6.1.4. Kaunglanghpu

The measured water quality values and environmental conditions are as shown in Table (6.1.4) and Fig. (6.1.4.1 to 6.1.4.5). Temperature is low and colour of water is very clear along the surveyed areas. Temperature of tributaries is lower and flow rate is also fast compared to the main river. Oxygen is well concentrated in the water because of high speed flow rate and common gravel bottom along the river and tributaries.

Surveyed areas along Kaunglanghpu dam environment were covered with rocky and steep banks. Gravel bottom is common in this region. Bamboo and banana forests can be found near Kaunglanghpu riparian areas and most parts are covered with secondary forests. Terrace farms were observed near major villages and Kaunglanghpu. No gold mining is found in this region.

Table 6.1.4. Water quality and environmental conditions of Kaunglanghpu Dam area.

Station	I	II	III	IV	V	VI	VII	VIII
GPS	N 27° 12' 45.8" E 98° 13' 15.7"	N 27° 03' 35.2" E 98° 21' 38.7"	N 27° 03' 45.1" E 98° 22' 55.7"	N 27° 04' 34.3" E 98° 21' 54.7"	N 27° 02' 23.0" E 98° 21' 57.7"	N 27° 01' 26.8" E 98° 21' 28.9"	N 27° 02' 25.6" E 98° 21' 44.5"	N 27° 04' 32.4" E 98° 23' 02.4"
Elevation (m)	788	696	728	781	703	670	659	739
Date	2/3/2009	5/3/2009	7/3/2009	10/3/2009	11/3/2009	13/3/2009	14/3/2009	15/3/2009
Time	10:00	11:22	11;16	10:54	15:00	9:54	11:04	11:18
Location / Parameter	II	II	IV (II)	IV (II)	IV (II)	II	II	IV (II)
Air Temperature (°C)	15	18	16	15	16	11	17	16
Water Temperature (°C)	11.39	12.62	10.91	9.16	11.72	11.65	12.28	10.51
pH	7.66	7.75	7.63	7.48	7.58	7.72	7.75	7.6
Transparency (cm)	-	-	135	-	-	-	-	-
Electrical Conductivity (mS)	0.082	0.099	0.061	0.027	0.054	0.078	0.084	0.049
Dissolved Oxygen (mg/L)	11.11	10.05	11.65	10.62	10.5	11.5	10.6	10.14
Dissolved Oxygen (%)	111.55	100.90	116.97	106.63	105.42	115.46	106.43	101.81
Total Nitrogen (ppm)	0.6139	0.4071	0.2992	0.2916	0.1105			
NH_3-N (ppm)	0.142	0.036	0.008	0.006	0.002			
NO_2-N (ppm)	0.007	0.008	0.008	0.009	0.006			
NO_3-N (ppm)	0.069	0.046	0.057	0.036	0.009			
Total Phosphorous (ppm)	0.0721	0.0641	0.0502	0.0486	0.0673			
Total Dissolved Solids TDS (gm/L)	0.054	0.064	0.04	0.025	0.035	0.051	0.055	0.032
Turbidity (NTU)								
Oxidative Redox Potential ORP (mV)	-96.8	-81.8	-60.9	-84.3	-90.5	-61.7	-70.8	-78.2
Salty	0.04	0.05	0.03	0.02	0.02	0.04	0.04	0.02

Weather		S	S	R	S	C	S	S	S
Water Clarity		CL	CL	CL	CL	CL	CL	CL	CL
Water Coloration		G	G	DG	G	G	DG	DG	G
River Width (m) (estimate)		100	150	40	10	40	100	50	50
Bank Condition	Left	Rc.	Rc.	Rc.	Rc.	Sd. & Rc.	Sd. & Rc.	Rc.	Rc.
	Right	Rc.	Rc.	Rc.	Rc.	Rc.	Rc.	Rc.	Rc.
Bank Height (m) (estimate)	Left	10	10	20	3	10	10	20	5
	Right	10	10	20	3	10	10	20	5
Bank Width (m) (estimate)	Left	0	0	0	0	10	10	10	0
	Right	0	0	0	0	0	10	0	0
Bank Gradient (°) (estimate)	Left	45	80	80	90	85	50	70	90
	Right	70	70	80	45	85	50	70	60
Bottom Condition		Gv.	Gv.	Gv.	Gv.	Sd. & Gv.	Rc.	Rc.	Rc.
Biological Condition in the Water		-	-	-	-	-	-	-	-
Biological Env. on the Banks	Left	-	-	-	-	Mos.	-	-	-
	Right	-	-	-	-	Mos.	-	-	-
Riparian Area Condition	Left	Sec.	Bam.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.
	Right	Sec.	Bam.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.

6.1.5. Pisa

The measured water quality values are as shown in Table (6.1.5) and Fig (6.1.5.1 to 6.1.5.5). The temperature becomes high because of the season but is lower than Mali Hka. Oxygen is also well concentrated and flow is very fast in most part of the region. pH value is the lowest compared to the other dam environments. Colour of water is very clear and rocky and gravel bottoms are common. Bank gradient is steep and rocky banks are common along the river.

Most of the riparian areas are covered with untouched forest because of difficult accessibility. There is no gold mining along the region.

Table 6.1.5. Water quality and environmental conditions of Pisa Dam area.

Station	I	II	III	IV	V
GPS	N 26° 43' 54.2" E 98° 22' 34.6"	N 26° 44' 26.7" E 98° 22' 42.1"	N 26° 44' 22.4" E 98° 22' 36.7"	N 26° 41' 55.9" E 98° 23' 20.9"	N 26° 39' 44.4" E 98° 23' 08.0"
Elevation (m)	533	546	553	780	1006

Date		17/4/2009	18/4/2009	28/4/2009	20/4/2009	21/4/2009
Time		10:00	12:05	12:46	9:52	8:42
Parameter / Location		II	IV (II)	II	IV (II)	IV (II)
Air Temperature (°C)		24	19	19	16.5	17
Water Temperature (°C)		15.65	13.42	13.37	15.07	16.08
pH		7.6	6.77	6.89	6.95	7.01
Transparency (cm)		-	-	-	-	-
Electrical Conductivity (mS/cm)		0.032	0.013	0.014	0.013	0.021
Dissolved Oxygen (mg/L)		11.53	10.6	13.94	10.04	10.57
Dissolved Oxygen (%)		115.76	106.43	133.8	108	113.7
Total Nitrogen (ppm)		0.5443	0.2454	0.2809	0.2122	0.644
NH_3-N (ppm)		0.033	0.008	0.009	0.001	0.006
NO_2-N (ppm)		0.007	0.006	0.008	0.006	0.007
NO_3-N (ppm)		0.145	0.032	0.068	0.067	0.034
Total Phosphorous (ppm)		0.04964	0.0853	0.04916	0.02425	0.0916
Total Dissolved Solids TDS (gm/L)						
Turbidity (NTU)		-1.4	18.9	17.6	-1.9	-0.6
Oxidative Redox Potential ORP (mV)		152	-169	-162	-167	-167
Salty						
Weather		½ C	Sh	Sh	½ C	C & Fg
Water Clarity		CL	TB	TB	CL	CL
Water Coloration		G	YB	YB	G	G
River Width (m) (estimate)		70	20	100	20	20
Bank Condition	Left	Rc	Rc	Rc & Gv	Rc & Gv	Rc
	Right	Rc	Rc	Rc	Rc	Rc
Bank Height (m) (estimate)	Left	10	5	10	10	1
	Right	10	5	10	10	1
Bank Width (m) (estimate)	Left	50	0	30	3	0
	Right	0	0	0	0	0
Bank Gradient (°) (estimate)	Left	40	60	50	80	60
	Right	80	80	70	80	90
Bottom Condition		Gv & Sd	Gr & Rc	Rc & Gv	Sd & Gv	Rc & Sd
Biological Condition in the Water		-	-	-	-	-
Biological Env. on the Banks	Left	-	Mos	Mos	Mos	Mos
	Right	-	Mos	Mos	Mos	Mos
Riparian Area Condition	Left	Sec	Sec	Sec	Bam	Sec
	Right	Sec	Sec	Sec	Bam	Sec

6.1.6. Wusok

The measured water quality values and environmental conditions are as shown in Table (6.1.6) and Fig. (6.1.6.1 to 6.1.6.5). Temperature is as low as other surveyed areas of May Hka River. Water color is very clear and oxygen is well concentrated because of high flow rate and rough bottom along the surveyed area.

Bank gradient is high and rocky banks are common along surveyed areas. Rocky and gravel bottoms are common along the region. Secondary forests are common except near the village which is covered with terrace and shifting farms. There is no gold mining in the region.

Table 6.1.6. Water quality and environmental conditions of Wusok Dam area.

Station	I	II	III	IV	V	VI	VII
GPS	N 26° 24' 29.3" E 98° 17' 31.0"	N 26° 28' 22.1" E 98° 17' 21.1"	N 26° 25' 59.0" E 98° 17' 34.4"	N 26° 24' 44.6" E 98° 17' 27.1"	N 26° 19' 45.3" E 98° 19' 56.8"	N 26° 36' 27.5" E 98° 22' 23.8"	N 26° 33' 18.3" E 98° 20' 42.9"
Elevation (m)	392	451	492	399	923	636	678
Date	12/4/2009	12/4/2009	25/4/2009	26/4/2009	27/4/2009	21/4/2009	22/4/2009
Time	8:30	17:20	9:41	10:21	14:37	15:12	13:00
Location **Parameter**	II	II	IV (II)	II	IV (II)	IV (II)	IV (II)
Air Temperature (°C)	17	17	21	19	27	21	20
Water Temperature (°C)	14.4	14.3	16.1	15.3	16.82	15.56	15.95
pH	7.42	7.33	7.55	7.6	7.2	7.65	7.2
Transparency (cm)	-	-	-	-	-	-	-
Electrical Conductivity (mS/cm)	0.024	0.027	0.035	0.069	0.014	0.045	0.017
Dissolved Oxygen (mg/L)	10.2	9.7	9.92	9.5	11.18	10.57	10.17
	102.41	97.39	99.60	95.38	112.25	106.12	102.11
Total Nitrogen (ppm)	0.1635	1.0373	0.2952	0.5148	0.2133	1.42	0.442
NH_3-N (ppm)	0.011	0.079	0.015	0.014	0.002	0.232	0.045
NO_2-N (ppm)	0.008	0.007	0.006	0.006	0.009	0.006	0.007
NO_3-N (ppm)	0.008	0.66	0.054	0.36	0.009	0.78	0.096
Total Phosphorous (ppm)	0.04055	0.1707	0.03226	0.09153	0.0471	0.1192	0.03036
Total Dissolved Solids TDS (gm/L)							
Turbidity (NTU)	12.7	12	11	19.2	-1.8	10.5	-2
Oxidative Redox Potential ORP (mV)	-153	-29	-172	-98	-130	-130	-157
Salty							
Weather	S	S	S	S	S	C	Sh

Water Clarity		CL	CL	CL	TB	CL	TB	CL
Water Coloration		YG	LG	LG	G	G	YG	LG
River Width (m) (estimate)		50	70	30	100	50	70	25
Bank Condition	Left	Sd. & Rc.	Sd. & Rc.	Rc.	Sd. & Gv.	Bd.	Rc	Rc & Bd
	Right	Rc.	Rc.	Rc.	Rc.	Bd.	Bd	Rc & Bd
Bank Height (m) (estimate)	Left	10	10	10	10	10	3	3
	Right	10	10	10	10	10	3	3
Bank Width (m) (estimate)	Left	100	50	0	30	10	0	0
	Right	10	0	0	0	5	10	0
Bank Gradient (°) (estimate)	Left	20	80	80	45	45	80	90
	Right	80	80	80	80	70	90	90
Bottom Condition		Gv. & Sd.	Gr. & Sd.	Gv. & Bd.	Sd. & Gv.	Gv. & Sd.	Rc & Sd	Gv and Sd
Biological Condition in the Water		-	-	-	-	-		
Biological Env. on the Banks	Left	-	Mos.	Mos.	-	Mos.	Mos.	Mos.
	Right	-	Mos.	Mos.	-	Mos.	Mos.	Mos.
Riparian Area Condition	Left	Vil.	Sec.	Sec.	Vil.	Sec.	Bam.	Bam.
	Right	Sec.	Sec.	Sec.	Sec.	Sec.	Sec & Sft	Bam.

6.1.7. Chibwe

The measured water quality values and environmental conditions are as shown in Table (6.1.7) and Fig. (6.1.7.1 to 6.1.7.5). Temperature is low compared to Mali Hka. Oxygen is well concentrated in the surveyed areas. Colour of water is very clear except in Ngawchang Hka, the major tributary in Chibwe Dam area. The colour of water of Ngawchang Hka is very turbid caused by suspended silts in the water.

River width of most parts of of the areas is wider and sandy bottoms can be found in those regions. Bank gradient is not steep compared to other Nmai Hka banks. Terrace farms, shifting farms and secondary forests can be found propotionately along the riparian areas especially near the villages. Gold mining can be found in the downstream areas of the dam.

Table 6.1.7. Water quality and environmental conditions of Chibwe Dam area.

Station		I	II	III	IV	V
GPS		N 26° 16' 13.6" E 98° 18' 41.4"	N 26° 16' 12.4" E 98° 18' 37.9"	N 26° 02' 05.8" E 98° 10' 35.7"	N 25° 58' 48.5" E 98° 09' 43.1"	N 25° 53' 41.2" E 98° 07' 48.1"
Elevation (m)		504	500	277	242	229
Date		10/4/2009	29/4/2009	23/4/2009	24/4/2009	25/4/2009
Time		9:00	8:36			
Parameter / **Location**		IV (II)	IV (II)	II	II	IV (II)
Air Temperature (°C)		20	21	22	26	28.5
Water Temperature (°C)		19	19.01	15.08	15.88	19.5
pH		7.39	7.65	7.7	7.2	7.4
Transparency (cm)		-	-	-	-	-
Electrical Conductivity (mS/cm)		0.046	0.089			
Dissolved Oxygen (mg/L)		11	8.36			
Dissolved Oxygen (%)		116.7	83.94			
Total Nitrogen (ppm)		0.4469	0.1241	1.0043	0.6405	0.5277
NH_3-N (ppm)		0.036	0.003	0.222	0.114	0.057
NO_2-N (ppm)		0.007	0.008	0.002	0.007	0.008
NO_3-N (ppm)		0.04	0.006	0.57	0.22	0.36
Total Phosphorous (ppm)		0.02959	0.055	0.07395	0.04721	0.1377
Total Dissolved Solids TDS (gm/L)						
Turbidity (NTU)		40.2	36			
Oxidative Redox Potential ORP (mV)		-196	362			
Salty						
Weather		S	S	C	S	S
Water Clarity		TB	TB	CL	CL	CL
Water Coloration		YB	YB	G	LG	LG
River Width (m) (estimate)		80	80	150	220	20
Bank Condition	Left	Rc.	Rc.	Rc.	Rc.	Rc.
	Right	Rc.	Rc.	Rc.	Rc.	Rc.
Bank Height (m) (estimate)	Left	5	5			
	Right	5	5			
Bank Width (m) (estimate)	Left	0	0	0	0	3
	Right	10	10	0	0	0
Bank Gradient (°) (estimate)	Left	70	70	80	85	70
	Right	60	60	70	80	80
Bottom Condition		Gv. & Sd.	Gv. & Sd.	Rc. & Sd.	Sd.	Sd. & Rc.
Biological Condition in the Water		-	-	-	-	-
Biological Env. on the Banks	Left	-	-	-	-	-
	Right	-	-	-	-	-
Riparian Area Condition	Left	Sec. & Ter.	Sec. & Ter.	Vil.	Vil.	Vil.
	Right	Vil.	Vil.	Sec.	Sec.	Agr.

Index:

I= Ayeyarwaddy	S= Sunny	G= Green	Sd= Sandy	Pri= Primary
II= May Hka	C= Cloudy	LG= Light Green	Rc= Rocky	Sec= Secondary
III= Mali Hka	R= Rainy	DG= Deep Green	Bd= Boulder	Bam= Bamboo forest
IV= Tributary	W= Windy	CL= Clear	Gv= Gravel	Sft= Shifting Farm
	Sh= Showering	TB= Turbid	Pb= Pebble	Ter= Terrace Farm
	Fg= Foggy	YG= Yellow Green	Md= Muddy	Agr= Agricultural Farm
		YB= Yellow Brown	St= Silty	Vil= Village
		Alg= Algae		GM= Gold Mining
		Bent= Benthos		Bus= Bush
		Mos= Mosses		Camp= Asia World Camp
		Pt= Phytoplankton		Org= Orange Farm
		Mc= Macrophyte		Is= Island
		Td= Toad larvae		

6.2. Aquatic organisms

6.2.1. Myitsone

Recorded lists of phytoplankton, zooplankton, periphyton, phytobenthos and zoobenthos for Myitsone Dam area are as shown in Tables.

6.2.1.1. Phytoplankton:

6.2.1.1.1. Qualitative analysis of Phytoplankton:

There are 64 genera and 205 species from 7 phylums are recorded from this survey. The genera and species compositions in each phylum are 34 genera and 158 species from phylum-Bacillariophyta, 14 genera and 20 species from phylum-Chlorophyta, 10 genera and 18 species from phylum-Cyanophyta, 2 genera and 3 species from phylum-Cryptophyta, 1 genera and 3 species from phylum-Chrysophyta, 2 genera and 2 species from phylum-Pyrrophyta and 1 genus and 1 species from phylum-Euglenophyta. The highest species composition is from phylum-Bacillariophyta and the percentage is about 77.1% (Table 6.2.1.1.1 & 6.2.1.1.2).

Table 6.2.1.1.1. Qualitative analysis of Phytoplankton in Myitsone Dam area.

Sr.	Scientific name	**M 1**	**M 2**	**M 3**	**M 4**	**I**	**II**	**III**	**IV**	**V**	**VI**
1	*Diatoma vulgaris*			*							
2	*Diatoma tenuis*				*						
3	*Diatoma mesodon*	*	*		*						*
4	*Diatoma elongatum*		*								
5	*Synedra ulna* var. *contracta*									*	*

6	*Synedra acus*	*	*	*							
7	*Rhizosolenia longiseta*										
8	*Cocconeis placentula*										
9	*Cocconeis placeniula* var.*euglypta*	*	*		*	*		*			
10	*Cocconeis pediculus*										
11	*Fragilaria biceps*	*	*		*	*	*	*	*	*	
12	*Fragilaria bidens*										
13	*Fragilaria ulna*	*			*	*	*	*	*	*	*
14	*Fragilaria ulna* var.*acus*	*									
15	*Fragilaria capucina*										
16	*Fragilaria construens*									*	
17	*Fragilaria arcus*	*	*	*	*					*	*
18	*Cymbella* sp.	*	*	*		*	*	*		*	*
19	*Cymbella minuta*	*	*	*	*				*	*	*
20	*Cymbella neoleptoceros*										
21	*Cymbella affinis*				*	*					*
22	*Cymbella sinuata*	*							*		
23	*Cymbella cymbiformis* var.*nonpunctata*										
24	*Cymbella turgidula*					*				*	
25	*Cymbella helvetica*										
26	*Cymbella lanceolata*					*			*	*	*
27	*Cymbella caespitosa*	*									
28	*Cymbella perpusilla*	*									
29	*Cymbella tumida*										
30	*Achnanthes conspicus*	*		*	*						
31	*Achnanthes laterostrata*										
32	*Achnanthes pusilla*										
33	*Achnanthes biasoletiana* var. *subatomus*	*	*	*	*	*	*	*	*	*	*
34	*Achnanthes minutissima* var.*jackii*										
35	*Achnanthes lanceolata* ssp. *frequentissima*										
36	*Achnanthes crenulata*	*									
37	*Achnanthes biasoletiana*	*	*	*	*	*	*	*	*	*	*
38	*Achnanthes minutissima*					*					
39	*Achnanthes lanceolata* ssp.*miota*										
40	*Achnanthes exigua* var.*heterovalvata*				*						
41	*Achnanthes lanceolata* var.*rostrata*	*									
42	*Achnanthes lanceolata*			*							
43	*Achnanthes minutissima* var.*saprophila*										
44	*Achnanthes minutissima* var.*affinis*		*	*	*						
45	*Achnanthes hungarica*										
46	*Achnanthes delicatula*		*								
47	*Navicula* sp1.	*				*	*	*		*	
48	*Navicula* sp2.										
49	*Navicula radiosafallax*	*	*	*	*	*			*	*	*
50	*Navicula americana*										
51	*Navicula biasoletiana*										

52	*Navicula capitatoradiata*	*		*	*	*	*	*	*	*	*
53	*Navicula bacillum*			*							
54	*Navicula brockmanii*										
55	*Navicula salinarum*	*									
56	*Navicula delicatilineolata*				*						
57	*Navicula schroeteri* var.*symmetrica*										
58	*Navicula oligotraphenta*						*				
59	*Navicula menisculus*						*				
60	*Navicula mutica*										
61	*Navicula cryptocephala*										
62	*Navicula erifuga*										
63	*Navicula helensis*										
64	*Navicula pupula*										
65	*Navicula mutica*										
66	*Navicula lanceolata*	*				*					
67	*Navicula viridula* var.*rostellata*										
68	*Navicula viridula* var.*germainii*					*					
69	*Navicula laterostrata*				*				*		
70	*Gomphonema* sp.										
71	*Gomphonema augur*										
72	*Gomphonema lingulatiformis*		*	*		*	*			*	*
73	*Gomphonema minutum*	*	*		*	*	*	*	*	*	*
74	*Gomphonema pumilum*	*	*	*		*	*	*	*	*	*
75	*Gomphonema augur* var.*gautieri*										
76	*Gomphonema rhombicum*										
77	*Gomphonema bararicum*										
78	*Gomphonema montanum* var.*subclavatum*										
79	*Gomphonema olivaceum*	*									
80	*Gomphonema parvulum*					*			*		
81	*Gomphonema parvulum* var.*parvulius*										
82	*Gomphonema hebridense*										
83	*Gomphonema pseudoaugur*										
84	*Gomphonema truncatum*										
85	*Nitzschia palea*					*					
86	*Nitzschia fruticosa*										
87	*Nitzschia sinuata* var.*tabellaria*										
88	*Nitzschia acicularis*										
89	*Nitzschia sp.*	*		*		*		*	*	*	*
90	*Nitzschia kuetzimgiana*										
91	*Nitzschia nana*										
92	*Nitzschia vermicularis* f. *minor*										
93	*Nitzschia recta*				*						
94	*Nitzschia reversa*										
95	*Nitzschia draveillensis*			*							
96	*Nitzschia frustulum*										
97	*Nitzschia sochabilis*				*						
98	*Nitzschia capitellata*		*								

99	*Nitzschia linearis* var.*subtilis*										
100	*Nitzschia sigma*					*					
101	*Nitzschia gessneri*										
102	*Nitzschia paleacea*			*							
103	*Nitzschia dissipata*					*			*	*	*
104	*Nitzschia inconspicua*	*									
105	*Nitzschia amplectens*	*									
106	*Nitzschia lacuum*	*									
107	*Epithemia sorex*	*									
108	*Epithemia adnata*										
109	*Melosira granulata* var.*angustissima*	*		*	*	*	*	*			
110	*Melosira granulata* var.*angustissima* f.*spiralis*					*	*	*	*		
111	*Melosira varians*	*	*		*	*	*		*	*	*
112	*Melosira ambigua*										
113	*Stauroneis* sp.					*			*		*
114	*Stauroneis pygmaea*										
115	*Stauroneis anceps*										
116	*Stauroneis kriegeri*	*	*								
117	*Stauroneis anceps var.javanica*										
118	*Gyrosigma* sp.				*						
119	*Gyrosigma acuminatum*								*		
120	*Cyclotella* sp.				*				*		
121	*Cyclotella stelligera*				*						
122	*Cylotella meneghiniana*			*							
123	*Coscinodiscus* sp.										
124	*Surirella* sp.										
125	*Surirella spiralis*										
126	*Surirella nervosa*										
127	*Surirella robusta*	*				*					
128	*Surirella linearis*					*					
129	*Surirella capronii*										
130	*Surirella robusta* var.*splendida*			*							
131	*Suriralla terricola*										
132	*Surirella brebissonii*										
133	*Amphora inariensis*										
134	*Amphora pediculus*										
135	*Pinnularia braunii* var.*amphicephala*										
136	*Pinnularia divergen* var.*capitata*										
137	*Pinnularia* sp.		*								
138	*Pinnularia subgibba*										
139	*Caloneis molaris*										
140	*Caloneis silicula*										
141	*Diploneis ovalis*										
142	*Diploneis elliptica*										
143	*Amphipleura* sp.				*						
144	*Eunotia parallela*										
145	*Eunotia tridentula*										

146	*Anomoeoneis spaerophora*										
147	*Plantzschia amphioxys* var.*major*										
148	*Neidium apiculatum*										
149	*Neidium ampliatum*										
150	*Cymatopleura solea*										
151	*Frustulia rulgaris*										
152	*Frustulia rhomboides*										
153	*Amphora libyca*										
154	*Sellaphora bacillum*	*									
155	*Bacillaria paradoxa*	*									
156	*Didymosphenia geminata*		*								
157	*Craticula halophila*										
158	*Aulacoseira distans*			*							
159	*Synechocystis minuscula*										*
160	*Lyngbya semiplena*										
161	*Lyngbya birgei*										
162	*Oscillatoria* sp.				*						
163	*Oscillatoria chlorina*			*							*
164	*Oscillatoria animalis*										
165	*Oscillatoria princeps*							*	*		
166	*Oscillatoria subbrevis*	*									
167	*Oscillatoria fraca*										
168	*Anabaena oscillarioides*	*			*						
169	*Anabaena cylindrica*										
170	*Nostoc minutum*	*									
171	*Nostoc spongiaeforme*										
172	*Phormidium tenus*	*		*	*	*			*		
173	*Microcystis aeruginisa*	*									
174	*Merismopedia glauca*	*									
175	*Chroococens minutus*										
176	*Chamnesiphon curvatus*										
177	*Chlamydomonas* sp.										
178	*Uronema confervicolum*		*								
179	*Spirogyra* sp.							*	*	*	
180	*Hormidium subtile*						*				
181	*Ulothrix* sp.				*						
182	*Ulothrix zonata*										
183	*Ulothrix variabilis*										
184	*Eudorina elegans*										
185	*Chlorella vulgaris*										
186	*Ankistrodesmus falcatus var.mirabilis*										
187	*Ankistrodesmus angustus*				*						
188	*Pediastrum tetras*			*							
189	*Pediastrum simplex*										
190	*Scenedesmus ellipticus*										
191	*Microspora stagnorum*										
192	*Microspora quadrata*										
193	*Draparnaidia* sp.					*		*			

194	*Cosmarium nastutum*										
195	*Staurastrum indentatum*										
196	*Staurastrum muticum*	*									
197	*Peridinium* sp.										
198	*Ceratium hirundinella*										
199	*Dinobryon seriularia*										
200	*Dinobryon cylindricum*										
201	*Dinobryon divergens*										
202	*Cryptomonas* sp.				*						
203	*Chroomonas acuta*										
204	*Cryptomonas ovata*					*			*		
205	*Euglena* sp.										

Solr.	Scientific name	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**	**XIII**	**XIV**	**XV**
1	*Diatoma vulgaris*									
2	*Diatoma tenuis*									
3	*Diatoma mesodon*								*	
4	*Diatoma elongatum*					*				
5	*Synedra ulna* var. *contracta*									
6	*Synedra acus*				*					
7	*Rhizosolenia longiseta*					*				
8	*Cocconeis placentula*									
9	*Cocconeis placeniula* var.*euglypta*	*	*	*	*	*	*	*	*	*
10	*Cocconeis pediculus*			*	*					*
11	*Fragilaria biceps*	*	*	*	*	*	*	*	*	*
12	*Fragilaria bidens*		*			*	*	*	*	
13	*Fragilaria ulna*				*	*	*	*	*	
14	*Fragilaria ulna* var.*acus*									
15	*Fragilaria capucina*									
16	*Fragilaria construens*									
17	*Fragilaria arcus*	*	*			*	*	*	*	*
18	*Cymbella* sp.	*								
19	*Cymbella minuta*	*			*	*		*	*	
20	*Cymbella neoleptoceros*	*								
21	*Cymbella affinis*	*				*	*	*	*	*
22	*Cymbella sinuata*	*	*						*	
23	*Cymbella cymbiformis* var.*nonpunctata*									
24	*Cymbella turgidula*									
25	*Cymbella helvetica*					*				
26	*Cymbella lanceolata*									
27	*Cymbella caespitosa*									
28	*Cymbella perpusilla*									
29	*Cymbella tumida*									
30	*Achnanthes conspicus*									
31	*Achnanthes laterostrata*									
32	*Achnanthes pusilla*	*								

33	*Achnanthes biasoletiana* var. *subatomus*	*	*	*	*	*	*	*	*	*
34	*Achnanthes minutissima* var.*jackii*	*								
35	*Achnanthes lanceolata* ssp. *frequentissima*	*		*				*		
36	*Achnanthes crenulata*	*	*			*	*		*	
37	*Achnanthes biasoletiana*	*	*	*	*	*	*	*	*	*
38	*Achnanthes minutissima*	*	*	*	*	*	*		*	*
39	*Achnanthes lanceolata* ssp.*miota*		*							
40	*Achnanthes exigua* var.*heterovalvata*									
41	*Achnanthes lanceolata* var.*rostrata*	*	*	*	*		*	*	*	
42	*Achnanthes lanceolata*									
43	*Achnanthes minutissima* var.*saprophila*			*						
44	*Achnanthes minutissima* var.*affinis*						*	*	*	
45	*Achnanthes hungarica*								*	
46	*Achnanthes delicatula*									
47	*Navicula* sp1.		*		*					*
48	*Navicula* sp2.									
49	*Navicula radiosafallax*	*	*	*	*	*	*	*	*	
50	*Navicula americana*	*								
51	*Navicula biasoletiana*	*	*		*					
52	*Navicula capitatoradiata*	*	*	*		*	*	*	*	*
53	*Navicula bacillum*	*	*	*						
54	*Navicula brockmanii*		*							
55	*Navicula salinarum*									
56	*Navicula delicatilineolata*									
57	*Navicula schroeteri* var.*symmetrica*									*
58	*Navicula oligotraphenta*		*			*		*		
59	*Navicula menisculus*			*		*			*	
60	*Navicula mutica*			*						
61	*Navicula cryptocephala*					*	*			
62	*Navicula erifuga*					*		*		
63	*Navicula helensis*						*			
64	*Navicula pupula*			*						
65	*Navicula mutica*				*					
66	*Navicula lanceolata*					*				
67	*Navicula viridula* var.*rostellata*					*				
68	*Navicula viridula* var.*germainii*									
69	*Navicula laterostrata*			*		*				
70	*Gomphonema* sp.	*								
71	*Gomphonema augur*				*					
72	*Gomphonema lingulatiformis*	*			*					
73	*Gomphonema minutum*	*	*		*	*	*	*	*	*
74	*Gomphonema pumilum*	*	*	*		*	*	*	*	
75	*Gomphonema augur* var.*gautieri*	*								
76	*Gomphonema rhombicum*		*							
77	*Gomphonema bararicum*		*							
78	*Gomphonema montanum* var.*subclavatum*			*						
79	*Gomphonema olivaceum*			*					*	

80	*Gomphonema parvulum*	*			*	*		*		
81	*Gomphonema parvulum* var.*parvulius*							*		
82	*Gomphonema hebridense*					*	*			
83	*Gomphonema pseudoaugur*									
84	*Gomphonema truncatum*				*					
85	*Nitzschia palea*	*								
86	*Nitzschia fruticosa*	*								
87	*Nitzschia sinuata* var.*tabellaria*	*		*						
88	*Nitzschia acicularis*									*
89	*Nitzschia sp.*	*	*	*	*			*	*	
90	*Nitzschia kuetzimgiana*									*
91	*Nitzschia nana*		*							
92	*Nitzschia vermicularis* f. *minor*									*
93	*Nitzschia recta*						*	*	*	*
94	*Nitzschia reversa*			*						
95	*Nitzschia draveillensis*			*						
96	*Nitzschia frustulum*				*					
97	*Nitzschia sochabilis*					*				
98	*Nitzschia capitellata*				*	*		*	*	
99	*Nitzschia linearis* var.*subtilis*									*
100	*Nitzschia sigma*						*			
101	*Nitzschia gessneri*									
102	*Nitzschia paleacea*									
103	*Nitzschia dissipata*		*			*		*		
104	*Nitzschia inconspicua*									
105	*Nitzschia amplectens*									
106	*Nitzschia lacuum*									
107	*Epithemia sorex*			*	*				*	
108	*Epithemia adnata*			*						
109	*Melosira granulata* var.*angustissima*				*	*	*	*	*	
110	*Melosira granulata* var.*angustissima* f.*spiralis*				*					
111	*Melosira varians*	*		*	*	*	*	*	*	*
112	*Melosira ambigua*	*	*		*					*
113	*Stauroneis* sp.						*			
114	*Stauroneis pygmaea*		*	*						
115	*Stauroneis anceps*		*							
116	*Stauroneis kriegeri*			*	*					
117	*Stauroneis anceps var.javanica*									
118	*Gyrosigma* sp.		*							
119	*Gyrosigma acuminatum*									*
120	*Cyclotella* sp.				*	*	*	*		
121	*Cyclotella stelligera*	*			*					
122	*Cylotella meneghiniana*				*					
123	*Coscinodiscus* sp.									
124	*Surirella* sp.						*			
125	*Surirella spiralis*		*							
126	*Surirella nervosa*					*				

127	*Surirella robusta*					*	*	*		
128	*Surirella linearis*					*	*		*	
129	*Surirella capronii*						*			
130	*Surirella robusta* var.*splendida*									
131	*Suriralla terricola*									
132	*Surirella brebissonii*						*			
133	*Amphora inariensis*	*	*			*	*			
134	*Amphora pediculus*	*			*					
135	*Pinnularia braunii* var.*amphicephala*	*								
136	*Pinnularia divergen* var.*capitata*						*			
137	*Pinnularia* sp.			*			*			*
138	*Pinnularia subgibba*				*					
139	*Caloneis molaris*	*								
140	*Caloneis silicula*					*				
141	*Diploneis ovalis*	*			*					
142	*Diploneis elliptica*									
143	*Amphipleura* sp.									
144	*Eunotia parallela*		*							
145	*Eunotia tridentula*									
146	*Anomoeoneis spaerophora*			*						
147	*Plantzschia amphioxys* var.*major*			*			*			
148	*Neidium apiculatum*				*	*				
149	*Neidium ampliatum*									
150	*Cymatopleura solea*					*				
151	*Frustulia rulgaris*					*				
152	*Frustulia rhomboides*									
153	*Amphora libyca*						*			
154	*Sellaphora bacillum*									
155	*Bacillaria paradoxa*					*	*	*		*
156	*Didymosphenia geminata*									
157	*Craticula halophila*	*								
158	*Aulacoseira distans*									
159	*Synechocystis minuscula*			*						
160	*Lyngbya semiplena*	*								
161	*Lyngbya birgei*								*	
162	*Oscillatoria* sp.						*			
163	*Oscillatoria chlorina*									
164	*Oscillatoria animalis*			*				*		
165	*Oscillatoria princeps*									
166	*Oscillatoria subbrevis*									
167	*Oscillatoria fraca*									
168	*Anabaena oscillarioides*	*			*					
169	*Anabaena cylindrica*									
170	*Nostoc minutum*		*	*						
171	*Nostoc spongiaeforme*									
172	*Phormidium tenus*	*		*		*	*	*		
173	*Microcystis aeruginisa*									
174	*Merismopedia glauca*			*						

175	*Chroococens minutus*			*						
176	*Chamnesiphon curvatus*									
177	*Chlamydomonas* sp.				*					
178	*Uronema confervicolum*									
179	*Spirogyra* sp.				*	*	*	*	*	
180	*Hormidium subtile*									
181	*Ulothrix* sp.					*			*	
182	*Ulothrix zonata*		*		*		*			
183	*Ulothrix variabilis*									
184	*Eudorina elegans*					*				
185	*Chlorella vulgaris*	*								
186	*Ankistrodesmus falcatus var.mirabilis*				*					
187	*Ankistrodesmus angustus*									
188	*Pediastrum tetras*									
189	*Pediastrum simplex*								*	
190	*Scenedesmus ellipticus*									
191	*Microspora stagnorum*		*							
192	*Microspora quadrata*									
193	*Draparnaidia* sp.									
194	*Cosmarium nastutum*					*				
195	*Staurastrum indentatum*					*				
196	*Staurastrum muticum*									
197	*Peridinium* sp.				*					
198	*Ceratium hirundinella*									*
199	*Dinobryon seriularia*				*	*				
200	*Dinobryon cylindricum*						*			
201	*Dinobryon divergens*					*	*	*	*	
202	*Cryptomonas* sp.									
203	*Chroomonas acuta*				*					
204	*Cryptomonas ovata*				*	*				*
205	*Euglena* sp.				*					

Sr.	Scientific name	**XVI**	**XVII**	**XVIII**	**XIX**	**XX**	**XXI**	**XXII**	**XXIII**
1	*Diatoma vulgaris*								
2	*Diatoma tenuis*								
3	*Diatoma mesodon*	*	*			*	*		
4	*Diatoma elongatum*	*	*				*		
5	*Synedra ulna* var. *contracta*								
6	*Synedra acus*								
7	*Rhizosolenia longiseta*								
8	*Cocconeis placentula*		*		*				
9	*Cocconeis placeniula* var.*euglypta*	*	*	*	*		*	*	*
10	*Cocconeis pediculus*							*	*
11	*Fragilaria biceps*	*	*	*	*		*	*	*
12	*Fragilaria bidens*							*	
13	*Fragilaria ulna*		*			*	*	*	*

14	*Fragilaria ulna* var.*acus*								
15	*Fragilaria capucina*					*			
16	*Fragilaria construens*								
17	*Fragilaria arcus*	*	*			*	*	*	
18	*Cymbella* sp.								
19	*Cymbella minuta*	*	*		*	*	*	*	*
20	*Cymbella neoleptoceros*								
21	*Cymbella affinis*	*	*		*	*	*		
22	*Cymbella sinuata*	*			*	*	*		
23	*Cymbella cymbiformis* var.*nonpunctata*			*					
24	*Cymbella turgidula*		*			*	*		*
25	*Cymbella helvetica*		*	*					
26	*Cymbella lanceolata*								
27	*Cymbella caespitosa*								
28	*Cymbella perpusilla*								
29	*Cymbella tumida*				*	*			
30	*Achnanthes conspicus*								
31	*Achnanthes laterostrata*	*							
32	*Achnanthes pusilla*								
33	*Achnanthes biasoletiana* var. *subatomus*	*	*	*	*	*	*	*	*
34	*Achnanthes minutissima* var.*jackii*						*		
35	*Achnanthes lanceolata* ssp. *frequentissima*								
36	*Achnanthes crenulata*	*	*		*	*	*	*	*
37	*Achnanthes biasoletiana*	*	*	*	*	*	*	*	*
38	*Achnanthes minutissima*	*	*	*	*	*	*	*	*
39	*Achnanthes lanceolata* ssp.*miota*								
40	*Achnanthes exigua* var.*heterovalvata*								
41	*Achnanthes lanceolata* var.*rostrata*	*	*	*	*	*	*	*	*
42	*Achnanthes lanceolata*								
43	*Achnanthes minutissima* var.*saprophila*		*						*
44	*Achnanthes minutissima* var.*affinis*	*	*						
45	*Achnanthes hungarica*								
46	*Achnanthes delicatula*		*						
47	*Navicula* sp1.								*
48	*Navicula* sp2.								
49	*Navicula radiosafallax*	*	*	*	*	*	*	*	*
50	*Navicula americana*	*							
51	*Navicula biasoletiana*								
52	*Navicula capitatoradiata*	*	*		*	*	*	*	*
53	*Navicula bacillum*								
54	*Navicula brockmanii*								
55	*Navicula salinarum*				*				
56	*Navicula delicatilineolata*								
57	*Navicula schroeteri* var.*symmetrica*								
58	*Navicula oligotraphenta*			*	*	*	*		*
59	*Navicula menisculus*	*	*		*	*		*	*
60	*Navicula mutica*								
61	*Navicula cryptocephala*								

62	*Navicula erifuga*								
63	*Navicula helensis*								
64	*Navicula pupula*	*							
65	*Navicula mutica*								
66	*Navicula lanceolata*						*	*	
67	*Navicula viridula* var.*rostellata*								
68	*Navicula viridula* var.*germainii*								
69	*Navicula laterostrata*								*
70	*Gomphonema* sp.								
71	*Gomphonema augur*								
72	*Gomphonema lingulatiformis*	*	*		*	*			
73	*Gomphonema minutum*	*	*	*	*	*	*	*	*
74	*Gomphonema pumilum*	*	*	*	*	*	*	*	*
75	*Gomphonema augur* var.*gautieri*								
76	*Gomphonema rhombicum*								
77	*Gomphonema bararicum*								
78	*Gomphonema montanum* var.*subclavatum*								
79	*Gomphonema olivaceum*								
80	*Gomphonema parvulum*		*	*		*			
81	*Gomphonema parvulum* var.*parvulius*	*							
82	*Gomphonema hebridense*								
83	*Gomphonema pseudoaugur*							*	
84	*Gomphonema truncatum*								
85	*Nitzschia palea*								
86	*Nitzschia fruticosa*								
87	*Nitzschia sinuata* var.*tabellaria*								
88	*Nitzschia acicularis*								
89	*Nitzschia sp.*	*					*		*
90	*Nitzschia kuetzimgiana*								
91	*Nitzschia nana*								
92	*Nitzschia vermicularis* f. *minor*								
93	*Nitzschia recta*		*		*	*	*		*
94	*Nitzschia reversa*								
95	*Nitzschia draveillensis*							*	
96	*Nitzschia frustulum*								
97	*Nitzschia sochabilis*				*	*			
98	*Nitzschia capitellata*	*							
99	*Nitzschia linearis* var.*subtilis*								
100	*Nitzschia sigma*				*				
101	*Nitzschia gessneri*			*					
102	*Nitzschia paleacea*				*				
103	*Nitzschia dissipata*					*	*	*	*
104	*Nitzschia inconspicua*								
105	*Nitzschia amplectens*								
106	*Nitzschia lacuum*								
107	*Epithemia sorex*							*	
108	*Epithemia adnata*							*	
109	*Melosira granulata* var.*angustissima*	*	*						

110	*Melosira granulata* var.*angustissima* f.*spiralis*								
111	*Melosira varians*	*	*			*	*	*	*
112	*Melosira ambigua*		*						
113	*Stauroneis* sp.					*			
114	*Stauroneis pygmaea*								
115	*Stauroneis anceps*								
116	*Stauroneis kriegeri*	*						*	*
117	*Stauroneis anceps var.javanica*	*	*						
118	*Gyrosigma* sp.								
119	*Gyrosigma acuminatum*	*							
120	*Cyclotella* sp.				*				
121	*Cyclotella stelligera*								
122	*Cylotella meneghiniana*								
123	*Coscinodiscus* sp.	*							
124	*Surirella* sp.								
125	*Surirella spiralis*								
126	*Surirella nervosa*								
127	*Surirella robusta*	*	*						
128	*Surirella linearis*	*							
129	*Surirella capronii*								
130	*Surirella robusta* var.*splendida*								
131	*Suriralla terricola*	*							
132	*Surirella brebissonii*								
133	*Amphora inariensis*				*		*	*	*
134	*Amphora pediculus*								
135	*Pinnularia braunii* var.*amphicephala*								
136	*Pinnularia divergen* var.*capitata*								
137	*Pinnularia* sp.				*			*	
138	*Pinnularia subgibba*								
139	*Caloneis molaris*								
140	*Caloneis silicula*								
141	*Diploneis ovalis*								
142	*Diploneis elliptica*								*
143	*Amphipleura* sp.								
144	*Eunotia parallela*								
145	*Eunotia tridentula*		*						
146	*Anomoeoneis spaerophora*								
147	*Plantzschia amphioxys* var.*major*								
148	*Neidium apiculatum*								
149	*Neidium ampliatum*		*						
150	*Cymatopleura solea*								
151	*Frustulia rulgaris*								
152	*Frustulia rhomboides*							*	
153	*Amphora libyca*								
154	*Sellaphora bacillum*								
155	*Bacillaria paradoxa*	*	*		*			*	
156	*Didymosphenia geminata*								
157	*Craticula halophila*				*	*			

158	*Aulacoseira distans*								
159	*Synechocystis minuscula*								
160	*Lyngbya semiplena*		*						
161	*Lyngbya birgei*	*							
162	*Oscillatoria* sp.								
163	*Oscillatoria chlorina*			*		*	*		
164	*Oscillatoria animalis*			*					
165	*Oscillatoria princeps*								
166	*Oscillatoria subbrevis*								
167	*Oscillatoria fraca*		*						
168	*Anabaena oscillarioides*								
169	*Anabaena cylindrica*							*	
170	*Nostoc minutum*			*				*	
171	*Nostoc spongiaeforme*						*		
172	*Phormidium tenus*	*	*						
173	*Microcystis aeruginisa*								
174	*Merismopedia glauca*								
175	*Chroococens minutus*								
176	*Chamnesiphon curvatus*					*			
177	*Chlamydomonas* sp.								
178	*Uronema confervicolum*								
179	*Spirogyra* sp.								
180	*Hormidium subtile*								
181	*Ulothrix* sp.						*		
182	*Ulothrix zonata*	*	*	*		*	*		
183	*Ulothrix variabilis*			*					
184	*Eudorina elegans*								
185	*Chlorella vulgaris*			*					
186	*Ankistrodesmus falcatus var.mirabilis*								
187	*Ankistrodesmus angustus*								
188	*Pediastrum tetras*	*							
189	*Pediastrum simplex*								
190	*Scenedesmus ellipticus*								
191	*Microspora stagnorum*								
192	*Microspora quadrata*						*		
193	*Draparnaidia* sp.								
194	*Cosmarium nastutum*								
195	*Staurastrum indentatum*								
196	*Staurastrum muticum*								
197	*Peridinium* sp.								
198	*Ceratium hirundinella*								
199	*Dinobryon seriularia*								
200	*Dinobryon cylindricum*								
201	*Dinobryon divergens*								
202	*Cryptomonas* sp.								
203	*Chroomonas acuta*								
204	*Cryptomonas ovata*	*							
205	*Euglena* sp.								

Table 6.2.1.1.2.. Phytoplankton species composition and percentage.

Phylum	Cyano phyta	Chrypto phyta	Bacillario phyta	Chloro phyta	Pyrro phyta	Chryso phyta	Eugleno phyta	Total
Species	18	3	158	20	2	3	1	205
Percentage (%)	8.78	1.46	77.1	9.76	0.98	1.46	0.49	100

6.2.1.1.2. Quantitative analysis of Phytoplankton:

The highest density was recorded about 32.4×10^5cells/L in station XII (near Pampa village, Ayeyarwaddy River) and the lowest was about 0.12×10^5cells/L in station XV (Pungre Hka Tributary). The mean concentration of Myitsone dam area is about 5.55×10^5cells/L (Table 6.2.1.1.3).

Table 6.2.1.1.3. Phytoplankton density in each sampling stations.

Sampling station	M1	M2	M3	M4	I	II	III	IV	V	VI	VII	VIII	IX	X
Density (10^5cells/L)	2.35	3.96	1.21	13.17	5.05	1.11	3.66	3.61	5.79	6.19	2.6	4.31	3.54	15.44
Sampling station	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI	XXII	XXIII	Mean
Density (10^5cells/L)	5.1	3.24	3.22	2.82	0.12	3.76	3.42	0.78	8.66	11.78	3.02	1.58	1.21	5.55

6.2.1.1.3. Common phytoplankton found in Myitsone Dam area.

Due to the surveyed data, the highest species composition was recorded from station XI (near Yekyi Village, Ayeyarwaddy River) , 51 species and the lowest species composition was recorded from station I (infront of Asia World Camp, Ayeyarwaddy River) & II (Mali Hka River), 16 species. Common species found in the surveyes stations are *Achnanthes biasoletiana*，*Gomphonema minutum*，*Fragilaria biceps* and *Cymbella affinis*.

6.2.1.2. Zooplankton:

6.2.1.2.1. Qualitative analysis of Zooplankton.

There are 67 species from Protozoa, 32 species from Rotifera and 25 species from Crustacea recorded from Myitsone dam area. The highest species composition is Protozoa and the percentage is about 54.03% (Table 6.2.1.2.1 to 6.2.1.2.4).

Table 6.2.1.2.1. Qualitative analysis of Protozoa in Myitsone Dam area.

Sr.	Species	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI	XXII	XXIII	M1	M2	M3	M4
1	*Amoeba* sp.	*																				
2	*Polychaos timidium*					*		*														
3	*Saccamoeba gongornia*		*																			*
4	*Arcella gibbosa*																				*	
5	*Arcella discoides*	*	*	*		*		*			*	*		*	*			*	*	*	*	
6	*Arcella hemisphaerica*	*			*		*				*	*	*	*	*	*	*		*	*		
7	*Arcella hemisphaerica undulate*			*										*							*	*
8	*Arcella rotundata*	*		*																		
9	*Arcella rotundata*																*					*
10	*Arcella vulgaris*					*	*															
11	*Nebela collaris*																			*		
12	*Quadrulella symmetrica*											*			*					*		
13	*Difflugia globulosa*				*	*	*	*	*	*	*	*	*		*			*	*		*	*
14	*Difflugia acuminata*			*			*	*														
15	*Difflugia oblonga*						*								*				*			
16	*Difflugia lucida*	*																				
17	*Difflugia avellana*						*															*
18	*Difflugia hydrostatica lithophila*							*														
19	*Difflugia gramen*							*														
20	*Difflugia mammillaris*										*											
21	*Difflugia* sp.									*												

22	*Centropyxis aerophila aerophila*																					*
23	*Centropyxis platystoma*						*	*			*	*		*	*				*	*	*	*
24	*Centropyxis platystoma armata*														*							
25	*Centropyxis constricta*		*				*				*				*				*	*	*	
26	*Centropyxis aculeata*	*	*	*		*	*	*	*					*		*	*	*	*			*
27	*Centropyxis aculeata grandis*	*									*											
28	*Centropyxis ecornis*					*	*	*		*	*				*							
29	*Centropyxis ecornis leidyi*																				*	*
30	*Centropyxis discoides*																		*			
31	*Centropyxis minuta*																					*
32	*Cyclopyxis arcellodes*							*			*									*		*
33	*Cyclopyxis deflandrei*										*	*				*		*			*	
Sr.	Species	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI	XXII	XXIII	M 1	M 2	M 3	M 4
34	*Pontigulasia incisa*					*	*	*														
35	*Phryganella nidulus*																					*
36	*Wailesella* sp.			*			*	*	*		*		*	*	*	*		*	*	*	*	*
37	*Euglypha filifera*	*		*			*											*				
38	*Euglypha rotunda*			*			*															
39	*Euglypha* sp.								*													
40	*Cyphoderia ampulla*							*	*										*	*		
41	*Pseudodifflugia gracilis*																					
42	*Pamphagus* sp.																					
43	*Plagiophrys scutiformis*																		*		*	
44	*Lieberkuhnia wagneri*				*																	
45	*Holophrya atra*																					*
46	*Coleps* sp.							*														
47	*Didinium balbianii nanum*				*																	
48	*Mesodinium pulex*				*				*													
49	*Lagynophrya conifera*				*																	
50	*Podophrya fixa*																		*			
51	*Sphaerophrya* sp.																				*	
52	*Hemiophrys* sp.				*	*																
53	*Litonotus* sp.							*														
54	*Vorticella* sp.			*			*															
55	*Epistylis rotans*															*						
56	*Cothurnia oblonga*																					
57	*Ophryolena* sp.				*																	*
58	*Malacophrys rotans*		*	*																		

59	*Cyclidium muscicola*				*																	
60	*Cyclidium muscicola*			*	*																	
61	*Cyclidium* sp.			*			*	*	*						*	*						*
62	*Strobilidium gyrans*				*	*																*
63	*Strobilidium velox*				*			*				*										
64	*Holosticha kessleri*				*																	
65	*Uroleptus caudatus*																					*
66	*Tintinnopsis wangi*				*																	
67	*Tintinnopsis conicus*				*																	

Table 6.2.1.2.2. Qualitative analysis of Rotifera in Myitsone Dam area.

Sr.	Species	VII	VIII	IX	X	XI	XII	XIII	XIV	XVI	XVIII	XIX	XX	XXI	XXII	XXIII	M 1	M 2	M 3	M 4
1	*Colurella adriatica*			*		*		*		*	*				*					
2	*Colurella* sp.																			
3	*Lepadella patella*					*			*						*					
4	*Lepadella acuminata*				*															*
5	*Trichotria tetractis*					*														
6	*Keratella cochleari*				*	*			*		*									
7	*Keratella valga*						*													
8	*Lecane closterocerca*							*											*	
9	*Lecane thienemanni*																		*	
10	*Lecane bulla*						*		*											
11	*Lecane stenroosi*							*												
12	*Lecane* sp.			*																
13	*Euchlanus.dilatata*													*						
14	*Epiphanes* sp.		*	*		*						*							*	*
15	*Notommata* sp.																	*		
16	*Resticula* sp.			*																
17	*Cephalodella catellina*					*														*
18	*Cephalodella innesi*			*		*						*	*			*				
29	*Cephalodella gibba*						*			*										
20	*Cephalodella*											*								
21	*Proales daphnicola*					*														
22	*Proales* sp.	*	*																	
23	*Scaridium longicaudum*				*															*

24	*Ascomorpha* sp.		*																	
25	*Synchaeta* sp.							*												
26	*Polyarthra vulgaris*				*		*													
27	*Trichocerca cylindrica*					*														
28	*Trichocerca pusilla*													*						
29	*Pompholyx sulcata*					*		*	*											
30	*Philodina* sp.	*		*	*						*			*		*	*			
31	*Habrotrocha* sp.			*																

Table 6.2.1.2.3. Qualitative analysis of Crustacea in Myitsone Dam area.

	Station Species	VII	X	XI	XII	XIII	XIV	XV	XVI	XXI	M1	M2
	Cladocera											
	Division Eucladocera											
	Superfamily Sidoidea											
	Family Sididae											
	Diaphanosom											
1	*Diaphanosoma leuchtenbergianum*			*								
	Superfamily Chydoroidea											
	Daphniidae											
	Ceriodaphnia											
2	*Ceriodaphnia cornuta*					*						
3	*Ceriodaphnia quadrangula*		*	*								
	Family Bosminidae											
	Bosmina											
4	*Bosmina longirostris*			*		*	*					
5	*Bosmina coregoni*			*			*					
6	*Bosmina fatalis*						*					
	Family Chydoridae											
	Alona											
7	*Alona guttata*			*								
	Chydorus											
8	*Chydorus sphaericus*		*									
	Copepoda											
	Harpacticoidae											
9	*Harpacticoida sp.*										*	
	Chirognatha											
	Canthocamptidae											
	Mesochra											

10	*Mesochra* sp.						*					
	Parastenocaridae											
	Parastenocaris											
11	*Parastenocaris brevipes*						*					
	Cyclopoida											
	Cyclopidae											
	Eucyclops											
12	*Eucyclops serrulatus*			*		*						
13	*Eucyclops macruroides denticulatus*			*								
	Paracyclops											
14	*Paracyclops fimbriatus*										*	
15	*Paracyclops* sp.						*	*				
	Acanthocyclops											
16	*Acanthocyclops viridis*						*					
	Microcyclops											
17	*Microcyclops varicans*		*		*		*					
	Mesocyclops											
18	*Mesocyclops leuckarti*		*	*		*						
19	*Mesocyclops pehpeiensis*		*									
	Thermocyclops											
20	*Thermocyclops mongolicus*					*						
21	*Thermocyclops vermifer*		*									
22	*Thermocyclops hyalinus*		*									
23	*Nauplius*	*	*	*		*	*		*	*	*	*
24	*Calanoida larva*		*									
25	*Cyclopida larva*		*	*		*	*					

Table 6.2.1.2.4. Zooplankton variety composition and percentage.

	Protozoa	Rotifera	Crustacea	Total
Species	67	32	25	124
Percentage (%)	54.03	25.81	20.16	100

6.2.1.2.2. Common Zooplankton found in Myitsone Dam area.

Due to the surveyed data, the highest species composition for Protozoa recorded from station M-4 (near Balaminhtin Bridge, Ayeyarwaddy River) was 18 and the lowest species composition recorded from station XVIII (Taunghpe Hka Tributary) was 3. Common species found in the surveyes stations are *Arcella discoides, Arcella hemisphaerica, Difflugia globulosa, Centropyxis platystoma, Centropyxis aculeate, Wailesella* sp..

The highest species composition of rotifera recorded from station XI (near Yekyi Village, Ayeyarwaddy River) was 9 and the lowest composition from station XX (May Hka River) and M-2 (May Hka River) was 1. *Colurella adriatica, Epiphanes* sp., *Cephalodella innesi, Philodina* sp. were found as common species in Myitsone dam area.

For crustacea, the highest species composition was recorded in station X (near Tarlawgyi Village, Ayeyarwaddy River), XI (near Yekyi Village, Ayeyarwaddy River) and XIV (near Waing Maw, Ayeyarwaddy River) was 10 and the lowest was in VII (Hpungin Hka Tributary, Mali Hka River), XII (near Pampa Village, Ayeyarwaddy River), XV (Pungre Hka Tributary), XVI (near N'Gen Village, Ayeyarwaddy River), XXI (near Khalone Island, May Hka River) and M-2 (May Hka River) and 1 species was recorded.

6.2.1.3. Periphyton:

6.2.1.3.1. Qualitative analysis of Periphyton:

There are 26 genera and 125 species of periphyton recorded from Myitsone Dam area. Among them, 31 species from genus-*Navicula*, 16 species from genus-*Achnanthes*, 13 species from genus-*Nitzschia* and 10 species from genus-*Cymbella* were recorded. The highest composition is genus *Navicula* and the percentage is about 24.8% (Table 6.2.1.3.1 & 6.2.1.3.2).

Table 6.2.1.3.1. Qualitative analysis of Periphyton in Myitsone Dam area.

Sr.	Genus	Species	Mali HkaTributary of	Mali Hka	Nmai HkaTributary of	Nmai Hka	AyeyarwaddyTributary of	Ayeyarwaddy
1	*Achnanthes*	*Achnanthes atomus*	*	*	*	*	*	*
2		*Achnanthes biasoletti*	*	*	*	*	*	*
3		*Achnanthes biasoletti var. subatomus*	*	*	*	*	*	*
4		*Achnanthes catenatum*	*			*	*	*
5		*Achnanthes conspicua*					*	
6		*Achnanthes crenulata*	*		*	*		
7		*Achnanthes exigua*	*	*	*		*	*
8		*Achnanthes hungarica*				*	*	
9		*Achnanthes lanceolata*	*			*	*	*
10		*Achnanthes lanceolata var.rostrota*	*	*	*		*	*
11		*Achnanthes minutissima*	*	*	*	*	*	*
12		*Achnanthes minutissima var. affinis*	*	*	*	*	*	*
13		*Achnanthes minutissima var. gracillima*	*		*	*	*	*
14		*Achnanthes minutissima var. saprophila*			*	*	*	*
15		*Achnanthes rupestoides*			*			
16		*Achnanthes subhudsonis*	*	*	*	*	*	*
17	*Amphi*	*Amphipleura pellucida*			*			

	pleura							
18	*Amphora*	*Amphora fontinalis*	*		*			
19		*Amphora montana*			*	*	*	
20		*Amphora pediculus*	*		*		*	*
21	*Anomoeoneis*	*Anomoeoneis pseudotusculus*	*					
22	*Bacil laria*	*Bacillaria paradoxa*	*	*	*		*	*
23	*Cocco neis*	*Cocconeis pediculus*	*					
24		*Cocconeis placentula var. lineata*	*		*			*
25		*Cocconeis placentula*			*	*	*	*
26	*Crymatop leura*	*Crymatopleura solea*	*					
27	*Cym bella*	*Cymbella cymbiformis*					*	
28		*Cymbella cymbiformis var. nonpunctata*	*					
Sr.	Genus	Species	Mali HkaTributary of	Mali Hka	Nmai HkaTributary of	Nmai Hka	AyeyarwaddyTributary of	Ayeyarwaddy
29		*Cymbella delicatula*				*	*	
30		*Cymbella lacustris*	*	*		*		*
31		*Cymbella microcephala*				*	*	*
32		*Cymbella minuta*		*	*	*	*	*
33		*Cymbella perpusilla*				*		
34		*Cymbella sinuata*			*			
35		*Cymbella tumida*		*	*	*	*	*
36		*Cymbella turgidula*	*	*	*	*	*	*
37	*Denti cula*	*Denticula tenuis*		*				
38	*Diades mis*	*Diadesmis confervacea*					*	*
39		*Diadesmis contenta*					*	
40	*Diatoma*	*Diatoma mesadon*				*		*
41		*Diatoma problematica*						*
42	*Diplo neis*	*Diploneis elliptica*	*					
43		*Diploneis marginestriata*	*					
44		*Diploneis oblongella*			*			
45	*Epithe mia*	*Epithemia adnata*	*		*			*
46		*Epithemia sorex*	*		*			*

Sr.	Genus	Species	Mali HkaTributary of	Mali Hka	Nmai HkaTributary of	Nmai Hka	AyeyarwaddyTributary of	Ayeyarwaddy
47	*Fragi laria*	*Fragilaria arcus*				*		*
48		*Fragilaria capucina*	*		*	*	*	*
49		*Fragilaria capucina var. vaucheriae*				*		*
50		*Fragilaria crotonensis*				*	*	
51		*Fragilaria fasciculata*			*			
52		*Fragilaria pinnata*						*
53		*Fragilaria pseudogaillonii*	*	*	*	*	*	*
54		*Fragilaria ulna*				*	*	*
55	*Frus tulum*	*Frustulum* sp	*					
56		*Frustulum vulgaris*			*		*	
57	*Gompho nema*	*Gomphonema augur var.gautieri*					*	
58		*Gomphonema bicep*		*				
59		*Gomphonema clavatum*	*	*	*			
60		*Gomphonema clevei*	*	*	*	*	*	*
61		*Gomphonema minutum*	*	*	*	*	*	*
62		*Gomphonema parvulum*	*	*	*	*		*
63		*Gomphonema parvulum var. exilissimum*					*	
64		*Gomphonema pumilum*	*		*	*		*
65		*Gomphonema rhombicum*	*		*	*	*	
66		*Gomphonema claratum*					*	
67		*Gomphonema sphnerophorum*			*			
68	*Gyro sigma*	*Gyrosigma acuminatum*					*	*
69		*Gyrosigma scalproides*		*				
70	*Luticola*	*Luticola mutica*			*		*	*
71	*Melosira*	*Melosira varians*		*	*	*	*	*
72	*Navicula*	*Navicula arvensis*		*	*			
73		*Navicula atomus*			*		*	*
74		*Navicula atomus var. permitis*	*		*		*	*
75		*Navicula bryophila*			*	*	*	*
76		*Navicula capitatoradiata*	*		*	*		*
77		*Navicula cincta*			*	*	*	*

Sr.	Genus	Species	Mali HkaTributary of	Mali Hka	Nmai HkaTributary of	Nmai Hka	AyeyarwaddyTributary of	Ayeyarwaddy
78		*Navicula cryptocephala*		*	*	*		*
79		*Navicula cryptotenella*	*		*	*	*	*
80		*Navicula decussis*			*			*
81		*Navicula delicatilineolata*			*	*	*	*
82		*Navicula erifuga*				*		
83		*Navicula gregaria*			*			*
84		*Navicula heimansioides*			*	*		
85		*Navicula lanceolata*				*		
86		*Navicula minuma*	*	*	*	*	*	*
87		*Navicula minuscula*	*	*				
88		*Navicula minuscula var.grunowii*	*	*	*	*	*	*
89		*Navicula notha*			*		*	*
90		*Navicula novaesiberica*						*
91		*Navicula obtecta*	*					
92		*Navicula oligotraphenta*			*			
93		*Navicula perpusilla*				*		
94		*Navicula radiosafallax*	*	*	*			
95		*Navicula reichardtiana*		*	*			*
96		*Navicula schroeteri var. symmetrica*		*		*	*	*
97		*Navicula seminulum*					*	
98		*Navicula* sp1						*
99		*Navicula subminuscula*					*	*
100		*Navicula thermaloides*					*	
101		*Navicula viridula*			*			
102		*Navicula viridula var.rostellata*					*	*
103	*Neidium*	*Neidium affine var. humerus*	*					
104		*Neidium dubium*	*					
105	*Nitzchia*	*Nitzschia amphibian*				*		
106		*Nitzschia angustatula*			*			
107		*Nitzschia clausii*		*	*		*	*
108		*Nitzschia dissipata*		*	*	*	*	*
109		*Nitzschia flexa*					*	

110		*Nitzschia frustulum*	*	*	*			*
111		*Nitzschia incospicua*	*		*		*	*
112		*Nitzschia linearis*						*
113		*Nitzschia palea*	*	*	*	*	*	*
114		*Nitzschia paleacea*			*		*	
115		*Nitzschia paleaeformis*					*	*
116		*Nitzschia recta*						*
117		*Nitzschia sinuata var. tabellaria*	*		*			
118	*Pinnu laria*	*Pinnularia* sp			*		*	*
119	*Rhopa lodia*	*Rhopalodia gibba*	*					
120		*Sellaphora bacillum*				*		
121	*Sella phora*	*Sellaphora japonica*	*		*	*	*	
122		*Sellaphora pupula*	*			*	*	*
123		*Surirella angusta*			*	*	*	*
124	*Surirella*	*Surirella linearis*		*	*		*	*
125		*Surirella robusta*			*		*	

Table 6.2.1.3.2. Periphyton species composition and percentage.

Genus	*Ach nan thes*	*Am phipl eura*	*Am pora*	*Ano moeo neis*	*Bacil laria*	*Cocc oneis*	*Crym atopl eura*	*Cym bella*	*Denti cula*	*Diad esmi s*	*Dia toma*	*Diplo neis*	*Epith emia*	*Fragil aria*
Species	16	1	3	1	1	3	1	10	1	2	2	3	2	8
Percen tage (%)	12.8	0.8	2.4	0.8	0.8	2.4	0.8	8.0	0.8	1.6	1.6	2.4	1.6	6.4
Genus	*Frus tulu*	*Gom phon ema*	*Gyro sig ma*	*Luti cola*	*Melo sira*	*Navic ula*	*Nei dium*	*Nitz chia*	*Pinnu la ria*	*Rhop alo dia*	*Sella pho ra*	*Surir ella*	Total	
Species	2	11	2	1	1	31	2	13	1	1	3	3	125	
Percen tage (%)	1.6	8.8	1.6	0.8	0.8	24.8	1.6	10.4	0.8	0.8	2.4	2.4	100	

6.2.1.3.2.Quantitative analysis of Periphyton:

The density of periphyton is higher in Tributaries of Ayeyarwaddy River and concentration is about 11.40×10^{10} ind./m^2. The lowest density, 0.28×10^{10} ind./m^2 was recorded from Mali Hka. Mean density of periphyton is about 5.12×10^{10}ind./m^2 in Myitsone area.

6.2.1.3.3.Common periphyton found in Myitsone Dam area.

Common species found in Myitsone dam area are *Achnanthes atomus*, *Achnanthes biasoletti*, *Ananthes biasoletti var. subatomus*, *Achnanthes minutissima, Achnanthes minutissima* var. *affinis, Achnanthes subhudsonis*, *Cymbella turgidula, Fragilaria pseudogaillonii, Gomphonema clevei, Gomphonema minutum* and *Navicula minuma* and *Nitzchia palea*.

The highest species composition is recorded from the tributary of May Hka and species list is about 71 species. The lowest species composition is from Mali Hka and species composition is about 35 species.

6.2.1.4. Benthos:

6.2.1.4.1. Qualitative analysis of Benthos:

There are 75 species from 3 phylums of benthos recorded from Myitsone Dam area. Among them, phylum-Arthropoda is dominant and 71 species found from this phylum. The composition of phylum-Arthropoda is about 94.67% (Table 6.2.1.4.1 & 6.2.1.4.2).

Table 6.2.1.4.1. Qualitative analysis of Benthos in Myitsone Dam area.

	Phylum	**Arthropoda**																		
	Class	**Isecta**																		
No	**Order**	**Family**	**Genus**	**Species**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**	**XIII**	**XIV**	**XV**	**XVII**	**XVIII**	**XIX**	**XX**	**XXI**	**XXII**	**XXIII**
1	Odonata	Enphaeidae		Enphaeidae sp.												*				*
2	Odonata	Gomphidae	*Stylogomphus*	*Stylogomphus* sp.		*														
3	Odonata	Gomphidae	*Leptogomphus*	*Leptogomphus* sp.										*						
4	Odonata	Gomphidae	*Megalogomphus*	*Megalogomphus* sp.										*						
5	Odonata	Gomphidae	*Phaenandrogomphus*	*Phaenandrogomphus* sp.		*	*									*				
6	Odonata	Gomphidae	*Lamelligomphus*	*Lamelligomphus* sp.												*		*		
7	Plecoptera	Perlidae		Perlidae sp.		*	*									*		*	*	*
8	Plecoptera	Peltoperlidae		Peltoperlidae sp.												*				
9	Plecoptera	Nemouridae		Nemouridae sp.												*				
10	Ephemeroptera	Heptageniidae	*Rhithrogena*	*Rhithrogena* sp.			*									*				
11	Ephemeroptera	Heptageniidae	*Cinygmina*	*Cinygmina* sp.		*									*	*		*	*	*
12	Ephemeroptera	Heptageniidae	*Heptagenia*	*Heptagenia* sp.												*				
13	Ephemeroptera	Heptageniidae		Heptageniidae *sp.*		*														
14	Ephemeroptera	Ephemerallidae	*Cincticostella*	*Cincticostella insolta*												*				
15	Ephemeroptera	Ephemerallidae	*Notacanthella*	*Notacanthella quadrata*												*		*		
16	Ephemeroptera	Ephemerallidae		Ephemerallidae sp.												*	*	*		*

17	Ephemeroptera	Isonychiidae		Isonychiidae sp.												*	*	*		*
18	Ephemeroptera	Baetidae	*Baetis*	*Baetis* sp.	*	*	*	*	*	*	*				*	*	*	*	*	*
19	Ephemeroptera	Baetidae	*Pseudocloeon*	*Pseudocloeon* sp.	*	*										*	*	*	*	
20	Ephemeroptera	Leptophlebiidae		Leptophlebiidae sp.		*	*								*	*			*	*
21	Ephemeroptera	Teloganodidae		Teloganodidae sp.		*														
22	Ephemeroptera	Caenidae		Caenidae sp.							*	*					*	*		
23	Ephemeroptera	Ephemeridae		Ephemeridae sp.							*									*
24	Trichoptera	Glossosomatidae		Glossosomatidae sp.														*		
25	Trichoptera	Philopotamidae		Philopotamidae sp.														*		
26	Trichoptera	Hydropsychidae	*Macrostemum*	*Macrostemum* sp.												*				
27	Trichoptera	Hydropsychidae	*Ceratopsyche*	Ceratopsyche sp.											*	*		*		*
28	Trichoptera	Helicopsychidae	*Helicopsyche*	*Helicopsyche* sp.												*		*		
29	Trichoptera	Xiphocentronidae	*Melanotrichia*	*Melanotrichia* sp.											*	*			*	
30	Trichoptera	Leptoceridae		Leptoceridae sp.	*											*			*	
31	Trichoptera	Hydroptilidae		Hydroptilidae sp.							*				*					
32	Trichoptera	Ecnomidae	*Ecnomus*	*Ecnomus* sp.												*				
33	Trichoptera	Psychomyiidae		Psychomyiidae sp.												*				
34	Trichoptera	Stenopsychidae	*Stenopsyche*	*Stenopsyche* sp.											*	*	*		*	*
35	Coleoptera	Elmidae		Elmidae sp.		*										*			*	
36	Coleoptera	Psephenida		Psephenidae sp1.		*													*	*
37	Coleoptera	Psephenidae		Psephenidae sp2.															*	*
38	Coleoptera	Lepiceridae		Lepiceridae sp.		*												*		
39	Coleoptera	Gyrinidae		Gyrinidae sp.												*		*		
40	Coleoptera	Scirtidae		Scirtidae sp.												*				
41	Coleoptera	Micromalthidae		Micromalthidae sp.												*				
42	Coleoptera	Ptilodactylidae		Ptilodactylidae sp.		*														
43	Hemiptera	Gelastocoridae		Gelastocoridae sp.												*				*
44	Hemiptera	Gerridae	*Phyacobates*	*Phyacobates* sp.			*													
45	Hemiptera	Aphelocheiridae		Aphelocheiridae sp.		*	*								*					*
46	Hemiptera	Corixidae		Corixidae sp.							*	*								
47	Diptera	Tabanidae		Tabanidae sp.											*	*				
48	Diptera	Ceratopogonidae		Ceratopogonidae sp.											*					
49	Diptera	Athericidae		Athericidae sp.		*														
50	Diptera	Simuliidae		Simuliidae sp.												*		*		
51	Diptera	Tipulidae	*Limoniinae*	*Limnophila* sp.		*	*									*	*	*	*	*
52	Diptera	Tipulidae	*Limoniinae*	Limoniinae sp.		*														
53	Diptera	Tipulidae	*Antocha sp*	*Antocha* sp.											*	*		*		
54	Diptera	Tipulidae	*Limoniinae*	*Limnophila* sp.																
55	Diptera	Chironomidae	*Polypedilum*	*Polypedilum* sp1												*				
56	Diptera	Chironomidae	*Polypedilum*	*Polypedilum* sp2	*						*	*			*	*		*		

57	Diptera	Chironomidae	*Thienemannimyia*	*Thienemannimyia* sp.		*					*	*			*	*	*	*		
58	Diptera	Chironomidae	*Eukiefferiella*	*Eukiefferiella* sp.												*				
59	Diptera	Chironomidae	*Cryptochironomus*	*Cryptochironomus* sp.												*				
60	Diptera	Chironomidae	*Rheotanytarsus*	*Rheotanytarsus* sp.		*									*	*				
61	Diptera	Chironomidae	*Tanytarsus*	*Tanytarsus* sp.							*	*						*		
62	Diptera	Chironomidae	*Robackia*	*Robackia* sp.		*										*				
63	Diptera	Chironomidae	*Apedilum*	*Apedilum* sp.														*		
64	Diptera	Chironomidae	*Platysmittia*	*Platysmittia* sp.											*					
65	Diptera	Chironomidae	*Orthocladius*	*Orthocladius* sp.							*				*			*	*	
66	Diptera	Chironomidae	*Chironomus*	*Chironomus* sp.							*									
67	Diptera	Chironomidae	*Microtendipes*	*Microtendipes* sp.							*									
68	Diptera	Chironomidae	*Procladius*	*Procladius* sp.							*									
69	Diptera	Chironomidae	*Parachironomus*	*Parachironomus* sp.															*	
70	Diptera			pupae						*	*				*					
	Class	**Crustacea**																		
No	**Order**	**Family**	**Genus**	**Species**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**	**XIII**	**XIV**	**XV**	**XVII**	**XVIII**	**XIX**	**XX**	**XXI**	**XXII**	**XXIII**
71	Decapoda	Palaemonidae	*Macrobrachium*	*Macrobrachium* sp.			*													
	Phylum	**Annelida**																		
	Class	**Oligochaeta**																		
No	**Order**	**Family**	**Genus**	**Species**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**	**XIII**	**XIV**	**XV**	**XVII**	**XVIII**	**XIX**	**XX**	**XXI**	**XXII**	**XXIII**
72	Tubificida	Tubificidae	*Spirosperma*	*Spirosperma nikolskyi*				*										*		
73	Tubificida	Tubificidae	*Limnodrilus*	*Limnodrilus amblysetus*															*	
74	Tubificida	Tubificidae	*Limnodrilus*	*Limnodrilus hoffmeisteri*							*									
	Phylum	**Nematomorpha**																		
	Class	**Nematoda**																		
No	**Order**	**Family**	**Genus**	**Species**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**	**XIII**	**XIV**	**XV**	**XVII**	**XVIII**	**XIX**	**XX**	**XXI**	**XXII**	**XXIII**
75				Nematoda sp.							*					*		*		

Table 6.2.1.4.2. Benthos species composition and percentage.

Phylum	Arthropoda	Annelida	Nematomorpha	Total
Species	71	3	1	75
Percentage (%)	94.67	4	1.33	100

6.2.1.4.2. Common Benthos found in Myitsone Dam area.

Common species found in Myitsone dam area is *Baetis* sp. from phylum-Arthropoda. The highest species composition is found in station XIX (Tum Pang Hka Tributary).

6.2.2. Ayeyarwaddy River

Phytoplankton, zooplankton, periphyton and phytobenthos recorded lists for Ayeyarwaddy River are as shown in Table (6.2.2.1 to 6.2.2.4). 54 species of phytoplankton, 105 species of zooplankton, 77 species of benthos and 88 species of periphyton are recorded from Ayeyarwaddy River. Among these records, 6 species of phytoplankton, 23 species of zooplankton and 2 species of periphyton cannot be identified into species level. For benthos, only 6 species out of 77 can be identified into species level.

Table 6.2.2.1. Qualitative analysis of Phytoplankton in Ayeyarwaddy River.

Sr.	Species
1	*Diatoma mesodon*
2	*Diatoma anceps*
3	*Synedra amphicephala var.intermedia*
4	*Synedra ulna var. contracta*
5	*Cocconeis placentula*
6	*Cocconeis placeniula var.euglypta*
7	*Fragilaria vaucheriae var.capitellata*
8	*Fragilaria bidens*
9	*Fragilaria ulna*
10	*Fragilaria arcus*
11	*Cymbella sp.*
12	*Cymbella minuta*
13	*Cymbella sinuata*
14	*Achnanthes biasoletiana var. subatomus*
15	*Achnanthes lanceolata ssp. frequentissima*
16	*Achnanthes crenulata*
17	*Achnanthes biasoletiana*
18	*Achnanthes minutissima*
19	*Achnanthes lanceolata var.rostrata*
20	*Achnanthes minutissima var.affinis*
21	*Achnanthes minutissima var.gracillima*
22	*Achnanthes ploenensis*

23	*Achnanthes petersenii*
24	*Achnanthes impexiformis*
25	*Achnanthes nitidiformis*
26	*Navicula radiosafallax*
27	*Navicula capitatoradiata*
28	*Navicula contenta var.biceps*
29	*Navicula oligotraphenta*
30	*Gomphonema minutum*
31	*Gomphonema pumilum*
32	*Gomphonema olivaceum var.olivaceoides*
33	*Gomphonema parvulum*
34	*Nitzschia dissipata*
35	*Nitzschia intermedia*
36	*Melosira varians*
37	*Melosira ambigua*
38	*Cyclotella sp.*
39	*Surirella sp.*
40	*Surirella linearis*
41	*Pinnularia sp.*
Sr.	**Species**
42	*Eunotia diodon*
43	*Eunotia sudetica*
44	*Craticula halophila*
45	*Luticola mutica*
46	*Lyngbya sp.*
47	*Oscillatoria chlorina*
48	*Oscillatoria animalis*
49	*Oscillatoria tenuis*
50	*Tychonema granulatum*
51	*Anabaena oscillarioides*
52	*Planktothrix cryptovaginata*
53	*Uronema confervicolum*
54	*Closterium sp.*

Table 6.2.2.2. Qualitative analysis of Zooplankton in Ayeyarwaddy River.

Sr.	Species
1	*Amoeba*
2	*Polychaos timidium*
3	*Saccamoeba gongornia*
4	*Arcella gibbosa*
5	*Arcella discoides*
6	*Arcella hemisphaerica*
7	*Arcella hemisphaerica undulata*

8	*Arcella rotundata*
9	*Arcella megastoma*
10	*Arcella vulgaris*
11	*Nebela collaris*
12	*Quadrulella symmetrica*
13	*Difflugia globulosa*
14	*Difflugia acuminata*
15	*Difflugia oblonga*
16	*Difflugia lucida*
17	*Difflugia avellana*
18	*Difflugia hydrostatica lithophila*
19	*Difflugia gramen*
20	*Difflugia mammillaris*
21	*Difflugia sp.*
22	*Centropyxis aerophila aerophila*
Sr.	**Species**
23	*Centropyxis platystoma*
24	*Centropyxis platystoma armata*
25	*Centropyxis constricta*
26	*Centropyxis aculeata*
27	*Centropyxis aculeata grandis*
28	*Centropyxis ecornis*
29	*Centropyxis ecornis leidyi*
30	*Centropyxis discoides*
31	*Centropyxis minuta*
32	*Cyclopyxis arcellodes*
33	*Cyclopyxis deflandrei*
34	*Pontigulasia incisa*
35	*Phryganella nidulus*
36	*Wailesella* sp.
37	*Euglypha filifera*
38	*Euglypha rotunda*
39	*Euglypha* sp.
40	*Cyphoderia ampulla*
41	*Plagiophrys scutiformis*
42	*Lieberkuhnia wagneri*
43	*Holophrya atra*
44	*Coleps* sp.
45	*Didinium balbianii nanum*
46	*Mesodinium pulex*

47	*Lagynophrya conifera*
48	*Spathidium scalpriforme*
49	*Spathidium mucicola*
50	*Podophrya fixa*
51	*Sphaerophrya* sp.
52	*Hemiophrys* sp.
53	*Litonotus* sp.
54	*Chilodonella nana*
55	*Vorticella microstoma*
56	*Vorticella* sp.
57	*Carchesium polypinum*
58	*Epistylis rotans*
59	*Ophryolena* sp.
60	*Malacophrys rotans*
Sr.	**Species**
61	*Lembadion bullinum*
62	*Cyclidium muscicola*
63	*Cyclidium* sp.
64	*Strobilidium gyrans*
65	*Strobilidium velox*
66	*Holosticha kessleri*
67	*Uroleptus caudatus*
68	*Tintinnopsis wangi*
69	*Tintinnopsis conicus*
70	*Dicranoporus sp.*
71	*Colurella unicauda*
72	*Colurella* sp.
73	*Lepadella patella*
74	*Lepadella acuminata*
75	*Trichotria tetractis*
76	*Keratella cochleari*
77	*Keratella valga*
78	*Lecane closterocerca*
79	*Lecane hamata*
80	*Lecane thienemanni*
81	*Lecane bulla*
82	*Lecane stenroosi*
83	*Lecane sp.*
84	*Euchlanus .dilatata*
85	*Asplanchnopus* sp.

86	*Epiphanes* sp.
87	*Notommata* sp.
88	*Resticula* sp.
89	*Cephalodella catellina*
90	*Cephalodella innesi*
91	*Cephalodella gibba*
92	*Cephalodella* sp.
93	*Eosphora* sp.
94	*Proales daphnicola*
95	*Proales* sp.
96	*Scaridium longicaudum*
97	*Ascomorpha* sp.
98	*Synchaeta* sp.
Sr.	**Species**
99	*Polyarthra vulgaris*
100	*Trichocerca cylindrica*
101	*Trichocerca pusilla*
102	*Pompholyx sulcata*
103	小三肢轮虫
104	*Philodina* sp.
105	*Habrotrocha* sp.

Table 6.2.2.3. Analysis of Benthos in Ayeyarwaddy River.

Sr.	**Species**
1	Enphaeidae sp.
2	S*tylogomphus* sp.
3	*Leptogomphus* sp.
4	*Megalogomphus* sp.
5	P*haenandrogomphus* sp.
6	*Lamelligomphus* sp.
7	Perlidae sp.
8	Peltoperlidae sp.
9	Nemouridae sp.
10	*Rhithrogena* sp.
11	*Cinygmina* sp.
12	*Heptagenia* sp.
13	*Thalerosphyrus* sp.
14	*Cincticostella insolta*
15	*Notacanthella quadrata*
16	Ephemerallidae sp
17	Isonychiidae sp.

18	*Baetis* sp.
19	*Pseudocloeon* sp.
20	Leptophlebiidae sp.
21	Teloganodidae sp.
22	Caenidae sp.
23	Ephemeridae sp.
24	Glossosomatidae sp.
25	Philopotamidae sp.
26	*Macrostemum* sp.
27	*Ceratopsyche* sp.
28	*Helicopsyche* sp.
29	*Melanotrichia* sp.
30	Leptoceridae sp.
Sr.	**Species**
31	Hydroptilidae sp.
32	*Ecnomus* sp.
33	Psychomyiidae sp.
34	*Stenopsyche* sp.
35	Elmidae sp.
36	Psephenidae sp1.
37	Psephenidae sp2.
38	Hydrochidae sp.
39	Hydraenidae sp.
40	Hydrophilidae sp.
41	Gyrinidae sp.
42	Scirtidae sp.
43	Micromalthidae sp.
44	Ptilodactylidae sp.
45	Gelastocoridae sp.
46	*Phyacobates* sp.
47	Aphelocheiridae sp.
48	Corixidae sp.
49	Tabanidae sp.
50	Ceratopogonidae sp.
51	Athericidae sp.
52	Simuliidae sp.
53	*Limnophila* sp.
54	*Thaumastoptera* sp.
55	*Antocha* sp.
56	*Polypedilum* sp1
57	*Polypedilum* sp2
58	*Thienemannimyia* sp.
59	*Eukiefferiella* sp.
60	*Cryptochironomus* sp.
61	*Rheotanytarsus* sp.
62	*Tanytarsus* sp.

63	*Robackia* sp.
64	*Apedilum* sp.
65	*Platysmittia* sp.
66	*Orthocladius* sp.
67	*Chironomus* sp.
68	*Microtendipes* sp.
69	*Procladius* sp.
70	*Parachironomus* sp.
71	双翅目蛹
72	*Macrobrachium* sp.
73	*Spirosperma nikolskyi*
Sr.	**Species**
74	*Limnodrilus amblysetus*
75	*Limnodrilus hoffmeisteri*
76	Enchytraeidae sp.
77	Nematoda sp.

Table 6.2.2.4. Qualitative analysis of Periphyton in Ayeyarwaddy River.

Sr.	**Species**	伊江支流 **Ayeyarwaddy**	伊江干流
1	*Achnanthes atomus*	+	+
2	*Achnanthes biasoletti*	+	+
3	*Achnanthes biasoletti var. subatomus*	+	+
4	*Achnanthes catenatum*	+	+
5	*Achnanthes conspicua*	+	
6	*Achnanthes exigua*	+	+
7	*Achnanthes hungarica*	+	
8	*Achnanthes lanceolata*	+	+
9	*Achnanthes lanceolata var.rostrota*	+	+
10	*Achnanthes minutissima*	+	+
11	*Achnanthes minutissima var. affinis*	+	+
12	*Achnanthes minutissima var. gracillima*	+	+
13	*Achnanthes minutissima var. saprophila*	+	+
14	*Achnanthes subhudsonis*	+	+
15	*Amphora montana*	+	
16	*Amphora pediculus*	+	+
17	*Bacillaria paradoxa*	+	+
18	*Cocconeis placentula var. lineata*		+
19	*Cocconeis placentula*	+	+
20	*Cymbella cymbiformis*	+	
21	*Cymbella delicatula*	+	

22	*Cymbella lacustris*		+
23	*Cymbella microcephala*	+	+
24	*Cymbella minuta*	+	+
25	*Cymbella tumida*	+	+
26	*Cymbella turgidula*	+	+
27	*Diadesmis confervacea*	+	+
28	*Diadesmis contenta*	+	
29	*diatoma mesadon*		+
30	*diatoma problematica*		+
Sr.	**Species**	伊江支流 **Ayeyarwaddy**	伊江干流
31	*Epithemia adnata*		+
32	*Epithemia sorex*		+
33	*Fragilaria arcus*		+
34	*Fragilaria capucina*	+	+
35	*Fragilaria capucina var. vaucheriae*		+
36	*Fragilaria crotonensis*	+	
37	*Fragilaria pinnata*		+
38	*Fragilaria pseudogaillonii*	+	+
39	*Fragilaria ulna*	+	+
40	*Frustulum vulgaris*	+	
41	*Gomphonema augur var.gautieri*	+	
42	*Gomphonema clevei*	+	+
43	*Gomphonema minutum*	+	+
44	*Gomphonema parvulum*		+
45	*Gomphonema parvulum var. exilissimum*	+	
46	*Gomphonema pumilum*		+
47	*Gomphonema rhombicum*	+	
48	*Gomphonema* sp1*(与 G.claratum 相似)*	+	
49	*Gyrosigma acuminatum*	+	+
50	*luticola mutica*	+	+
51	*Melosira varians*	+	+
52	*Navicula atomus*	+	+
53	*Navicula atomus var. permitis*	+	+
54	*Navicula bryophila*	+	+
55	*Navicula capitatoradiata*		+
56	*Navicula cincta*	+	+
57	*Navicula cryptocephala*		+
58	*Navicula cryptotenella*	+	+
59	*Navicula decussis*		+

60	*Navicula delicatilineolata*	+	+
61	*Navicula gregaria*		+
62	*Navicula minuma*	+	+
63	*Navicula minuscula var.grunowii*	+	+
64	*Navicula notha*	+	+
65	*navicula novaesiberica*		+
66	*Navicula reichardtiana*		+
67	*Navicula schroeteri var. symmetrica*	+	+
Sr.	**Species**	伊江支流 **Ayeyarwaddy**	伊江干流
68	*Navicula seminulum*	+	
69	*Navicula* sp1		+
70	*Navicula subminuscula*	+	+
71	*Navicula thermaloides*	+	
72	*Navicula viridula var.rostellata*	+	+
73	*Nitzschia clausii*	+	+
74	*Nitzschia dissipata*	+	+
75	*Nitzschia flexa*	+	
76	*Nitzschia frustulum*		+
77	*Nitzschia incospicua*	+	+
78	*Nitzschia linearis*		+
79	*Nitzschia palea*	+	+
80	*Nitzschia paleacea*	+	
81	*Nitzschia paleaeformis*	+	+
82	*Nitzschia recta*		+
83	*Pinnularia* sp	+	+
84	*Sellaphora japonica*	+	
85	*sellaphora pupula*	+	+
86	*Surirella angusta*	+	+
87	*Surirella linearis*	+	+
88	*Surirella robusta*	+	
Total		67	70

6.2.3. May Hka River

Phytoplankton, zooplankton, periphyton and phytobenthos recorded lists for May Hka River are as shown in Table (6.2.3.1 to 6.2.3.4). 76 species of phytoplankton, 114 species of zooplankton, 105 species of benthos and 90 species of are recorded from May Hka River. Among these records, 9 species of phytoplankton, 22 species of zooplankton and 1 species of periphyton cannot be identified into species level. For benthos, only 24 species out of 105 can be identified into species level.

Table 6.2.3.1. Qualitative analysis of Phytoplankton in May Hka River.

Sr.	Species	恩梅开江上游 **May Hka**	恩梅开江中游	恩梅开江下游
1	*Diatoma vulgaris var. ovalis*		+	
2	*Diatoma mesodon*	+	+	+
3	*Diatoma moniliformis*		+	
4	*Diatoma anceps*	+	+	
5	*Synedra sp.*		+	
6	*Synedra amphicephala var.intermedia*	+		
7	*Synedra ulna var. contracta*	+		
8	*Cocconeis placentula*	+	+	
9	*Cocconeis placeniula var.euglypta*	+	+	+
10	*Fragilaria vaucheriae var.capitellata*		+	
11	*Fragilaria bidens*	+		
12	*Fragilaria ulna*	+	+	
13	*Fragilaria capucina var.vaucheriae*		+	
14	*Fragilaria arcus*	+	+	+
15	*Fragilaria brevistriata*		+	
16	*Cymbella sp.*		+	
17	*Cymbella minuta*	+	+	+
18	*Cymbella affinis*	+	+	
19	*Cymbella sinuata*	+	+	
20	*Cymbella cymbiformis*		+	
21	*Cymbella turgidula*		+	
22	*Achnanthes biasoletiana var. subatomus*	+	+	+
23	*Achnanthes lanceolata ssp. frequentissima*	+	+	+
24	*Achnanthes crenulata*	+	+	
25	*Achnanthes biasoletiana*	+	+	+
26	*Achnanthes minutissima*	+	+	+
27	*Achnanthes exigua*	+	+	

28	*Achnanthes minutissima var.affinis*	+	+	+
29	*Achnanthes minutissima var.gracillima*	+	+	
30	*Achnanthes ploenensis*	+		
31	*Achnanthes impexiformis*		+	
32	*Achnanthes catenata*		+	
33	*Achnanthes montana*		+	
34	*Navicula sp1.*	+	+	+
Sr.	**Species**	恩梅开江上游 **May Hka**	恩梅开江中游	恩梅开江下游
35	*Navicula radiosafallax*	+	+	+
36	*Navicula capitatoradiata*	+	+	+
37	*Navicula contenta var.biceps*	+		
38	*Navicula oligotraphenta*	+	+	
39	*Navicula minima*		+	
40	*Navicula capitata var.hungarica*		+	
41	*Gomphonema sp.*	+	+	
42	*Gomphonema minutum*	+	+	+
43	*Gomphonema pumilum*	+	+	+
44	*Gomphonema rhombicum*		+	
45	*Gomphonema olivaceum var.olivaceoides*	+	+	
46	*Gomphonema parvulum*		+	
47	*Gomphonema parvulum var.exilissimum*	+		
48	*Gomphonema angustum*		+	+
49	*Gomphonema ribrio*	+	+	
50	*Nitzschia palea*			
51	*Nitzschia recta*		+	
52	*Nitzschia dissipata*	+	+	
53	*Nitzschia intermedia*	+		
54	*Nitzschia brevissima*		+	
55	*Melosira granulata*			+
56	*Melosira varians*		+	
57	*Stauroneis anceps var.obtusa*		+	
58	*Cyclotella sp.*	+		
59	*Cylotella meneghiniana*		+	
60	*Surirella linearis*	+	+	
61	*Pinnularia subcapitata*		+	
62	*Amphipleura sp.*		+	
63	*Eunotia tridentula*	+		
64	*Eunotia diodon*	+		

65	*Eunotia exigua*	+	+	
66	*Luticola mutica*		+	
67	*Oscillatoria sp.*	+		
68	*Oscillatoria chlorina*		+	+
69	*Oscillatoria animalis*		+	
70	*Oscillatoria granulata*		+	+
Sr.	**Species**	恩梅开江上游 **May Hka**	恩梅开江中游	恩梅开江下游
71	*Nostoc minutum*		+	
72	*Phormidium diguetii*			+
73	*Cylindrospermum sp.*		+	+
74	*Uronema confervicolum*			+
75	*Ulothrix tenerrima*		+	
76	*Bulbochaete sp.*		+	
Total		40	61	21

Table 6.2.3.2. Qualitative analysis of Zooplankton in May Hka River.

Sr.	Species	I	II	III	IV	V
1	*Amoeba verrucosa*		+			
2	*Trichamoeba villosa*				+	
3	*Mayorella* sp.					+
4	*Polychaos timidium*		+		+	
5	*Saccamoeba gongornia*	+		+	+	
6	*Microchlamys Patella*			+		
7	*Arcella discoides*	+	+	+	+	+
8	*Arcella hemisphaerica*		+		+	+
9	*Arcella hemisphaerica undulata*		+			+
10	*Arcella rotundata*					+
11	*Arcella megastoma*		+		+	+
12	*Arcella vulgaris*					+
13	*Arcella* polypora					+
14	*Arcella* sp.					+
15	*Hyalosphenia subflava*		+			
16	*Hyalosphenia* sp.					+
17	*Nebela collaris*		+	+		
18	*Nebela tincta*	+				
19	*Quadrulella symmetrica*	+	+	+	+	+
20	*Quadrulella irregularis*				+	

21	*Difflugia globulosa*	+	+	+	+	+
22	*Difflugia acuminata*					+
23	*Difflugia oblonga*	+	+	+		+
24	*Difflugia oblonga brevicolla*			+		
25	*Difflugia lucida*		+	+	+	
Sr.	**Species**	**I**	**II**	**III**	**IV**	**V**
26	*Difflugia ampora*	+				+
27	*Difflugia glans*	+	+			+
28	*Difflugia gramen*			+	+	
29	*Difflugia varians*		+			
30	*Difflugia lobstoma*				+	
31	*Difflugia sp.*	+	+			+
32	*Centropyxis aerophila aerophila*			+		
33	*Centropyxis platystoma*	+	+	+	+	+
34	*Centropyxis platystoma armata*	+				+
35	*Centropyxis constricta*	+	+	+	+	+
36	*Centropyxis aculeata*	+	+	+	+	+
37	*Centropyxis aculeata oblonga*	+			+	+
38	*Centropyxis aculeata grandis*	+	+			+
39	*Centropyxis ecornis*	+	+		+	+
40	*Centropyxis cassis compressa*			+		
41	*Centropyxis minuta*	+	+	+	+	+
42	*Centropyxis hemisphaerica*		+			
43	*Cyclopyxis arcellodes*	+	+	+	+	+
44	*Cyclopyxis arcellodes*	+				
45	*Cyclopyxis kahli cyclostoma*	+				
46	*Cyclopyxis deflandrei*	+	+	+	+	+
47	*Pontigulasia incisa*		+	+	+	+
48	*Pontigulasia* sp.	+				
49	*phryganella hemisphaerica*	+	+	+		
50	*Wailesella* sp.	+	+	+	+	+
51	*Euglypha filifera*		+	+	+	
52	*Euglypha tuberculata*	+				
53	*Euglypha acabthophora*					+
54	*Euglypha rotunda*		+		+	+
55	*Euglypha* sp.		+			
56	*Cyphoderia ampulla*	+	+	+	+	+
57	*Cyphoderia ampulla vitrrara*			+		+
58	*Pseudodifflugia gracilis*	+			+	+
59	*Pamphagus granulatus*	+		+	+	+

60	*Pamphagus* sp.			+		+
61	*Acanthocystis pantopoda*	+	+			
62	*Urotricha ovata*		+			
63	*Coleps bicuspis*		+			
Sr.	**Species**	**I**	**II**	**III**	**IV**	**V**
64	*Askenasia volvox*	+				
65	*Lagynophrya conifera*					+
66	*Chaenea teres*					+
67	*Chilodonella nana*		+			
68	*Vorticella microstoma*					+
69	*Vorticella* sp.	+	+			+
70	*Epistylis rotans*		+			
71	*Malacophrys rotans*				+	
72	*Cyclidium muscicola*		+			
73	*Cyclidium centrale*		+			
74	*Cyclidium oblongum*		+			
75	*Cyclidium flagellatum*		+			
76	*Cyclidium* sp.		+	+		+
77	*Strobilidium velox*				+	
78	*Strombidium* sp.				+	
79	*Astylonychia* sp.		+			
80	未定纤毛虫					+
81	*Dicranoporus robustus*					+
82	*Dicranoporus edestes*					+
83	*Encentrum* sp.					+
84	*Colurella adriatica*	+		+		+
85	*Colurella unicauda*		+	+		+
86	*Colurella uncinata deflexa*	+				
87	*Colurella obtusa*		+			
88	*Colurella* sp.		+	+		
89	*Lepadella patella*	+	+		+	+
90	*Lepadella acuminata*					+
91	*Lophocharis salpina*	+				
92	*Keratella valga*	+				
93	*Keratella testudo*					+
94	*Lecane closterocerca*		+			+
95	*Lecane crenata*		+			
96	*Lecane bulla*					+
97	*Lecane doryssa*					+
98	*Euchlanus calpidia*		+			

99	*Epiphanes brechionus*		+			
100	*Epiphanes* sp.	+	+	+		
101	*Resticula* sp.		+			
Sr.	**Species**	**I**	**II**	**III**	**IV**	**V**
102	*Resticula* sp.		+			
103	*Cephalodella catellina*			+	+	+
104	*Cephalodella innesi*	+			+	+
105	*Cephalodella gibba*	+	+			+
106	*Cephalodella sterea*		+			
107	*Cephalodella* sp.					+
108	*Proales daphnicola*		+			
109	*Ascomorpha* sp.		+			
110	田奈异尾轮虫				+	
111	*Trichocerca* sp.					+
112	*Philodina* sp.	+	+	+	+	+
113	*Rotaria tardigrada*		+		+	+
114	*Habrotrocha* sp.		+		+	+
Total		40	61	33	37	61

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Table 6.2.3.3. Qualitative analysis of Benthos in May Hka River.

Sr.	Species	I	II	III & IV	V
1	Enphaeidae sp.			+	+
2	*Leptogomphus* sp.	+			
3	*Phaenandrogomphus* sp.		+		+
4	*Protohermes* sp.				+
5	Perlidae sp.	+	+	+	+
6	Perlodidae sp.			+	
7	Nemouridae sp.		+		
8	Capniidae sp.			+	
9	Leuctridae sp.		+	+	
10	Nemouridae sp.			+	
11	*Rhithrogena* sp.		+	+	
12	E*peorus* sp.			+	
13	*Cinygma* sp.			+	+
14	*Cinygmina* sp.	+	+	+	+
15	*Notacanthurus maculosus*	+		+	
16	Prosopistomatidae sp.			+	
17	*Cincticostella insolta*				
18	*Cincticostella boja*	+		+	
19	*Cincticostella Gosei*		+	+	
20	*Cincticostella* sp.			+	
21	*Drunella Cryptomeria*			+	
22	*Drunella bella*		+		
23	*Uracanthella rufa*				+
24	*Uracanthella* sp.		+		
25	*Torleya* sp.				+
26	*Serratella Jianghongenis.*			+	
27	Ephemerallidae sp	+	+		+
28	Isonychiidae sp.				+

29	*Baetis* sp.	+	+	+	+
30	*Pseudocloeon* sp.		+	+	+
Sr.	**Species**	**I**	**II**	**III & IV**	**V**
31	*Choroterpides* sp1.				+
32	*Choroterpides* sp2.		+		+
33	*Habrophlebiodes* sp.			+	+
34	*Choroterpes yunnanensis*		+		
35	*Choroterpes* sp.		+		
36	*Thraulus Semicastanea*	+	+		
37	*Clypeocaenis flava*				+
38	*Glabrocaenis Petersi*				+
39	*Caenis nigropunctata*		+		+
40	*Caenis* sp.			+	
41	Caenidae sp.			+	+
42	Potamanthidae sp.				+
43	Ephemeridae sp.	+		+	+
44	蜉蝣目成虫		+		
45	Glossosomatidae sp.			+	+
46	Hydrobiosidae sp.			+	
47	Philopotamidae sp.		+		
48	*Macrostemum* sp.		+		
49	*Ceratopsyche* sp.	+	+	+	+
50	*Helicopsyche* sp.				+
51	Leptoceridae sp.		+		+
52	Hydroptilidae sp.				+
53	*Brachycentrus* sp.		+		+
64	*Micrasema* sp.	+	+	+	
55	Rhyacophilidae sp.			+	+
56	*Stenopsyche* sp.	+		+	+
57	Polycentropodidae sp.	+			
58	毛翅目蛹				+
59	Elmidae sp.	+	+	+	+
60	Psephenidae sp1.				

61	Psephenidae sp2.			+	
Sr.	**Species**	**I**	**II**	**III & IV**	**V**
62	Amphizoidae sp.				+
63	Lampyridae sp.		+		
64	Hydrophilidae sp.			+	
65	Gyrinidae sp.			+	
66	Scirtidae sp.	+	+	+	
67	鞘翅目一种				+
68	多食亚目一种	+		+	
69	Aphelocheiridae sp.				+
70	Tabanidae sp.	+	+	+	
71	Ceratopogonidae sp.			+	
72	Empididae sp.		+		
73	*Rhaphium* sp.		+		
74	Athericidae sp.	+	+	+	
75	Pelecorhynchidae sp.	+		+	
76	Tanyderidae sp.		+		
77	Simuliidae sp.	+	+	+	+
78	*Limnophila* sp.	+	+	+	+
79	*Dicranota* sp.	+			
80	*Hexatoma* sp.				+
81	*Antocha* sp.		+	+	+
82	*Polypedilum* sp2	+	+	+	+
83	*Thienemannimyia* sp.	+	+	+	+
84	*Einfeldia* sp.	+			
85	*Cryptochironomus* sp.		+		
86	Chironominae sp2.				+
87	摇蚊科一种			+	
88	*Hydrobaenus* sp.		+		
89	*Dicrotendipes* sp.		+		
90	*Cardiocladius* sp.	+	+		+
91	*Rheotanytarsus* sp.		+		
92	*Tanytarsus* sp.		+		+

Sr.	Species	I	II	III & IV	V
93	*Platysmittia* sp.	+			
94	*Orthocladius* sp.	+	+		
95	*Chironomus* sp.				
96	*Microtendipes* sp.	+	+	+	+
97	*Procladius* sp.				+
98	双翅目蛹	+	+		
99	*Spirosperma nikolskyi*		+		
100	巨毛水丝蚓	+			
101	*Limnodrilus* sp.	+			
102	Enchytraeidae sp.			+	
103	寡毛纲一种		+		
104	咽蛭			+	
105	涡虫		+		
Total		**32**	**49**	**48**	**45**

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Table 6.2.3.4. Qualitative analysis of Periphyton in May Hka River.

Sr.	Species	恩江支流 **May Hka**	恩江干流
1	*Achnanthes atomus*	+	+
2	*Achnanthes biasoletti*	+	+
3	*Achnanthes biasoletti var. subatomus*	+	+
4	*Achnanthes catenatum*		+
5	*Achnanthes crenulata*	+	+
6	*Achnanthes exigua*	+	
7	*Achnanthes hungarica*		+
8	*Achnanthes lanceolata*		+
9	*Achnanthes lanceolata var.rostrota*	+	
10	*Achnanthes minutissima*	+	+
11	*Achnanthes minutissima var. affinis*	+	+
12	*Achnanthes minutissima var. gracillima*	+	+
13	*Achnanthes minutissima var. saprophila*	+	+
14	*Achnanthes rupestoides*	+	
15	*Achnanthes subhudsonis*	+	+
16	*Amphipleura pellucida*	+	
17	*Amphora fontinalis*	+	
18	*Amphora montana*	+	+
19	*Amphora pediculus*	+	
20	*Bacillaria paradoxa*	+	
21	*Cocconeis placentula var. lineata*	+	
22	*Cocconeis placentula*	+	+
23	*Cymbella delicatula*		+
24	*Cymbella lacustris*		+
25	*Cymbella microcephala*		+
26	*Cymbella minuta*	+	+
27	*Cymbella perpusilla*		+
28	*Cymbella sinuata*	+	
29	*Cymbella tumida*	+	+
30	*Cymbella turgidula*	+	+
31	*diatoma mesadon*		+
32	*Diploneis oblongella*	+	
33	*Epithemia adnata*	+	
34	*Epithemia sorex*	+	
35	*Fragilaria arcus*		+

Sr.	Species	恩江支流 **May Hka**	恩江干流
36	*Fragilaria capucina*	+	+
37	*Fragilaria capucina var. vaucheriae*		+
38	*Fragilaria crotonensis*		+
39	*Fragilaria fasciculata*	+	
40	*Fragilaria pseudogaillonii*	+	+
41	*Fragilaria ulna*		+
42	*Frustulum vulgaris*	+	
43	*Gomphonema clavatum*	+	
44	*Gomphonema clevei*	+	+
45	*Gomphonema minutum*	+	+
46	*Gomphonema parvulum*	+	+
47	*Gomphonema pumilum*	+	+
48	*Gomphonema rhombicum*	+	+
49	*Gomphonema sphnerophorum*	+	
50	*luticola mutica*	+	
51	*Melosira varians*	+	+
52	*Navicula arvensis*	+	
53	*Navicula atomus*	+	
54	*Navicula atomus var. permitis*	+	
55	*Navicula bryophila*	+	+
56	*Navicula capitatoradiata*	+	+
57	*Navicula cincta*	+	+
58	*Navicula cryptocephala*	+	+
59	*Navicula cryptotenella*	+	+
60	*Navicula decussis*	+	
61	*Navicula delicatilineolata*	+	+
62	*Navicula erifuga*		+
63	*Navicula gregaria*	+	
64	*Navicula heimansioides*	+	+
65	*Navicula lanceolata*		+
66	*Navicula minuma*	+	+
67	*Navicula minuscula var.grunowii*	+	+
68	*Navicula notha*	+	
69	*Navicula oligotraphenta*	+	
70	*Navicula perpusilla*		+
71	*Navicula radiosafallax*	+	

Sr.	Species	恩江支流 **May Hka**	恩江干流
72	*Navicula reichardtiana*	+	
73	*Navicula schroeteri var. symmetrica*		+
74	*Navicula viridula*	+	
75	*Nitzschia amphibia*		+
76	*Nitzschia angustatula*	+	
77	*Nitzschia clausii*	+	
78	*Nitzschia dissipata*	+	+
79	*Nitzschia frustulum*	+	
80	*Nitzschia incospicua*	+	
81	*Nitzschia palea*	+	+
82	*Nitzschia paleacea*	+	
83	*Nitzschia sinuata var. tabellaria*	+	
84	*Pinnularia* sp	+	
85	*sellaphora bacillum*		+
86	*Sellaphora japonica*	+	+
87	*sellaphora pupula*		+
88	*Surirella angusta*	+	+
89	*Surirella linearis*	+	
90	*Surirella robusta*	+	
Total		71	54

6.2.4. Mali Hka River

Phytoplankton, zooplankton, periphyton and phytobenthos recorded lists for Mali Hka River are as shown in Table (6.2.4.1 to 6.2.4.4). 69 species of phytoplankton, 62 species of zooplankton, 26 species of benthos and 65 species of periphyton are recorded from Ayeyarwaddy River. Among these records, 11 species of phytoplankton, 10 species of zooplankton and 1 species of periphyton cannot be identified into species level. For benthos, only 2 species out of 26 can be identified into species level.

Table 6.2.4.1. Qualitative analysis of Phytoplankton in Mali Hka River.

Sr.	Species	迈立开江 中下游 **Mali Hka**
1	*Diatoma vulgaris*	+
2	*Diatoma mesodon*	+
3	*Diatoma moniliformis*	+
4	*Synedra acus*	+
5	*Cocconeis placentula*	+
6	*Cocconeis placeniula var.euglypta*	+
7	*Fragilaria bidens*	+
8	*Fragilaria ulna*	+
9	*Fragilaria arcus*	+
10	*Fragilaria brevistriata*	+
11	*Cymbella sp.*	+
12	*Cymbella minuta*	+
13	*Cymbella affinis*	+
14	*Cymbella sinuata*	+
15	*Cymbella turgidula*	+
16	*Achnanthes biasoletiana var. subatomus*	+
17	*Achnanthes lanceolata ssp. frequentissima*	+
18	*Achnanthes crenulata*	+
19	*Achnanthes biasoletiana*	+
20	*Achnanthes minutissima*	+
21	*Achnanthes minutissima var.affinis*	+
22	*Achnanthes minutissima var.gracillima*	+
23	*Achnanthes ploenensis*	+
24	*Achnanthes helvetica*	+
25	*Navicula sp1.*	+
26	*Navicula radiosafallax*	+
27	*Navicula capitatoradiata*	+
28	*Navicula oligotraphenta*	+
29	*Navicula menisculus*	+
30	*Navicula capitata var.hungarica*	+
31	*Gomphonema minutum*	+
32	*Gomphonema pumilum*	+
33	*Gomphonema parvulum*	+
34	*Gomphonema truncatum*	+
35	*Gomphonema angustum*	+

Sr.	Species	迈立开江 中下游 **Mali Hka**
36	*Nitzschia palea*	+
37	*Nitzschia recta*	+
38	*Nitzschia dissipata*	+
39	*Nitzschia tubicola*	+
40	*Nitzschia intermedia*	+
41	*Melosira granulata*	+
42	*Melosira varians*	+
43	*Melosira ambigua*	+
44	*Stauroneis sp.*	+
45	*Cyclotella sp.*	+
46	*Surirella linearis*	+
47	*Surirella brebissonii*	+
48	*Pinnularia sp.*	+
49	*Eunotia sp.*	+
50	*Eunotia tridentula*	+
51	*Eunotia exigua*	+
52	*Eunotia minor*	+
53	*Eunotia bilunaris*	+
54	*Frustulia saxonica*	+
55	*Didymosphenia geminata*	+
56	*Craticula halophila*	+
57	*Luticola acidoclinata*	+
58	*Lyngbya sp.*	+
59	*Oscillatoria chlorina*	+
60	*Oscillatoria granulata*	+
61	*Oscillatoria willei*	+
62	*Phormidium diguetii*	+
63	*Chroococens minutus*	+
64	*Cylindrospermum sp.*	+
65	*Cylindrospermum stagnale*	+
66	*Uronema confervicolum*	+
67	*Microspora sp.*	+
68	*Draparnaidia sp.*	+
69	*Bulbochaete sp.*	+

Table 6.2.4.2. Qualitative analysis of Zooplankton in Mali Hka River.

Sr.	Species	LASA
1	*Amoeba verrucosa*	+
2	*Vannella platypodia*	+
3	*Saccamoeba gongornia*	+
4	*Microchlamys Patella*	+
5	*Arcella discoides*	+
6	*Arcella hemisphaerica*	+
7	*Arcella megastoma*	+
8	*Arcella vulgaris*	+
9	*Arcella* catinus	+
10	*Nebela lageniformis*	+
11	*Quadrulella symmetrica*	+
12	*Difflugia globulosa*	+
13	*Difflugia acuminata*	+
14	*Difflugia lucida*	+
15	*Difflugia glans*	+
16	*Difflugia gramen*	+
17	*Difflugia bidens*	+
18	*Difflugia sp.*	+
19	*Centropyxis platystoma*	+
20	*Centropyxis platystoma armata*	+
21	*Centropyxis aculeata*	+
22	*Centropyxis aculeata oblonga*	+
23	*Centropyxis aculeata grandis*	+
24	*Centropyxis ecornis*	+
25	*Centropyxis minuta*	+
26	*Cyclopyxis arcellodes*	+
27	*Cyclopyxis deflandrei*	+
28	*Pontigulasia incisa*	+
29	*Wailesella* sp.	+
30	*Euglypha filifera*	+
31	*Euglypha acabthophora*	+
32	*Euglypha rotunda*	+
33	*Cyphoderia ampulla*	+
34	*Pamphagus granulatus*	+
35	*Raphidiophrys* viridis	+
36	*Urotricha sp.*	+
Sr.	**Species**	**LASA**

37	*Didinium balbianii nanum*	+
38	*Lagynophrya* sp.	+
39	*Vorticella microstoma*	+
40	*Cothurnia annulata*	+
41	*Cyclidium muscicola*	+
42	*Cyclidium* sp.	+
43	*Strobilidium gyrans*	+
44	*Holosticha kessleri*	+
45	*Tintinnidium fluviatile*	+
46	*Colurella adriatica*	+
47	*Colurella unicauda*	+
48	*Colurella* sp.	+
49	*Lepadella patella*	+
50	*Lepadella triptera*	+
51	*Trichotria tetractis*	+
52	*Lecane closterocerca*	+
53	*Lecane crenata*	+
54	*Lecane bulla*	+
55	*Lecane glypta*	+
56	*Euchlanus pellucida*	+
57	*Epiphanes* sp.	+
58	*Cephalodella innesi*	+
59	*Ascomorpha* sp.	+
60	*Philodina* sp.	+
61	*Rotaria rotatoria*	+
62	*Habrotrocha* sp.	+

Table 6.2.4.3. Qualitative analysis of Benthos in Mali Hka River.

Sr.	Species

1	Perlidae sp.
2	*Cinygmina* sp.
3	*Notacanthurus* sp.
4	Ephemerallidae sp
5	*Baetis* sp.
6	Leptophlebiidae sp.
7	*Ceratopsyche* sp.
8	*Arctopsyche* sp.
9	*Helicopsyche* sp.
10	Leptoceridae sp.
11	*Stenopsyche* sp.
12	Elmidae sp.
13	Psephenidae sp1.
14	Psephenidae sp2.
15	Aphelocheiridae sp.
16	*Limnophila* sp.
17	*Hexatoma* sp.
18	*Antocha* sp.
19	*Thienemannimyia* sp.
20	Chironominae sp1.
21	*Cardiocladius* sp.
22	*Rheotanytarsus* sp.
23	*Orthocladius* sp.
24	*Procladius* sp.
25	双翅目蛹
26	奥特开水丝蚓

Table 6.2.4.4.Qualitative analysis of Periphyton in Mali Hka River.

Sr.	**Species**	迈江支流 **Mali Hka**	迈江干流

1	*Achnanthes atomus*	+	+
2	*Achnanthes biasoletti*	+	+
3	*Achnanthes biasoletti var. subatomus*	+	+
4	*Achnanthes catenatum*	+	
5	*Achnanthes crenulata*	+	
6	*Achnanthes exigua*	+	+
7	*Achnanthes lanceolata*	+	
8	*Achnanthes lanceolata var.rostrota*	+	+
9	*Achnanthes minutissima*	+	+
10	*Achnanthes minutissima var. affinis*	+	+
11	*Achnanthes minutissima var. gracillima*	+	
12	*Achnanthes subhudsonis*	+	+
13	*Amphora fontinalis*	+	
14	*Amphora pediculus*	+	
15	*Anomoeoneis pseudotusculus*	+	
16	*Bacillaria paradoxa*	+	+
17	*Cocconeis pediculus*	+	
18	*Cocconeis placentula var. lineata*	+	
19	*Crymatopleura solea*	+	
20	*Cymbella cymbiformis var. nonpunctata*	+	
21	*Cymbella lacustris*	+	+
22	*Cymbella minuta*		+
23	*Cymbella tumida*		+
24	*Cymbella turgidula*	+	+
25	*Denticula tenuis*		+
26	*Diploneis elliptica*	+	
27	*Diploneis marginestriata*	+	
28	*Epithemia adnata*	+	
29	*Epithemia sorex*	+	
30	*Fragilaria capucina*	+	
31	*Fragilaria pseudogaillonii*	+	+
32	*Frustulum* sp	+	
33	*Gomphonema bicep*		+
34	*Gomphonema clavatum*	+	+
35	*Gomphonema clevei*	+	+
Sr.	**Species**	迈江支流 **Mali Hka**	迈江干流
36	*Gomphonema minutum*	+	+
37	*Gomphonema parvulum*	+	+
38	*Gomphonema pumilum*	+	

39	*Gomphonema rhombicum*	+	
40	*Gyrosigma scalproides*		+
41	*Melosira varians*		+
42	*Navicula arvensis*		+
43	*Navicula atomus var. permitis*	+	
44	*Navicula capitatoradiata*	+	
45	*Navicula cryptocephala*		+
46	*Navicula cryptotenella*	+	
47	*Navicula minuma*	+	+
48	*Navicula minuscula*	+	+
49	*Navicula minuscula var.grunowii*	+	+
50	*Navicula obtecta*	+	
51	*Navicula radiosafallax*	+	+
52	*Navicula reichardtiana*		+
53	*Navicula schroeteri var. symmetrica*		+
54	*Neidium affine var. humerus*	+	
55	*Neidium dubium*	+	
56	*Nitzschia clausii*		+
57	*Nitzschia dissipata*		+
58	*Nitzschia frustulum*	+	+
59	*Nitzschia incospicua*	+	
60	*Nitzschia palea*	+	+
61	*Nitzschia sinuata var. tabellaria*	+	
62	*Rhopalodia gibba*	+	
63	*Sellaphora japonica*	+	
64	*sellaphora pupula*	+	
65	*Surirella linearis*		+
Total		52	35

6.3. Fish

96 species from 21 families were recorded from this survey. The highest species composition was recorded from Myitsone Dam area and recorded list is about 72 species. The lowest species composition was recorded from May Hka River. The identified fish list from May Hka River is about 30 species. About 31 species were recorded from Mali Hka River. 4 species cannot be identified into species level.

Surveyed areas along May Hka River were dominant with cold water genus of *Schizothorax* (Snow Trout) especially in the upstream areas (Table: 6.3.1). Unidentified species have to be studied in detail in the future. There may be endemic species present in these regions and this is an important field to be studied for reduction of impact on them. *Schizothorax* species may be endemic species but detailed study is required.

1 endangered species of *Schizothorax grahami* (Kunming Snout Trout) was recorded from May Hka River from Chibwe Dam area to upstream along May Hka River (Fig. 48). 1 data deficient species of *Macrognathus aral* (One-stripe Spiny Eel) was recorded from downstream of Myitsone Dam area (Fig. 49).

40 fish egges were collected from Lasa Dam area. 1 berried female of *Schizothorax* sp. was caught from Wusok Dam area in April (Fig. 50).

Long migrants of genus *Anguilla nebulosa*, *Anguilla bengalensis* and *Tor putitora* were recorded from Myitkyina to Putao in Mali Hka River and from Myitkyina to Kaunglanhpu in May Hka River (Fig. 51).

Among the recorded lists, *Bangana devdevi*, *Eutropiichthys vacha*, *Neolissochilus hexagonolepis*, *Pangasius pangasius*, *Garra* species, *Labeo* specie, *Schizothora*x species and *Tor* species are the economically important species along the surveyed areas and need protection (Fig. 52). Records of length-weight relationship of economically important species are shown in table (6.3.2).

1 kind of cray fish was recorded as a possible species for aquaculture in the surveyed areas (Fig. 53). This species is reared in pond successfully in China for human consumption.

Schizothorax spp. are dominant among the cold water fish in all sampling stations along May Hka River. They are caught by set drift nets which are set on the bank of the river in the evening and harvested in the morning. Other common fish species are *Tor* sp., *Bangana* sp, *Garra* sp, *Neolissocheilus* sp. and *Glyptothorax* sp, and are caught by the same fishing method along the river.

Set drift nets of various mesh sizes are common fishing apparatus along the region. The length and the depth of drift nets depend on fishing area. Common length is about 10 meters and depth is about 1 meter. Cast nets are used in still water areas. Long lines and hooks are also used in Chibwe Dam area. Fishermen from Myitsone Dam area and downstream of Lasa and Chibwe Dam areas own small fishing boats. The major threat to environmental conservation along the surveyed areas is dynamite fishing which cause destruction not only to target species but also to other organisms.

Aquaculture is not developed in the study areas. The records of fisheries production of Kachin State for 2007-2008 (March) to 2008-2009 (August) are shown in Table (6.3.3) to (6.3.16).

Table 6.3.1. Distribution of fish species in EIA survey areas of Kachin State.

Family		Genus		Species		Author	Common Name	Local Name	Localities			IUCN status
Sr.		Sr.		Sr.					I	II	III	
I	**Ambassidae**	1	*Chanda*	1	*nama*	Hamilton, 1822	Elongate Glass-Perchlet	Nga zin zat	*			NE
		2	*Parambassis*	2	*ranga*	Hamilton, 1822	Indian Glassy Fish	Nga zin zat	*			NE
II	**Anabantidae**	3	*Anabas*	3	*testudineus*	Bloch, 1792	Climbing	Nga bye ma	*			NE

							Perch					
III	**Anguillidae**	4	*Anguilla*	4	*bengalensis*	Gray, 1831	Indian Mottled Eel	Nga lin bun			*	NE
				5	*nebulosa*	McClelland, 1844	Mottled Eel	Nga mee toung/ Nga lin ban		*		NE
IV	**Badidae**	5	*Badis*	6	*ruber*	Schreitmuller, 1923	Nga Thein Net	Nga mee laung	*			NE
V	**Bagridae**	6	*Batasio*	7	*blythii*	Blyth, 1860			*			NE
		7	*Hemibagrus (Mystus)*	8	*microphthalmus*	Day, 1877	Irrawaddy Mystus	Nga aik/ Nga ngaik	*			NE
		8	*Mystus*	9	*carvasius*	Hamilton, 1822	Gangetic Mystus	Nga zin yine kywe	*			NE
				10	*pulcher*	Chaudhuri, 1911	Pulcher Mystus	Nga zin yine	*			NE
		9	*Sperata*	11	*acicularis*	Ferraris & Runge, 1999		Nga Gyaung	*			NE
VI	**Balitoridae**	10	*Acanthocobitis*	12	*botia*	Hamilton, 1822	Mottled Loach	Nga tha le doe	*			NE
				13	*rubidipinnis*	Blyth, 1860		Nga tha le doe	*			NE
VII	**Belonidae**	12	*Xenentodon*	15	*cancila*	Hamilton, 1822	Freshwater Garfish	Nga phaung yoe	*			NE
VIII	**Channidae**	13	*Channa*	16	*aurolineata*	Hamilton, 1822	Great Snakehead	Nga yant die	*			NE
				17	*harcourtbutleri*	Annandale, 1918	Burmese Snakehead	Nga yant	*			NE
				18	*punctata*	Bloch, 1793	Spotted Snakehead	Nga yant pa naw	*			NE
				19	sp.				*			
IX	**Clariidae**	14	*Clarias*	20	*batrachus*	Linnaeus, 1758	Walking Catfish/ Magor	Nga khu	*			NE
		17	*Syncrossus*	25	*berdmorei*	Blyth, 1860	Blyth's loach		*	*		NE
XI	**Cyprinidae**	18	*Amblypharyngodon*	26	*atkinsonii*	Blyth, 1860	Burmese Carplet	Nga byet	*			NE
		19	*Bangana*	27	*devdevi*	Hora, 1936	Labeo Devdevi	Kyauk nga lu	*	*	*	NE
		20	*Barilius*	28	*barila*	Hamilton, 1822	Barred Baril	Nga kyee gyun	*	*	*	NE
				29	*barnoides*	Vinciguerra, 1890			*	*		NE
		21	*Cabdio (Cyprinus)*	30	*morar*	Hamilton, 1822	Carplet	Yin baung zar	*		*	NE
		22	*Chagunius*	31	*baileyi*	Rainboth, 1986		Nga ga lone	*			NE
		23	*Crossocheilus*	32	*burmanicus*	Hora, 1936		Nga din lone	*	*		NE
		24	*Garra*	33	*lamta*	Hamilton, 1822	Lamta Garra	Nga kyauk kat	*	*	*	NE
				34	*nasuta*	McClelland, 1838	Khasi Garra	Nga kyauk kat		*	*	NE
				35	*notata*	Blyth, 1860	Tenasse rim Garra	Nga kyauk kat		*	*	NE
				36	*qiaojiensis*	Wu & Yao, 1977		Nga kyauk kat		*	*	NE
		25	*Labeo*	37	*angra*	Hamilton, 1822	Angra Labeo	Nga lu myi kwet	*		*	NE
				38	*boga*	Hamilton, 1822	Boga Labeo	Nga lone	*		*	NE
				39	*dyocheilus*	MaClelland, 1839		Kyauk nga lu	*		*	NE
				40	*gonius*	Hamilton, 1822	Kuria Labeo	Nga daine	*		*	NE
				41	*pierrei*	Sauvage, 1880					*	NE
				42	*yunnanensis*	Chaudhuri, 1911					*	NE
		26	*Mekongina*	43	*latius*	Hamilton, 1822			*			NE
		27	*Morulius*	44	*calbasu*	Hamilton, 1822	Orange fin Labeo	Nga net pyar/ Nga poke net	*			NE
				45	*chrysophekadion*	Bleeker, 1850	Black Sharkminnow		*			NE
		28	*Mystacoleucus*	46	*marginatus*	Valenciennes, 1842			*			NE

		29	*Neolissochilus*	47	*hexagonolepis*	McClelland, 1839	Copper Mahseer	Nga ni	*	*	*	NE
		30	*Osteobrama*	48	*belangeri*	Valenciennes, 1844	Manipur Osteobra ma	Nga phant ma	*		*	NE
				49	*feae*	Vinciguerra, 1890		Nga phant ma			*	NE
		31	*Puntius*	50	*chola*	Hamilton, 1822	Swamp Barb	Nga khone ma	*			NE
				51	*orphoides*	Valenciennes, 1842	Javaen Barb	Nga khone ma	*			NE
				52	*stoliczkaenus*	Day, 1971		Nga khone ma	*			NE
				53	sp.				*			NE
		32	*Raiamus*	54	*guttatus*	Day, 1970	Burmese Trout	Nga la war	*			NE
		33	*Rasbora*	55	*rasbora*	Hamilton, 1822	Gangetic Scissortail Rasbora	Nga daung zin / Nga lu bay sin	*			NE
		34	*Salmostoma*	56	*sardinella*	Valenciennes, 1844	Sardinella Razorbelly Minnow	Nga phyin dauk/ Yin baung zar	*			NE
		35	*Scaphiodonichthys*	57	sp./*burmanicus*	Vinciguerra, 1890			*			NE
		36	*Schizothorax* (*Schizothorax*)	58	*chongi*	Fang, 1936		Ye khe nga		*	*	NE
				59	*grahami*	Regan, 1904	Kunming Snout Trout	Ye khe nga		*	*	CR, {B 1ab(i,ii,iii,iv,v)+ 2ab(I,ii,iii,iv,v)}
				60	*meridionalis*	Tsao, 1964		Ye khe nga		*	*	NE
				61	*myzostomus*	Tsao, 1964		Ye khe nga		*	*	NE
				62	*richardsonii*	Gray, 1832	Snow Trout	Ye khe nga		*	*	NE
				63	*wangchiachii*	Fang, 1936		Ye khe nga		*		NE
		37	*Systomus*	64	*orphoides*	Valenciennes, 1842		Nga khone ma	*			NE
		38	*Tor*	65	*brevifilis*	Peters, 1881		Nga dauk	*	*	*	NE
				66	*putitora*	Hamilton, 1822	Golden Mahseer	Nga dauk	*	*	*	NE
				67	*qiaojiensis*	Wu, 1977		Nga dauk	*	*	*	NE
				68	*tor*	Hamilton, 1822	Tor Mahseer	Nga dauk	*	*	*	NE
XII	**Gobiidae**	39	*Glossogobius*	69	*giuris*	Hamilton, 1822	Bar Eyed Goby/Tank Goby	Ka tha boe	*			NE
XIII	**Heteropneustidae**	40	*Heteropneustes*	70	*fossilis*	Bloch, 1794	Scorpion Fish/ Stinging Catfish	Nga gyee	*			NE
XIV	**Mastacembelidae**	41	*Macrognathus*	71	*aral*	Bloch & Schneider , 1801	One-stripe Spiny Eel	Nga la mwae	*			DD
		42	*Mastacembelus*	72	*armatus*	Lacepede, 1800	Zig-zag Eel	Nga la mwae	*			NE
				73	*manipurensis*	Hora, 1921			*			
				74	*unicolor*	Cuvier, 1832			*			NE
XV	**Notopteridae**	43	*Notopterus*	75	*notopterus*	Pallas, 1769	Bronze Feather-back	Nga phe	*			NE
XVI	**Osphronemidae**	44	*Colisa*	76	*labiosa*	Day, 1877	Thick lipped Gourami	Nga phyin tha let	*			NE
XVII	**Pangasiidae**	45	*Pangasius*	77	*pangasius*	Hamilton, 1822	Yellow-tail Catfish	Nga dan	*			NE
XVIII	**Pristigasteridae**	46	*Ilisha*	78	*megaloptera*	Swainson, 1839	Bigeye Ilisha				*	NE
XIX	**Schilbeidae**	47	*Clupisoma*	79	*prateri*	Hora, 1937	Burmese Garua	Nga myin oak phar			*	NE
				80	sp.						*	NE
		48	*Eutropiichthys*	81	*vacha*	Hamilton, 1822	Batchwa vacha/ River Catfish	Nga myin kun ban	*		*	NE
		49	*Silonia*	82	*silondia*	Hamilton, 1822	Silond Catfish	NgaMyin/ Nga myin yin	*			NE
XX	**Siluridae**	50	*Ompok*	83	*pabo*	Hamilton, 1822	Pabo Catfish	Nga nu than	*			NE

				84	sp. /*bimaculatus*	Bloch, 1794	Butter Catfish	Nga nu than	*			NE
		51	*Wallago*	85	*attu*	Bloch & Schneider , 1801	Wallago/ Boal/ Freshwater Shark	Nga but	*			NE
XXI	**Sisoridae**	52	*Bagarius*	86	*bagarius*	Hamilton, 1822	Dwarf Goonch	Nga maung ma	*			NE
				87	*yarrelli*	Sykes, 1839	Goonch	Nga maung ma	*			NE
		53	*Gagata*	88	*gasawyuh*	Roberts & Ferraris, 1998		Nga nan kyaung	*			NE
		54	*Glyptothorax*	89	*cavia*	Hamilton, 1822	Cat fish	Nga maung ma	*	*		NE
				90	*dorsalis*	Vinciguerra, 1890		Nga maung ma		*		NE
				91	*longicauda*	Li, 1984				*		NE
				92	*minimaculatus*	Li, 1984			*	*		NE
				93	*trilineatus*	Blyth, 1860	Three-lined Catfish	Nga maung ma				NE
				94	sp.					*	*	NE
		55	*Pseudecheneis*	95	*sulcata*	McClelland, 1842	Sucker Throat Catfish	Lay yin pyan nga		*		NE
		56	*Pseudexostoma*	96	*yunanensis*	Tchang, 1935				*		NE
Total									72	30	31	

Index:

I	Ayeyarwaddy River	CR	Critically Endangered
II	May Hka River	DD	Data Deficient
III	Mali Hka River		

Table 6.3.2. Length-weight relationship of economically important fish species.

Sr.	**species**	**Standard length (mm)**	**Total weight (g)**
1	*Neolissochilus hexagonolepis*	100～550	12.7～4000
2	*Bangana devdevi*	180～405	104～1284
3	*Schizothorax meridionalis*	72～218	5.5～158.4
4	*Labeo boga*	160～283	103～452
5	*Tor putitora*	58～320	5～525
6	*Eutripiichthys vacha*	210～315	94.3～293.4
7	*Pangasius pangasius*	215～263	120～250

Table 6.3.3. Production of Fish from the Kachin State (2007-2008/ June).

Sr.	**District** **Township**	**2007-2008**			
		Aquaculture	**Inn**	**Open**	**Total**
A	**Myitkyina District**	**147.8**	**-**	**-**	**147.8**
1.	Myitkyina	53.5	-	-	53.5

2.	Waing-maw	88.0	-	-	88.0
3.	Tanaing	6.3	-	-	6.3
4.	Chibwe	-	-	-	-
5.	Sawt-law	-	-	-	-
6.	Injaryan	-	-	-	-
7.	Sin-Bo	-	-	-	-
B.	**Moe-Nyin District**	**97.0**	**-**	**-**	**97.0**
1.	Moe-Nyin	40.0	-	-	40.0
2.	Moe-Kaung	48.0	-	-	48.0
4.	Phar-Kant	9.0	-	-	9.0
C.	**Bamaw District**	**182.5**	**-**	**-**	**182.5**
1.	Bamaw	71.0	-	-	71.0
2.	Shwe-Ku	20.0	-	-	20.0
3.	Moe-Mauk	84.0	-	-	84.0
4.	Man-Si	7.5	-	-	7.5
D.	**Putao Distirct**	**-**	**-**	**-**	**-**
1.	Putao	-	-	-	-
2.	Machanbaw	-	-	-	-
3.	Sumpraboom	-	-	-	-
4.	Khaung-lan-phu	-	-	-	-
5.	Naung-Moon	-	-	-	-
	Total	**427.3**	**-**	**-**	**427.3**

Table 6.3.4. Production of Fish from the Kachin State (2007-2008/ July).

Sr.	**District / Township**	**2007-2008**			
		Aquaculture	**Inn**	**Open**	**Total**
A	**Myitkyina District**	**165.0**	**73.0**	**71.98**	**309.98**
1.	Myitkyina	59.0	11.0	2.03	72.03

2.	Waing-maw	99.0	13.0	2.45	114.45
3.	Tanaing	7.0	34.0	58.0	99.0
4.	Chibwe	-	-	0.34	0.34
5.	Sawt-law	-	-	-	-
6.	Injaryan	-	-	0.16	0.16
7.	Sin-Bo	-	15.0	9.0	24.0
B.	**Moe-Nyin District**	**107.4**	**71.0**	**370.0**	**548.4**
1.	Moe-Nyin	44.5	16.0	350.0	410.5
2.	Moe-Kaung	53.0	28.0	11.0	92.0
4.	Phar-Kant	9.9	27.0	9.0	45.9
C.	**Bamaw District**	**202.7**	**351.0**	**208.0**	**761.7**
1.	Bamaw	78.5	130.0	60.0	268.5
2.	Shwe-Ku	22.0	210.0	135.0	367.0
3.	Moe-Mauk	94.0	11.0	8.0	113.0
4.	Man-Si	8.2	-	5.0	13.2
D.	**Putao Disitrct**	**-**	**-**	**7.5**	**7.5**
1.	Putao	-	-	5.0	5.0
2.	Machanbaw	-	-	1.65	1.65
3.	Sumpraboom	-	-	0.35	0.35
4.	Khaung-lan-phu	-	-	0.33	0.33
5.	Naung-Moon	-	-	0.17	0,17
	Total	**475.1**	**495.0**	**657.48**	**1627.58**

Table 6.3.5. Production of Fish from the Kachin State (2007-2008/September).

Sr.	**District / Township**	**2007-2008**			
		Aquaculture	**Inn**	**Open**	**Total**
A	**Myitkyina District**	**198.7**	**227.0**	**240.0**	**665.7**
1.	Myitkyina	70.5	34.0	7.13	111.63

2.	Waing-maw	119.5	40.0	7.97	167.47
3.	Tanaing	8.7	105.0	194.2	307.9
4.	Chibwe	-	-	1.11	1.11
5.	Sawt-law	-	-	-	-
6.	Injaryan	-	-	0.52	0.52
7.	Sin-Bo	-	48.0	29.07	77.07
B.	**Moe-Nyin District**	**133.0**	**229.0**	**1247.9**	**1609.9**
1.	Moe-Nyin	55.0	60.0	1180.64	1295.64
2.	Moe-Kaung	66.0	88.0	36.25	190.25
4.	Phar-Kant	12.0	81.0	31.01	124.0
C.	**Bamaw District**	**244.5**	**1101.0**	**722.1**	**2067.6**
1.	Bamaw	94.0	405.0	209.46	708.46
2.	Shwe-Ku	26.5	660.0	467.05	1153.55
3.	Moe-Mauk	114.0	36.0	29.06	179.06
4.	Man-Si	10.0	-	16.53	26.53
D.	**Putao Disitrct**	**-**	**-**	**24.0**	**24.0**
1.	Putao	-	-	15.8	15.8
2.	Machanbaw	-	-	5.3	5.3
3.	Sumpraboom	-	-	1.0	1.0
4.	Khaung-lan-phu	-	-	1.01	1.01
5.	Naung-Moon	-	-	0.89	0.89
	Total	**576.2**	**1557.0**	**2234.0**	**4367.2**

Table 6.3.6. Production of Fish from the Kachin State (2007-2008/ October).

Sr.	**District** / **Township**	**2007-2008**			
		Aquaculture	**Inn**	**Open**	**Total**
A	**Myitkyina District**	**233.2**	**382.0**	**320.89**	**936.09**
1.	Myitkyina	81.5	56.0	9.63	147.13

2.	Waing-maw	141.5	69.0	10.47	220.97
3.	Tanaing	10.2	178.0	260.57	448.77
4.	Chibwe	-	-	1.46	1.46
5.	Sawt-law	-	-	-	-
6.	Injaryan	-	-	0.69	0.69
7.	Sin-Bo	-	79.0	38.07	117.07
B.	**Moe-Nyin District**	**153.8**	**335.0**	**1668.0**	**2156.8**
1.	Moe-Nyin	64.0	88.0	1580.64	1732.64
2.	Moe-Kaung	76.0	130.0	46.35	252.35
4.	Phar-Kant	13.8	117.0	41.01	171.81
C.	**Bamaw District**	**284.55**	**1599.0**	**955.5**	**2839.05**
1.	Bamaw	110.0	600.0	279.46	989.46
2.	Shwe-Ku	31.0	950.0	615.45	1596.45
3.	Moe-Mauk	132.0	49.0	39.06	220.06
4.	Man-Si	11.55	-	21.53	33.08
D.	**Putao Disitrct**	**-**	**-**	**35.5**	**35.5**
1.	Putao	-	-	22.8	22.8
2.	Machanbaw	-	-	7.8	7.8
3.	Sumpraboom	-	-	1.53	1.53
4.	Khaung-lan-phu	-	-	1.54	1.54
5.	Naung-Moon	-	-	1.83	1.83
	Total	**671.35**	**2316.0**	**2979.89**	**5967.44**

Table 6.3.7. Roduction of Fish from the Kachin State (2007-2008/ November).

Sr.	**District** / **Township**	**2007-2008**			
		Aquaculture	**Inn**	**Open**	**Total**
A	**Myitkyina District**	**269.7**	**542.0**	**683.39**	**1495.09**
1.	Myitkyina	93.5	80.0	42.36	215.86

2.	Waing-maw	164.5	99.0	114.67	378.17
3.	Tanaing	11.7	252.0	409.47	673.17
4.	Chibwe	-	-	7.98	7.98
5.	Sawt-law	-	-	4.98	4.98
6.	Injaryan	-	-	4.63	4.63
7.	Sin-Bo	-	111.0	99.3	210.3
B.	**Moe-Nyin District**	**176.0**	**448.0**	**2753.23**	**3377.23**
1.	Moe-Nyin	73.5	118.0	2386.53	2578.03
2.	Moe-Kaung	87.0	175.0	218.23	480.23
4.	Phar-Kant	15.5	155.0	148.47	318.97
C.	**Bamaw District**	**326.65**	**2124.0**	**1530.19**	**3980.84**
1.	Bamaw	126.0	800.0	434.28	1360.28
2.	Shwe-Ku	35.5	1260.0	877.49	2172.99
3.	Moe-Mauk	152.0	64.0	124.73	340.73
4.	Man-Si	13.15	-	93.69	106.84
D.	**Putao Distirct**	**-**	**-**	**117.14**	**117.14**
1.	Putao	-	-	79.09	79.09
2.	Machanbaw	-	-	22.46	22.46
3.	Sumpraboom	-	-	3.73	3.73
4.	Khaung-lan-phu	-	-	5.07	5.07
5.	Naung-Moon	-	-	6.79	6.79
	Total	**772.35**	**3114.0**	**5083.95**	**8970.3**

Table 6.3.8. Production of Fish from the Kachin State (2007-2008/ December).

Sr.	**District** **Township**	**2007-2008**			
		Aquaculture	**Inn**	**Open**	**Total**
A	**Myitkyina District**	**306.36**	**706.00**	**788.14**	**1800.50**
1.	Myitkyina	105.5	105.00	45.86	256.36

2.	Waing-maw	187.5	129.00	118.67	435.17
3.	Tanaing	13.36	327.00	491.47	831.83
4.	Chibwe	-	-	8.98	8.98
5.	Sawt-law	-	-	4.98	4.98
6.	Injaryan	-	-	4.88	4.88
7.	Sin-Bo	-	145.00	113.30	258.30
B.	**Moe-Nyin District**	**201.00**	**562.00**	**3299.23**	**4062.23**
1.	Moe-Nyin	83.00	148.00	2906.53	3137.53
2.	Moe-Kaung	100.00	220.00	231.23	551.23
4.	Phar-Kant	18.00	194.00	161.47	373.47
C.	**Bamaw District**	**372.00**	**2666.00**	**1860.19**	**4898.19**
1.	Bamaw	144.00	1010.00	544.28	1698.28
2.	Shwe-Ku	41.00	1575.00	1077.49	2693.49
3.	Moe-Mauk	172.00	81.00	136.73	389.73
4.	Man-Si	15.00	-	101.69	116.69
D.	**Putao Distirct**	**3.90**	**-**	**129.64**	**133.54**
1.	Putao	3.90	-	86.59	90.49
2.	Machanbaw	-	-	25.46	25.46
3.	Sumpraboom	-	-	4.73	4.73
4.	Khaung-lan-phu	-	-	5.57	5.57
5.	Naung-Moon	-	-	7.29	7.29
	Total	**883.26**	**3934.00**	**6077.20**	**10894.46**

Table 6.3.9. Production of Fish from the Kachin State (2007-2008/ January).

Sr.	**District** / **Township**	**2007-2008**			
		Aquaculture	**Inn**	**Open**	**Total**
A	**Myitkyina District**	**333.61**	**767.50**	**884.61**	**1985.72**
1.	Myitkyina	115.50	115.00	48.91	279.41

2.	Waing-maw	203.50	139.50	122.31	465.31
3.	Tanaing	14.61	356.00	567.52	938.13
4.	Chibwe	-	-	9.48	9.48
5.	Sawt-law	-	-	4.98	4.98
6.	Injaryan	-	-	5.11	5.11
7.	Sin-Bo	-	157.00	126.30	283.30
B.	**Moe-Nyin District**	**218.80**	**614.00**	**3628.23**	**4461.03**
1.	Moe-Nyin	90.70	161.00	3206.53	3458.23
2.	Moe-Kaung	108.50	241.00	249.23	598.73
4.	Phar-Kant	19.60	212.00	172.47	404.07
C.	**Bamaw District**	**406.40**	**2912.00**	**2029.19**	**5347.59**
1.	Bamaw	157.50	1104.00	589.28	1850.78
2.	Shwe-Ku	44.70	1720.00	1182.49	2947.19
3.	Moe-Mauk	188.00	88.00	146.73	422.73
4.	Man-Si	16.20	-	110.69	126.89
D.	**Putao Distirct**	**4.6**	**-**	**140.64**	**145.24**
1.	Putao	4.6	-	93.59	98.19
2.	Machanbaw	-	-	27.96	27.96
3.	Sumpraboom	-	-	5.08	5.08
4.	Khaung-lan-phu	-	-	6.10	6.10
5.	Naung-Moon	-	-	7.91	7.91
	Total	**963.41**	**4293.70**	**6682.67**	**11939.58**

Table 6.3.10. Production of Fish from the Kachin State (2007-2008/ March).

Sr.	**District** / **Township**	**2007-2008**			
		Aquaculture	**Inn**	**Open**	**Total**
A	**Myitkyina District**	**381.0**	**870.0**	**1025.62**	**2277.42**
1.	Myitkyina	131.73	130.0	54.06	315.79

2.	Waing-maw	232.57	158.0	129.89	520.46
3.	Tanaing	16.70	405.55	677.34	1099.59
4.	Chibwe	-	-	10.10	10.10
5.	Sawt-law	-	-	4.98	4.98
6.	Injaryan	-	-	5.58	5.58
7.	Sin-Bo	-	177.25	143.67	320.92
B.	**Moe-Nyin District**	**250.29**	**700.37**	**4117.63**	**5068.29**
1.	Moe-Nyin	103.61	184.13	3640.07	3927.81
2.	Moe-Kaung	124.19	273.92	284.20	682.31
4.	Phar-Kant	22.49	242.32	193.36	458.17
C.	Bamaw District	463.88	3325.90	2308.98	6098.76
1.	Bamaw	179.97	1260.63	683.09	2123.69
2.	Shwe-Ku	51.03	1964.34	1335.70	3351.07
3.	Moe-Mauk	214.52	100.93	163.83	479.28
4.	Man-Si	18.36	-	126.36	144.72
D.	**Putao Distirct**	**4.85**	**-**	**160.29**	**165.14**
1.	Putao	4.85	-	107.50	112.35
2.	Machanbaw	-	-	31.91	31.91
3.	Sumpraboom	-	-	5.89	5.89
4.	Khaung-lan-phu	-	-	6.99	6.99
5.	Naung-Moon	-	-	8.00	8.00
	Total	**1100.02**	**4897.07**	**7612.52**	**13609.61**

Table 6.3.11. Production of Fish from the Kachin State (2008-2009/ June).

Sr.	**District Township**	**2008-2009**			
		Aquaculture	**Inn**	**Open**	**Total**
A	**Myitkyina District**	**194.3**	**-**	**-**	**194.3**
1.	Myitkyina	56.0	-	-	56.0

2.	Waing-maw	131.9	-	-	131.9
3.	Tanaing	6.4	-	-	6.4
4.	Chibwe	-	-	-	-
5.	Sawt-law	-	-	-	-
6.	Injaryan	-	-	-	-
7.	Sin-Bo	-	-	-	-
B.	**Moe-Nyin District**	**119.1**	**-**	**-**	**119.1**
1.	Moe-Nyin	53.25	-	-	53.25
2.	Moe-Kaung	53.5	-	-	53.5
4.	Phar-Kant	12.35	-	-	12.35
C.	**Bamaw District**	**207.92**	**-**	**-**	**207.92**
1.	Bamaw	95.6	-	-	95.6
2.	Shwe-Ku	27.82	-	-	27.82
3.	Moe-Mauk	74.0	-	-	74.0
4.	Man-Si	10.5	-	-	10.5
D.	**Putao Distirct**	**-**	**-**	**-**	**-**
1.	Putao	-	-	-	-
2.	Machanbaw	-	-	-	-
3.	Sumpraboom	-	-	-	-
4.	Khaung-lan-phu	-	-	-	-
5.	Naung-Moon	-	-	-	-
	Total	**521.32**	**-**	**-**	**521.32**

Table 6.3.12. Production of Fish from the Kachin State (2008-2009/ July).

Sr.	**District / Township**	**2008-2009**			
		Aquaculture	**Inn**	**Open**	**Total**
A	**Myitkyina District**	**220.3**	**96.0**	**73.9**	**390.2**
1.	Myitkyina	61.5	15.0	2.5	79.0

2.	Waing-maw	151.9	18.0	2.0	171.9
3.	Tanaing	6.9	45.0	65.0	116.9
4.	Chibwe	-	-	0.3	0.3
5.	Sawt-law	-	-	-	-
6.	Injaryan	-	-	0.1	0.1
7.	Sin-Bo	-	18.0	4.0	22.0
B.	**Moe-Nyin District**	**132.1**	**78.0**	**393.0**	**603.1**
1.	Moe-Nyin	59.75	18.0	370.0	447.75
2.	Moe-Kaung	59.5	30.0	13.0	102.5
4.	Phar-Kant	12.85	30.0	10.0	52.85
C.	**Bamaw District**	**231.42**	**412.0**	**302.0**	**945.42**
1.	Bamaw	103.6	150.0	85.0	338.6
2.	Shwe-Ku	30.82	250.0	195.0	475.82
3.	Moe-Mauk	86.0	12.0	16.0	114.0
4.	Man-Si	11.0	-	6.0	17.0
			-		
D.	**Putao Disitrct**	**-**	**-**	**8.5**	**8.5**
1.	Putao	-	-	6.0	6.0
2.	Machanbaw	-	-	1.95	1.95
3.	Sumpraboom	-	-	0.3	0.3
4.	Khaung-lan-phu	-	-	0.1	0.1
5.	Naung-Moon	-	-	0.15	0.15
	Total	**583.82**	**586.0**	**777.4**	**1947.22**

Table 6.3.13. Production of Fish from the Kachin State (2008-2009/ August).

Sr.	**District** / **Township**	**2008-2009**			
		Aquaculture	**Inn**	**Open**	**Total**
A	**Myitkyina District**	**246.3**	**194.0**	**153.1**	**593.4**
1.	Myitkyina	67.0	30.0	5.0	102.0

2.	Waing-maw	171.9	36.0	4.3	212.2
3.	Tanaing	7.4	90.0	135.0	232.4
4.	Chibwe	-	-	0.6	0.6
5.	Sawt-law	-	-	-	-
6.	Injaryan	-	-	0.2	0.2
7.	Sin-Bo	-	38.0	8.0	46.0
B.	**Moe-Nyin District**	**145.1**	**160.0**	**793.0**	**1098.1**
1.	Moe-Nyin	66.25	40.0	740.0	846.25
2.	Moe-Kaung	65.5	62.0	28.0	155.5
4.	Phar-Kant	13.35	58.0	25.0	96.35
C.	**Bamaw District**	**254.92**	**851.0**	**621.5**	**1727.42**
1.	Bamaw	111.6	305.0	170.0	586.6
2.	Shwe-Ku	33.82	520.0	405.0	958.82
3.	Moe-Mauk	98.0	26.0	34.0	158.0
4.	Man-Si	11.5	-	12.5	24.0
D.	**Putao Disitrct**	**-**	**-**	**18.26**	**18.26**
1.	Putao	-	-	12.0	12.0
2.	Machanbaw	-	-	3.9	3.9
3.	Sumpraboom	-	-	0.65	0.65
4.	Khaung-lan-phu	-	-	0.82	0.82
5.	Naung-Moon	-	-	0.89	0.89
	Total	**646.32**	**1205.0**	**1585.86**	**3437.18**

Table 6.3.14. Production of Fish from the Kachin State (2008-2009/ December).

Sr.	**District / Township**	**2008-2009**			
		Aquaculture	**Inn**	**Open**	**Total**
A	**Myitkyina District**	**350.48**	**844.87**	**896.68**	**2029.03**
1.	Myitkyina	88.40	136.08	46.40	270.88

2.	Waing-maw	252.00	145.15	119.05	516.20
3.	Tanaing	10.08	397.32	627.61	1035.01
4.	Chibwe	-	-	9.24	9.24
5.	Sawt-law	-	-	5.77	5.77
6.	Injaryan	-	-	4.62	4.62
7.	Sin-Bo	-	166.32	83.99	250.31
B.	**Moe-Nyin District**	**225.86**	**617.71**	**3478.41**	**4321.98**
1.	Moe-Nyin	94.70	155.92	3024.45	3275.07
2.	Moe-Kaung	111.84	244.27	252.18	608.29
4.	Phar-Kant	19.32	217.52	201.78	438.62
C.	**Bamaw District**	**435.17**	**3062.74**	**2522.09**	**6020.00**
1.	Bamaw	168.06	1160.00	721.46	2049.52
2.	Shwe-Ku	51.18	1812.62	1500.32	3364.12
3.	Moe-Mauk	199.30	90.12	190.17	479.59
4.	Man-Si	16.63	-	110.14	126.5
D.	**Putao Disitrct**	**5.00**	**-**	**139.21**	**144.21**
1.	Putao	5.00	-	93.75	98.75
2.	Machanbaw	-	-	27.81	27.81
3.	Sumpraboom	-	-	5.14	5.14
4.	Khaung-lan-phu	-	-	5.54	5.54
5.	Naung-Moon	-	-	6.97	6.97
	Total	**1016.51**	**4525.32**	**7036.39**	**12578.22**

Table 6.3.15. Production of Fish from the Kachin State (2008-2009/ January).

Sr.	**District / Township**	**2008-2009**			
		Aquaculture	**Inn**	**Open**	**Total**
A	**Myitkyina District**	**382.37**	**907.57**	**974.37**	**2264.31**
1.	Myitkyina	96.40	146.60	49.77	292.77

2.	Waing-maw	275.00	157.15	129.05	561.20
3.	Tanaing	10.97	427.32	685.13	1123.42
4.	Chibwe	-	-	9.97	9.97
5.	Sawt-law	-	-	5.77	5.77
6.	Injaryan	-	-	4.94	4.94
7.	Sin-Bo	-	176.50	89.74	266.24
B.	**Moe-Nyin District**	**245.28**	**659.53**	**3783.33**	**4688.14**
1.	Moe-Nyin	102.50	166.16	3291.54	3560.20
2.	Moe-Kaung	121.84	260.07	272.18	654.09
4.	Phar-Kant	20.94	233.30	219.61	473.85
C.	**Bamaw District**	**469.78**	**3308.74**	**2708.01**	**6486.53**
1.	Bamaw	179.58	1260.00	781.73	2221.31
2.	Shwe-Ku	55.78	1951.62	1600.32	3607.72
3.	Moe-Mauk	216.67	97.12	205.82	519.61
4.	Man-Si	17.75	-	120.14	137.89
D.	**Putao Distirct**	**5.79**	**-**	**150.25**	**156.04**
1.	Putao	5.79	-	100.91	106.70
2.	Machanbaw	-	-	30.02	30.02
3.	Sumpraboom	-	-	5.64	5.64-
4.	Khaung-lan-phu	-	-	6.06	6.06
5.	Naung-Moon	-	-	7.62	7.62
	Total	**1103.22**	**4875.84**	**7615.96**	**13595.02**

Table 6.3.16. Production of Fish from the Kachin State (2008-2009/ February).

Sr.	**District** **Township**	**2008-2009**			
		Aquaculture	**Inn**	**Open**	**Total**
A	**Myitkyina District**	**416.20**	**1003.29**	**1063.51**	**2483.00**
1.	Myitkyina	104.98	161.60	54.77	321.15

2.	Waing-maw	299.25	172.37	141.65	613.27
3.	Tanaing	11.97	471.82	745.13	1228.92
4.	Chibwe	-	-	10.97	10.97
5.	Sawt-law	-	-	5.77	5.77
6.	Injaryan	-	-	5.48	5.48
7.	Sin-Bo	-	197.50	99.74	297.24
B.	**Moe-Nyin District**	**268.25**	**733.53**	**4130.61**	**5132.39**
1.	Moe-Nyin	112.50	185.16	3591.54	3889.20
2.	Moe-Kaung	132.81	290.07	299.46	722.34
4.	Phar-Kant	22.94	258.30	239.61	520.85
C.	**Bamaw District**	**516.78**	**3637.00**	**2994.97**	**7148.75**
1.	Bamaw	199.58	1377.50	856.73	2433.81
2.	Shwe-Ku	60.78	2152.48	1781.64	3994.90
3.	Moe-Mauk	236.67	107.02	225.82	569.51
4.	Man-Si	19.75	-	130.78	150.53
D.	**Putao Distirct**	**6.09**	**-**	**164.92**	**171.01**
1.	Putao	6.09	-	110.91	117.00
2.	Machanbaw	-	-	33.02	33.02
3.	Sumpraboom	-	-	6.14	6.14
4.	Khaung-lan-phu	-	-	6.58	6.58
5.	Naung-Moon	-	-	8.27	8.27
	Total	**1207.32**	**5373.82**	**8354.01**	**14935.15**

7. DISCUSSIONS

7.1. Water quality

The riverine ecosystem of study areas is typical lotic ecosystem. The controlling factors of lotic ecosystem are weather, soil characteristics, vegetation and land use of riparian area of the rivers. These will affect the ecological parameters of temperature, flow rate, water depth, water transparency, light penetration, chemical composition, pH and dissolved oxygen concentration in the water. These are important parameters of water quality for the aquatic organisms. Any changes of these parameters will lead to create new species composition and distribution of aquatic organisms in specific area. According to the studies, most of the parameters of water quality are still in good conditions, except the high turbidity of water in Mali Hka River and Ngawchang Hka Tributary.

According to the records along Myitsone Dam environment, temperature of May Hka River is distinctly lower than Mali Hka and Ayeyarwaddy Rivers. In May Hka, the temperature of Yenam Dam environment is the lowest and gradually increases to Myitsone confluence. This is dependent on the source of the rivers and environmental conditions. The sources of the rivers are originated from snow capped mountains of northern Myanmar. In the low flow season, the source of water comes especially from melting of snow and ice of the mountains. In the high flow season, the water comes especially from the rain. Water can be heated or cooled through radiation on the surface and conduction to or from the air and surrounding environment. The amount of shading caused by the valley shaped mountains, climate of the region and elevation of the surveyed areas influence temperature distribution.

Most lotic species are poikilotherms whose internal temperature varies with their environment. Therefore temperature is a key abiotic factor for them. Species composition and distribution will differ between the rivers because of temperature difference. Cold water species are common in May Hka than Mali Hka River because of low water temperature in May Hka.

After damming, the water temperature in the reservoir will rise and become thermally stratified. This will depend on the water retention time, the depth of the reservoir and lack of circulation between water layers. The reservoir will undergo eutrophication because of favourable conditions such as warm temperature, good light intensity and higher nutrient concentration for blooming of phototrophic organisms.

Fast moving turbulent water is the typical feature of surveyed areas and contains greater concentration of dissolved oxygen, which supports greater biodiversity than the slow moving or stagnant water. Running water dissolves more oxygen than still water especially in a reservoir behind a dam. Oxygen is limited in the specific environment where circulation between the surface and deeper layers is poor, the activity of animals is very high and there is a large amount of the occurrence of organic decay. The amount of dissolved oxygen in the water is frequently the key substance in determining the extents and kinds of organic life in the water body. Fish and aquatic organisms need dissolved oxygen to survive and conversely, it is fatal to many kinds of anaerobic pathogenic bacteria. Dissolved oxygen concentration of the surveyed areas is nearly saturated and this condition is favourable to aquatic organisms in those areas. After damming, dissolved oxygen concentration in the reservoir will be changed very distinctly from the preimpoundment condition. Dissolved oxygen concentration within water layers will also differ because of low circulation in the water columns. Some aquatic organisms those which can not adapt to the new environment will disappear and resistant species will survive continuously.

Some fish species are favourable to the fast flowing water and gravel bottom for spawning. Running water is important for fertilization and completion of larval stages for these species. The change in flow rate and submergence of the spawning grounds will severely affect those species.

Water flow is the key factor in lotic ecosystems. The velocity of water flow varies along the river. It is typically based on variability of friction within the bottom or sides of the river and incline gradient. In addition, the amount of water input into the system from direct precipitation or rainfall affect flow rate. Flowing waters can alter the shape of the bank and river bottom through erosion and deposition, creating a variety of habitats along the river. The flow rate in May Hka River is the highest and several rapids were observed along the river. V-shaped to U-shaped rocky banks are dominant along May Hka River because of the fast flowing water. The banks on Mali Hka River around Lasa dam environment are not steep compared to May Hka River. Because of low flow speed along Ayeyarwaddy River, bank width is wider and gradient is gradual especially downstream of Myitsone Dam site.

The inorganic substrate of lotic systems is composed of material present in the catchment that is eroded, transported, and deposited by the current. Inorganic substrates are classified by size on the Wentworth scale, which ranges from boulders, to pebbles, to gravel, to sand, and to silt (Giller and Malmqvist, 1998). Typically, particle size of larger boulders and stones in more mountainous areas decrease downstream to sandy bottoms in lowland rivers. This is because the higher gradients of mountain streams create a faster flow, moving smaller substrate materials further downstream for deposition. Various substrate types such as rocky, gravel, pebble to sandy are composed of fine particles, leaves, submerged wood and plants of river banks and beds were observed along the rivers. Rocky and gravel banks and beds are more common in May Hka and Mali Hka rivers than Ayeyarwaddy River. Sandy bottom and banks can be found downstream of Myitsone confluence.

Light penetration or water transparency is also important to aquatic ecosystem, because it provides the energy necessary to drive primary production via photosynthesis, and can also provide refuge for prey species in shadows. The amount of light that a system receives can be related to a combination of internal and external river variables. Most of the surveyed areas along May Hka are covered with valley walls and light might be shaded by those walls. In Mali Hka River, light penetration will be reduced caused by turbid water coloration. Because of various forms of gold mining along Mayli Hka and Myitsone dam area, colour of water is turbid caused by high concentration of suspended silt in the water. These are limitating factors for light penetration into the water. The composition and distribution of phototrophic organisms depend on light penetration into the water. After damming, the deposition of sediments carried along the river and the higher water transparency will cause for bloomimg of phototrophic organisms in addition with other conditions.

According to the study, pH values are lower in May Hka and Mali Hka rivers compared to downstream of Ayeyarwaddy River. In May Hka, pH value from Pisa is the lowest and less than 7 in some sampling sites. This may be caused by the discharge into the river from the forests of the catchment areas along the rivers. The conditions of riparian forests along the downstream of Kaunglanghpu Dam to the upstream of Chibwe Dam are better than the other areas.

Electrical conductivity is the measurement of the ability of water to conduct an electric current. The greater the content of ions in the water, the more current can carry and the higher the value. This is used to estimate the total ion concentration of the water and is often used as an alternative measure of dissolved solids. Higher values of electrical conductivity in some tributaries depend on the ion concentration of the source or catchment areas. The higher concentration of electrical conductivity in Lasa Dam area may be caused by the high turbidity and high concentration of certain ions in the water from gold mining.

Various concentrations of nutrients along the river are depending on the different environmental conditions along the rivers. Water chemistry varies tremendously along the river. The chemical composition is determined by inputs from the geology of its watershed, or catchment area, but can also be influenced by precipitation and addition of human sources pollution. Large differences in water chemistry do not usually exist within small lotic systems, however, the concentrations of most nutrients, dissolved salts, and pH decrease as distance increases from the river's source. Upper reaches of the surveyed areas are not affected as much as the original riverine conditions because of low population and no industry along the river. Agriculture is not developed and there is no chemical pollution caused by agricultural run off. Riverine water quality of Mali Hka is worse compared to May Hka and downstream of Myitsone Dam areas because of gold mining processes. During the dam construction period, these will be reduced because of rising water level along the river. After completion of the dams, these may be totally submerged under the water and water quality will become better than the previous conditions.

The other problem of gold mining is mercury usage in gold purification process. A lot of mercury used in gold processing is disposed into the river water every day. Mercury is a very dangerous chemical for every kind of organisms including human beings. Mercury deposite on the river bed will severely affect bottom feeders such as *Schizothorax* spp., *Tor* spp. and *Neolissochileus* spp. Autotrophic organisms such as algae absorb every kind of chemical constituents from the surrounding medium for their photosynthesis process. At the same time, mercury will be absorbed into their cell body. The bottom feeders that feed on the algae will be severely affected by mercury poison. These fishes are not suitable for human consumption. Therefore, dam construction is good for environmental degredation caused by mercury poisoning of gold mining. Systematic gold mining technology has to be introduced into the region for reducing mercury and any kinds of chemical poisoning to the environment.

Turbidity of water in Ngawchang Hka Tributary is caused by the effluent of factory in the upstream of the tributary. This problem has to be considered seriously for Chibwe Dam area. The suspended silts in the water will deposit in Chibwe Dam and in the long term process this will cause a serious problem not only to the aquatic organisms but also to the people in this region. Negotiations to maintain water quality in Chibwe Dam is urgently required with the factory personnels before the dam construction.

Submergence of some plants in the riparian region along the dams and leaves falling into the dams will cause the change of chemical composition in the storage dams initially and then releasing of hydrogen sulphide and ammonia in the long term will lead to unfavourable water quality condition to the aquatic organisms in the dams. The chemical composition and concentration of nutrients will be higher than preimpoundment condition because of sedimentation along the barriers. Because of the higher concentration of nutrients and other preferable factors, aquatic phototrophic organisms will bloom rapidly. This blooming will lead to eutrophication in the dams. In the eutrophication, diurnal variation of pH and oxygen will be higher and this is an unfavourable condition for the aquatic organisms. All water parameter changes before and after dam construction will result in the changes of aquatic organisms including fish species composition and distribution in the study areas.

The ecosystem after damming will change from lotic to lentic ecosystem. Water flow rate will be reduced, water volume will be increased and water layers will be stratified. Thermal stractification will occur in the water layers because of stagnant condition as there is not enough mixing process in water layers. Oxygen concentration will also drop especially in the deep water layer. pH will be higher than the preimpoundment condition because of phototrophic organisms blooming in the water. Diurnal variation of dissolved oxygen and pH will occur in the dams. All of these effect cumulatively to the aquatic organisms in the long term. These changing effects are very important for the aquatic ecosystem. All changes will lead to new ecosystem for the aquatic organism.

As the water uptake for turbines is usually in the hypolimnion, cold water will be discharged downstream during the operation of the power station. The hypolimnion may become cold and deoxygenated, and discharge of such water downstream may have negative impact on the aquatic fauna in the river below the dam. Downstream flow rate in the river will depend on the amount of the compensated discharge from the dam. Water volume is considerably reduced during the dry season. As a result, the downstream may change to pools alternating with dry stretches in summer season. Due to decreased water discharges, water temperature will rise in the daytime and decline sharply at night in the downstream of the dams.

Flood rhythm in the downstream and upstream will be changed very prominently after damming. Water quality will deteriorate after storage of water in the reservoir. Release of good quality water is required for maintaining well-functioning downstream aquatic habitats. Artificial destratification is one of the effective mitigation measures for maintaining a good quality of water in a reservoir which undergoes stratification. It requires a process to lift cooler bottom water to the surface of a stratified impoundment. This helps to mix water and to maintain uniform temperature and vertical distribution of dissolved oxygen. From the above facts, maintaining aquatic ecological conditions is extremely essential to maintain water quality after each dam constructions.

Saltwater intrusion is a big problem if the dams construct near the river mouth region. But there is not a severe problem of saltwater intrusion in the rivermouth region after dam construction in the origin of Ayeyarwaddy River. Ayeyarwaddy River is one of the longest rivers in the world and the length is about 2170 kilometers. Main branch river naming Chindwin River and many minor rivers join Ayeyarwaddy River until rivermouth region. The volume of flow waters from those joining rivers will compensate the reduce flow of water volume at the starting point of Ayeyarwaddy River. The other favourable condition for this problem is the dams will not be finished at the same time and the flow volume will not be blocked suddenly. This problem has to study in detail in the future especially in the low flow season.

Cold water from May Hka will be blocked by series of dams on May Hka River. Damming on Ayeyarwaddy River in the downstream of Myitsone confluence will block also the inflow of coldwater into Ayeyarwaddy River from May Hka River. This will be a problem for inflow water quality into Ayeyarwaddy River and successive problem is distribution of aquatic organisms in the upstream of Ayayarwaddy River. The distribution pattern of aquatic organisms especially fish species will be effected. Separate dams should be considered upstream of Myitsone confluence on May Hka and Mali Hka Rivers instead of Myitsone Dam for reducing this problem.

7.2 Aquatic organisms

The food base of streams within riparian forests is mostly derived from the trees, but wider streams and those that lack a canopy derive the majority of their food base from algae. In the aquatic food web, algae are the fundamental part of the system.

Algae, consisting of phytoplankton and periphyton, are the most significant sources of primary production in most streams and rivers. Phytoplankton floats freely in the water column and it is unable to maintain population in fast flowing streams. They can, however, develop sizable populations in slow moving rivers and backwaters. Periphytons are typically filamentous and tufted algae. They can attach themselves to objects to avoid being washed away by fast current. In places where flow rates are negligible or absent, periphyton may form a gelatinous, unanchored floating mat. Because of fast flowing water along surveyed areas, periphyton is more abundant than phytoplankton. But phytoplankton species composition is as high as periphyton species composition. This means good quality of water and no pollution in those areas. Surviving in unpolluted flow water can be beneficial to plants and algae because the current is usually well aerated and it provides a continuous supply of nutrients. Phytoplankton and periphyton composition and distribution are limited by flow, light intensity, water chemistry, substrate, and grazing pressure. These organisms exhibit limited adaptions to fast flow and are most successful in reduced currents such in Tarlawgyi on Ayayarwaddy River.

Species density and compostion of phytoplankton in Myitsone Dam area is the highest in Ayeyarwaddy River and the lowest in Mali Hka River. Warmer temperature and slow flow of Ayeyarwaddy River are favour to phytoplankton species richness in the water. Lowest species richness in Mali Hka River is caused by the high turbidity of water along the river and this is the controlling factor for phototrophic organisms blooming in the water. Phytoplankton species composition in May Hka River is lower compared to Ayeyarwaddy River but higher than Mali Hka River.

Highest periphyton species density in Ayeyarwaddy River and lowest in Mali Hka River is dependent on flow rate, light intensity and other environmental conditions of the rivers. Periphyton species richness is the highest in May Hka depending on the undamaged condition of the natural water beds.

Zooplankton species composition is the highest in downstream of Myitsone Dam and the lowest in May Hka River depending on the phytoplankton richness and environmental conditions. Because of the fast flow water along May Hka River, organisms that suspend in the water column such as zooplankton cannot maintain in high density.

The comparison of species composition of aquatic organisms between the rivers is the highest in May Hka River and the lowest in Mali Hka River. This means better quality of water of May Hka River than the other rivers. Benthos and periphyton from Mali Hka River is significantly lower than the other rivers. This means the worst condition of river bed condition in Mali Hka River caused by gold mining and decomposed chemical such as mercury. Low composition of wandering organisms in the water column such as phytoplankton and zooplankton in Mali Hka River means the nuisance condition of turbid water to the aquatic organisms.

More primitive plants, such as mosses attach themselves to solid objects. This typically occurs in colder headwaters where rocky substrate offers attachment sites. Mosses are common along May Hka River upstream of Pisa dam site. Algae and mosses are important to lotic systems as a source of energy for forming microhabitats that shelter other fauna from predators and also from the current, and as a food resource.

Dams alter flow, temperature, and sediment regime of lotic systems. Additionally, damming at multiple locations along the river will amplify the impact. Dams can cause enhanced clarity and reduced variability in stream flow, and these will lead to an increase in periphyton abundance. Invertebrates immediately below a dam can show reductions in species richness due to an overall reduction in habitat heterogeneity.

Insects are the dominant invertebrates in lotic systems. These species exhibit tremendous diversity and can be found occupying almost every available habitat, including the surfaces of stones, deep below the substratum, adrift in the current, and in the surface film. Insects have developed several strategies for living in the adverse flows of lotic systems. Some avoid high current areas, inhabiting in the substratum or the sheltered side of rocks. Like most of the primary producers, lotic invertebrates often rely heavily on the current to bring them food and oxygen. Invertebrates, especially insects, are important as both consumers and prey items in lotic system.

Benthos species composition from Phylum-Arthropoda is the highest in Tungpang Hka Tributary along May Hka River depending on the better environmental condition of riparian areas along the River. The other favourable factors of May Hka River environment for the aquatic organisms is good oxygen concentration and untouchable condition of the river banks along most parts of the river.

Due to the surveyed results, May Hka River environment is better than Mayli Hka and Ayeyarwaddy Rivers for the aquatic organisms. These conditions will be altered after damming and some species that can adapt to the new environment will survive continuously and some species will be lost.

Unidentified species of aquatic organisms is required to study into special level. Some species may be typical species of coldwater especially Hamalayan region. International study programme have to conduct for maintaining biodiversity of this region.

7.3. Fish

7.3.1. Fish in general

Fish are the best known inhabitants of lotic systems. The ability of fish species to live in flowing waters depends upon the swimming speed and the duration it can stay in the running water. This ability can vary greatly between species and is tied to the habitat in which it can survive. Continuous swimming expends a tremendous amount of energy and, therefore, fishes spend only short periods in full current. In fast flowing water, individuals remain close to the bottom or the banks, behind obstacles, and sheltered from the current and swim in the current only to feed or change locations. Some species have adapted to living only on the bottom, never venturing into the open water flow. These fishes are dorso-ventrally flattened species such as *Pseudexostoma* sp., to reduce flow resistance and often have eyes on top of their heads to observe what is happening above them. Some also have sensory barbels such as *To*r sp., *Schizothorax* sp. and *Neolissochilus* sp., positioned under the head to assist in the testing of subsratum.

Lacustrine conditions of the reservoir will differ from those of the continuously flowing river and this will also have an impact on the original fish fauna. Some species live in flow current do not like lacustrine conditions and can not survive well in the dams. Swar (1992) discussed that *Garra lamta, Glyptosternum, Coraglanis*, *Puntius* sp, *Glyptothorax pectinopterus, G. cavia*, *Psilorhynchus* and *Pseudecheneis* do not like lacustrine conditions. Carp minnow (*Barilius bendelensis*), stone loach (*Nemacheilus beavani*) and stone roller (*Garra gotyla*) find reservoir conditions favorable, and reservoir conditions are ideal for rapid colonization by hardy fish such as murrels and catfish (*Heteropneustes fossilis*). *Garra* spp., *Glyptothorax* spp. and *Pseudecheneis* spp. will get a problem after damming and these spp. have to find out new suitable habitats.

Shoreline erosion and rapid and intensive drawdown are other problems faced by fish as they affect spawning and egg incubation. Swar (2002) pointed out that soil erosion affects the river ecology, resulting in the loss of breeding and nursing grounds of the riverine fish species. Physical injury or blocking of gills from silt or other suspended material has also affected the river fish fauna. High suspended silt concentration in the water of Ngawchang Hka Tributary and Mali Hka River are not good for fish living in those rivers and also for the spawning beds in the rivers.

Some economically important species of family-cyprinidae such as *Schizothorax* spp. inhabit in flow water and prefer fast flow speed on the gravel bottom for spawning. This helps fertilization and completion of larval life span of those species. In stagnant water, the eggs will sink to the bottom and larvae cannot swim to the surface layer for the completion of larval life span. The larvae will die on the bottom and population of these species will climb down gradually after damming. Fish eggs those collected from Lasa Dam environment in April sampling have to study in detail in the future for specific species.

1 ovary matured *Schizothorax* species specimen collected from Wusok Dam area in April sampling will be related to higher temperature in that season. Spawning season of most fish species is related to higher water temperature and enough food availability. Recorded temperature from specimen collected site is about 15.3°C and this temperature is well enough for ovary maturation of cold water species. After dam construction, temperature changes will lead to changes of spawning area along the river.

Some fish species may disappear, others will adjust by changing froms stenophagous to euryphagous. Omnivorous or planktivorous fish may adapt to the reservoir conditions. Fish are affected indirectly when their food organisms are destroyed caused by any changes in their riverine ecosystem. Fish food organisms will be highly affected by reduced flow rates and new species that prefer slow current will invade into the areas. Fish species that prefer the speedy current will be affected directly by the changes in their food and habitat after damming. This leads to stunted growth because of change of food, diseases and parasite infestation from malnutrition and increased mortality.

The problem in this area is extensive plantation method of shifting cultivation along the riverine catchment areas. This will cause land sliding along the catchment areas. Petr (2003) pointed out that poor agricultural practices lead to soil erosion and an increase in water turbidity, with spawning beds of valuable cold water fish species such as *Tor* sp., *Schizothorax* sp. and trout silted over. Not only are the natural habitats damaged or destroyed, but hatcheries constructed along streams may be damaged and made inoperative by the increased flow rates from deforested catchments, and the associated increase in transport of sediments, including stones and boulders, in fast running streams.

A dam will fragment and isolate upstream fish from downstream and affect significantly on migratoty fish. Some migratory species may decline abruptly in reservoirs because of dam barriers. Migration is done to find suitable spawning and feeding grounds. A dam will obstruct the route of the long and mid-distance migratory fish. Upstream migrants will arrive at the dam site during the flow phase. Long distant migrants are most affected by a dam. These species will abandon the original pool and colonize deep pool regions downstream or upstream. Gubhaju (2002) discussed that short and mid-distance migratory fish *Schizothorax* and *Schizothoraichthys* move upstream in response to high turbidity, higher water temperature, and due to the scarcity of food during the rainy season in the lower reaches. Snow trout, once abundant in the Kulekhani River, became rare after the river was dammed. The same happened to mahseer after the impoundment of Phewa and Begnas lakes in Pokhara Valley. *Neolissocheilus hexagonolepis,* on the other hand, is a common fish in reservoir conditions (Swar, 1992). Populations of snow trouts are less affected, as they make a small-scale migration to tributaries to breed in clear and cool water during the monsoon and return to the main stream during the low flow period. Finally, dams fragment river systems, isolating previously continuous populations, and preventing the migrations of anadromous and catadromous species. Rai (2008) drew conclusion that migratory fish species are vulnerable during their life cycle due to river damming, and about 20% of the world's fresh water fishes are estimated near extinction or in urgent need of conservation. Therefore, to sustain biodiversity and fisheries in rivers requires sustainable management both of habitats and systems of exploitation.

One favourable condition for cold water mid-migrant species is open channels that remain along the dams such as Taron Wang Tributary in Yenam Dam, Ahkyang Ti

Tributary in Kaunglanhpu Dam, Mekh Rame Tributary in Pisa Dam, Maw (Ma) Kyaung Tributary in Wusok Dam, Ngawchang Hka Tributary in Chibwe Dam. Hkrang Hka and Shang Hka (Nam Tisang) Tributaries remain as open channels in Lasa Dam, Mali Hka. Those channels are important habitats for cold water species such as snow trouts. Maintaing the environmental conditions of those tributaries are extremely essential to maintain cold water species along the rivers. Maintaining these areas will help to reduce dam impact on cold water species after damming.

Lotic systems typically connect to each other, forming a path from spring, stream, river to ocean, and many fishes have life cycles that require stages in both fresh and seawater. *Anguilla* spp. are catadromous and are born and develop in the ocean and then move into freshwater as adults. *Anguilla* spp. will be lost in some parts such as upstreams of Mali Hka and May Hka Rivers because of dam barriers. *Anguilla bengalensis* and *Schizothorax richardsonii* have been also known to decline abruptly in reservoirs (Swar, 1992). But the whole population of *Anguilla* spp. will not disappear from Ayeyarwaddy River because they migrate from the river mouth to upstream along the river.

For the conservation of migratory fish, trapping and hauling is one kind of mitigation measures. It involves trapping of fish below the dam and transporting them to the reservoir or further upstream to maintain fish diversity and gene pool. But it is labor intensive and stressful to fish which increases their mortality. It also needs an appropriate location and facilities have to be designed at the earliest possible stage. But this is one of the effective mitigation measures for conservation of the migratory fish.

Maintenance of flow level is one of the important factors to maintain the situation of downstream fisheries situation. There may be decrease water depth in the downstream during the dry season due to the flow diversion and damming of the river. The effect is local and can be overcome to some extent by releasing compensation flow downstream. Compensation flow for the conservation of microflora, aquatic insects and fish in the downstream zone do need maintaining of downstream population. Regular releases of flushing flows will maintain quality of downstream spawning gravel bottoms from fine sediments covering.

Bottom feeders such as *Schizothorax* spp. and *Tor* spp. may be pulled and get killed due to the intake of the hydropower turbines. Even riverine fish that can adapt to fast current may be lost because of this problem. This problem is unavoidable because of the turbines in the dams.

Entrapment of fish is a critical problem after damming and some provision should be made to protect the fish against entrapment. Installation of appropriate screen devices at the intake will divert the fish from entering water intakes. Therefore, ideal fish bypass facilities should be installed along the dams.

Fish lift, fish passes and fish passages can be also considered as mitigation measures for migratory species. Fish passes play an important role in the conservation of the native fish resource. For the conservation of native species such as snow trouts, the maintenance of spawning grounds and fish hatcheries should be established as a means of enhancing the fish stocks affected by dams. Some resident fish utilise gravel bed areas for spawning. Considerable loss of spawning grounds of these species will take place immediately below dams. Therefore, adequate attention must be given to the protection of the spawning and nursery gravel beds and additional measures such as depositing gravel to increase the spawning habitat. Placing triangle and large boulders on the bottom to create pools in the downstream of the dam for spawning have to be considered.

Fish passes or passages are typically used to mitigate the effect of dams. Fish passes are one of the most important remedies for assisting fish migration. According to the fish records, hydropower projects of the Ayeyarwaddy River basin above Myitkyina are generally established in areas of fish migration and fish passes are recommended to mitigate the barrier effect of the dam. Gubhaju (2002) pointed out that a fish pass should meet the following criteria:

- it should be adapted to the requirements of the species concerned;
- it should be of a pool type, rocky ramp type, or a vertical slot;
- flow velocities must not exceed the swimming capacity of fish;
- it should provide passage for all fish sizes - large and small;
- it should be provided with proper fencing, with total ban on fishing.

Gubhaju (2002) also discussed that the more natural types of passes, e.g. rocky ramps or artifical rivers (bypass channels), can even enhance the beauty of the landscape. There are hundreds of good examples of well-designed and effective fish passes in the world. A fish pass needs to be tested for the known fish species migratory behaviour. The pass has to be monitored by fishery specialists. If the monitoring finds that fish do not use the fish pass, the pass has to be improved.

The problem in this area is using small mesh size fishing net. Fishermen along the surveyed areas also use dynamide extensively. Swar and Shrestha (1997) pointed out that several types of fishing gears, e.g. cast nets, small mesh size seine nets, gill nets and trammel nets are used in different rivers of Nepal. Gill nets, especially those with small mesh size, tend to be nonselective in their catch. Thus large quantity of fish fry, fingerlings smaller than the legal size limit and non-targeted species such as juvenile Gangetic Dolphin, crocodiles and turtles are captured and killed as by-catch by fishermen. Mortalities of these non-target organisms may have an unwanted impact on the riverine ecosystem and the aquatic biodiversity. The ever-increasing human population has become the main cause of high, illegal and irrational fishing pressure on the aquatic ecosystems. Fishing effort has been intensified without considering the size and species of fish. Such activities not only degrade the target fish population by changing the population size and structure, but also affect other species linked to it in the food chain. Non-target species may also be injured or killed by the use of unsuitable fishing gear and practices. The explosives, extensively used illegally in Nepal, are often misused in killing fish in large numbers. They are killed together with other aquatic animals, and this is accompanied by damage to the habitat of which recovery is slow. The knowledge transfer to the local people on importance of environmental conservation is urgently required.

Reservoir associated hatchery has to be considered to produce seed of important native fish such as mahseer, snow trout and labeo species. Stocking the reservoir and tail water will replenish the losses resulting from the disappearance of the natural spawning grounds and from secession of migrations. The fishermen should be provided seed from the hatchery to grow fish in ponds to marketable size. Culture fisheries such as cage or pond culture have to be developed in the region. This provides alternative means of subsistence and income, thus reducing the pressure of the capture fishery on native stocks. Therefore, regular fish stocking after damming is one way of enhancing reservoir fish stocks, reservoir-based aquaculture. In Nepal, a successful cage culture is being practiced in Trishuli and Kulekhani reservoirs where it provides income to the local fishery communities (Gubhaju, 2002). Dams can enhance some riverine fisheries, particularly tail-water fisheries immediately below dams that benefit from discharge of nutrients from the upstream reservoir.

Dam construction will change not only the riverine ecosystem but also fish distribution patterns in the region. To recover from the changes, mitigation or compensation measures have to be applied to reduce the impacts after damming. Compensation measures consist of fish hatcheries and stocking programs designed to reproduce the productivity of the fishery. Electrical power generation supports the development of the region, but the river ecosystems suffers adversely, especially the maintenance of fish species, which were not considered in earliest hydropower projects. The ecosystem will change and both feeding grounds and breeding grounds will be destroyed, leading to loss of fish species. Loss of fish species will lead to impact biodiversity in specific environment.

Due to the records, cold water species do not migrate downstream of Chibwe Dam environment in May Hka River and Lasa Dam environment in Mali Hka River. Warm water species, except long migrants, do not migrate upstream of those dams. This means Chibwe and Lasa Dam environments are the transition areas for cold and warm water species. We can conclude that dam constructions should start in those areas first to reduce impact on cold water species because cold water species are more important than warm water species in those regions.

7.3.2. Migratory fish

Migratory fish can be divided into 3 categories such as potamodromous, oceanodromous and diadromous species. Potamodromous and diadromous species found in this study. Potamodromous fish migrate within fresh water only such as *Labeo dyocheilus* (McClelland) and *Raiamas guttatus* (Day). Diadromous fish travel between salt and fresh water. Diadromous fish can be divided into 3 groups such as anadromous, catadromous and amphidromous fish. Catadromous and amphidromous speices are recorded from this survey. Catadromous fish live in fresh water, and breed in the ocean such as *Anguilla bengalensis* (Gray) and *Anguilla nebulosa* (McClelland). Amphidromous fish move between fresh and salt water during their life cycle, but not to breed such as *Mystus carvasius* (Hamilton) and *Xenentodon cancilla* (Hamilton).

Long distant and mid or short distant migrants found in this area. Long distant migrants such as *Anguilla bengalensis* (Gray, 1831), *Anguilla nebulosa* (McClelland) and *Tor putitora* (Hamilton) will be affected severely after dam construction. These long distant migrants will be lost upstream of Myitsone Dam but will remain downstream of Myitsone Dam. The route of mid or short distant migrants of cold water fish such as Snow Trout will be affected after dam construction. But the favourable condition for cold water migrants is open tributaries remain above each dam. The headwaters of these tributaries originate in the snow capped mountains of Himalayas mountain range and the water in the tributaries is cold. This cold water environment is suitable for cold water species.

Important migratory species found in this area are *Anguilla nebulosa*, *Anguilla bengalensis*, *Tor putitora*, *Neolissochilus hexagonolepis*, *Bagarius yarrelli*, *Pangasius pangasius*, *Wallago attu*, *Labeo* species and *Schizothorax* species. These migratory species have to protect scientifically from impact after dam construction.

7.3.3. IUCN status of fishes recorded

Only one species is recorded as critically endangered species in IUCN (International Union for Conservation of Nature and Natural Resources) red list of threatened species in surveyed areas. Kunming Snout Trout, *Schizothorax grahami* (Regan), distinctly found in Nmai Hka upstream, has been recorded as endangered species list in IUCN, 2009. This fish is found as distinct cold water species in study areas. Kunming Snout

Trout prefers riffle habitats and cold water. It hides under big stones or caves under water in winter. In summer, it feeds in fast flowing water over sand and cobbles. It feeds and grows in lakes or rivers, but during the breeding season it will migrate to the rivers or any other kind of stream inlet to Lake Dianchi where it spawns in riffles (Chen and Cao, 2000). These scientists pointed out that major threats to this species loss from the lake are likely due to introduced fish species, water pollution, over-fishing, and breeding sites lost due to siltation and blocked access.

This species was found in Yenam, Kaunglanhpu and Chibwe dam area. Adults were found in Yenam and Kaunglanhpu dam areas and juveniles were found in Chibwe dam area in May. This means Kunming Snout Trout migrate downstream until Chibwe Dam area in May for spawning and remigrate to upstream areas. After damming, many open channels will remain in each dam and these will reduce blockage effect on migration route of this species along the rivers. Maintaining environmental conditions of dams and their tributaries are important for conservation of this species from extinction. More researches have to pay attention on the maintenance of this species in this area which is essential from the biodiversity point of view. Colleraborative researches have to be undertaken within international organizations and national organizations supported by the construction company.

1 data deficient species of *Macrognathus aral* (One-stripe Spiny Eel) (Bloch & Schneider) was also recorded in downstream of Myitsone dam area. According to fishbase record, this species is regionally extinct in Sri Lanka. They occur in running and stagnant waters with silt or mud substrate. This species can be found in fresh and brackish waters and deltas of large rivers, common in ponds and slow flowing rivers with vegetation in plains. This species is common in rice paddy fields and they are nocturnal feeder, on insects and worms. This species can be found in tropical Asian countries such as Pakistan, India, Sri Lanka, Bangladesh, Nepal and Myanmar and is distributed between latitude 4°N to 10°N. To be protected from extinction, it is essential for further researches to be carried out on this species. This species will not be affected by dam construction because this species is found only downstream of Myitsone Dam.

Other species have not been evaluated yet in IUCN red list of threatened species. These fish species have to study in detail.

7.3.4. Economically important species

In May Hka and Mali Hka Rivers, *Schizothorax* spp., *Bangana devdevi* (Hora), *Neolissochilus hexagonolepis* (McClelland), *Tor* spp. and *Garra* spp. were recorded as economically important fish species. *Bangana devdevi*, *Neolissochilus hexagonolepis* (McClelland), *Garra lamta* (Hamilton), *Eutropiichthys vacha* (Hamilton), *Pangasius pangasius* (Hamilton), *Tor s*pp. and *Labeo* spp. were recorded as important species list in Ayeyarwaddy River.

In those species, *Schizothorax* spp. inhabit distinctly to cold water and can be found only upstream of Chibwe and Lasa Dams. Warm water spp. such as *Eutropiichthys vacha*, *Pangasius pangasius* and *Labeo* spp. can be found only downstream of Lasa and Chibwe dams. *Bangana devdevi* can be found from Myitsone to upstream of Lasa and Wutsok dams but cannot be found in cold water environment.

Attentions have to directed for the development of artificial spawning for larval production for those species. Hatcheries have to be established in the region for producing fingerlings and restocking into the rivers. Technology for cold water aquaculture has to be introduced into the region and transferred to the local people. Collaborative works within local authorized groups, local peoples and researchers do need further developments.

7.3.5. Potential for aquaculture in the reservoir

Lacustrine condition and extensive surface area in the reservoirs will create reservoir fisheries in the region. The reservoirs will collect rich nutrients from depositions that, in turn, will promote plankton growth and create the potential for development of planktivorous fish culture. As this occurs, new job opportunities will be created for local people living around the reservoir. At the same time, regional fish production will also be increased. Poverty can be reduced and food security improved when subsistence fishermen achieve higher levels of sustainable productivity.

However, a fish hatchery is necessary near the dam site to breed and produce enough fingerlings for aquaculture activities as well as for economically important high value local fish species to be stocked into the river for conservation. Fishing pressure is an increasing factor with increasing human populations. Meanwhile, fish populations are decreasing due to over fishing and other environmental problems all over the world. The storage type reservoirs can accommodate commercial aquaculture.

The other kinds of cold water species such as cray fish those occur naturally in the region can be cultured in the ponds. Systematic techniques of pond culture for cold water species into the region are essential. Investment for the aquaculture development in the region is a must.

8. BRIEF SUMMARY

Aquatic ecological conditions, aquatic organisms and fish species list were surveyed in Hydropower Development of Ayeyarwaddy River Basin above Myitkyina project.

1. Temperature in May Hka River is found distinctly lower than Mali Hka and Ayeyarwaddy Rivers.
2. Water quality in Mali Hka is worsened because of various levels of gold minings along the river.
3. Serious turbidity of water recorded in Ngawchang Hka Tributary caused by factory effluent was found distinctly.
4. Dissolved oxygen concentrations along the rivers are nearly saturated to saturated values.
5. Riparian areas of May Hka is better than Mali Hka and Ayeyarwaddy Rivers because of low population and difficult to access there.
6. Phytoplankton species composition is the highest in May Hka River and the lowest in Ayeyarwaddy River.
7. Zooplankton species composition is the highest in May Hka River and the lowest in Mali Hka River.
8. Benthos species composition is the highest in May Hka River and the lowest in Mali Hka River.
9. Periphyton species composition is the highest in May Hka River and the lowest in Mali Hka River.
10. 5 economically important fish genera from May Hka and Mali Hka and 7 genera from Ayeyarwaddy River are recorded.
11. 3 species of long distant migrants such as *Anguilla bengalensis*, *Anguilla nebulosa* and *Tor putitora* found in the surveyed areas.
12. Short or mid-distant migrants of cold water species such as *Schizothorax* species were found in upstreams of May Hka and Mali Hka Rivers.

13. 1 endangered fish species, *Schizothorax grahami* (Regan, 1904) is recorded from upstream of Chibwe Dam site in May Hka River.

14. 1 data deficient species, *Macrognathus aral* (Bloch & Schneider 1801) was recorded from downstream of Myitsone Dam site.

15. Dam construction should start in Chibwe Dam in May Hka River and Lasa Dam in Mali Hka River for reducing impact on cold water species.

16. To maintain the incoming cold water from May Hka in the originating of Ayeyarwaddy River, separate dams should be constructed in suitable sites upstream of Myitsone confluence on May Hka and Mali Hka Rivers instead of downstream for reducing impact on aquatic organisms distribution.

9. MITIGATION MEASURES

Due to the requirement of dam constructions for development of the region, the following mitigation measures have to be undertaken before and after dam construction period led by the government participating with local authorities and supported by Construction Company.

1. plan eco-friendly techniques for construction and employ maintenance in the areas of the dam projects for reducing the biodiversity impact;
2. encourage the small scale and medium scale instead of mechanized scale gold mining in the dam construction period for reducing severe damage to the riverine ecosystem caused by high turbidity;
3. encourage the river bank gold mining instead of river bed mining in the dam construction period for reducing direct impact on the benthos;
4. restrict fishing near the dam construction areas during construction period for reducing high fish catch on the fish aggregation near the barriers;
5. construct fish bypass system and collector channel at work site in the construction period for collecting the fish aggregates;
6. implement of fish trapping and hauling program before and after dam construction for collecting the fish;
7. construct suitable fish migration devices along with the dam for important migratory fish such as ladders or passages, including silt passage;
8. plan the regular draining for reducing irregular flooding rhythm and allowances for downstream water requirements of the aquatic organisms in the river;
9. establish conservation and protected zones or areas along the main rivers and tributaries for biodiversity conservation;
10. establish the hatcheries in the suitable areas for restocking economically important indigenous fish species; (eg. *Schizothorax* sp./Snow Trout, *Tor* sp./Nga Dauk, *Neolissochilus* sp./Nga Ni)
11. establish grow out farms, reservoir fishery and cage cultures on cold water fish species in the surveyed areas;
12. establish regular environmental monitoring and scientific research plans for the dams;
13. encourage the researchers and research projects for important fields in the dam areas;

14. establish education plans to upgrade the environmental knowledge for the local people; (eg. importance of riparian forest, dangerous of dynamite fishing, importance of banned season for fishery, etc.)

15. encourage the local people for long term plantation plan on the aquatic macrophytes or terrestrial plants in the riparian areas along the dams for suitable new habitats and shades for aquatic organisms;

16. plan to reduce shifting cultivation practice to reduce land erosion and develop suitable agricultural technique in mountainous regions not only for rice and edible plants but also for valuable Himalayan herbs for traditional medicine.

10. RECOMMENDATIONS

For successfully implementing the mitigation measures, the followings should be undertaken along with dam construction in the region led by the government participating with local authorities and supported by Construction Company.

1. establish suitable fund for short term and long term aquatic biodiversity conservation;
2. establish research center collaboratively within regional University or Institute and International Organizations;
3. establish suitable linkage between local and international organizations and conservationists for implementing Himalayan biodiversity conservation;
4. establish active NGO teams for aquatic ecological conservation;
5. negotiate between government sector, construction company and nature conservationists for eco-friendly technique urgently and establish task force group for follow up procedures;
6. establish monitoring group including government authorities, local representatives and nature conservationists for gold mining;
7. establish the regional fisheries team comprising government staff, local representatives and NGO members for development of fisheries conservation sector;
8. establish scientific research team for undertaking aquatic ecological conditions along the project areas in the construction period for drawing long term conservation plan in the region;
9. establish scientific research team for feasible fish passage design for migratory fish in the project dams;
10. find out suitable professions or jobs for the local people not only in fisheries but also in animal farming and valuable Himalayan herb and other plantations in the region;
11. initiate investigations on stocking of suitable fish in the rivers for enhancement of fish production;
12. initiate investigations into the possibilities of aquaculture in rivers and tributaries utilizing indigenous species;
13. initiate activities for further development of manpower in the field of fisheries production and conservation;
14. draw work plan within fisheries conservationists and other conservationists for working collaboratively in the region;

15. establish research linkage between the countries of Trans-Himalayan region for conservation and development of cold water fishery;

16. pay adequate attention to the conservation of cold water fish to maintain their gene pool in collaboration with international Institutions;

17. make provisions in the laws to oblige power companies to pay for the most efficient mitigation measures and to prove its efficiency;

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Fig. 3.1. Myanmar and Chinese team members working collaboratively.

Fig. 5.1. YSI (Yellow Spring Instrument) multipurpose model no. 6600 and TROLL multi-parameter series no. 9500.

Fig. 5.2. INDEX model pH, TDS and conductivity test kits.

Fig. 5.3. GARMIN GPS models GPSmap 60CSx and etrex-Legend Cx.

Fig. 5.4. Nikon COOLPIX L18 digital cameras and SONY Cyber-shot DSC-S730 digital camera.

Fig. 5.5 Phytoplankton and Zooplankton sampling using 25# mesh Phytoplankton net and 13# mesh Zooplankton net.

Fig 5.6. Benthos sampling using D-shape kick-net.

Fig. 5.7. Sampling the Periphyton.

Fig. 5.9. Fish markets in Myitkyina and Putao.

MYITSONE:

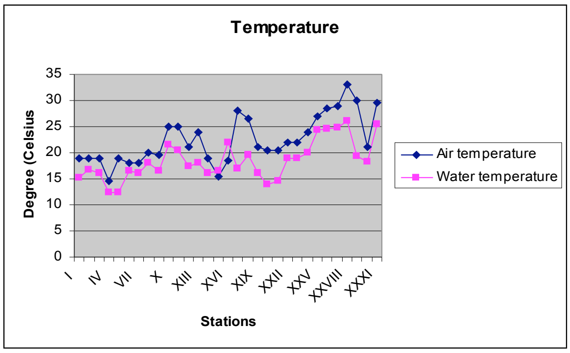
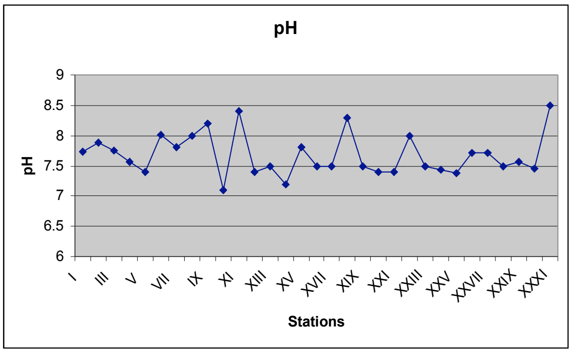


Fig. 6.1.1.1 Temperature distribution along Myitsone Dam environment..



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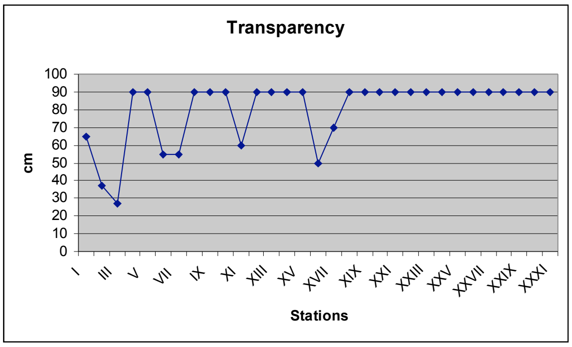


Fig. 6.1.1.3. Transparency distribution along Myitsone Dam environment.

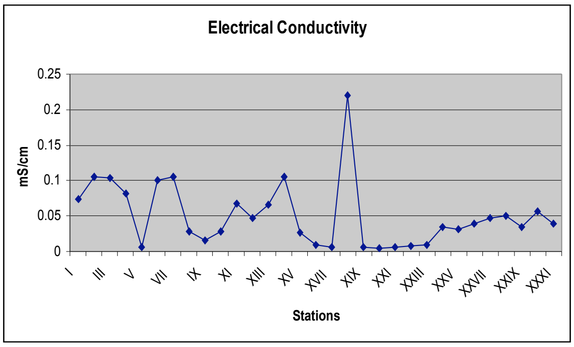


Fig. 6.1.1.4. Electrical conductivity distribution along Myitsone Dam environment.

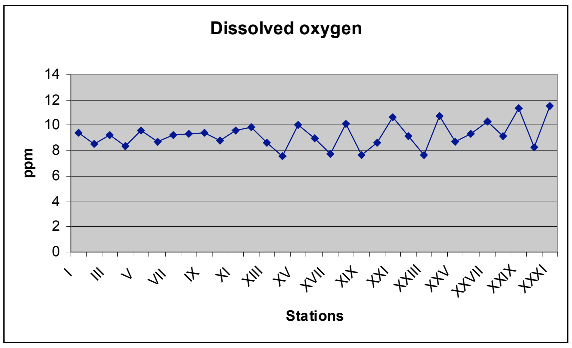


Fig. 6.1.1.5 Dissolved oxygen distribution along Myitsone Dam environment.

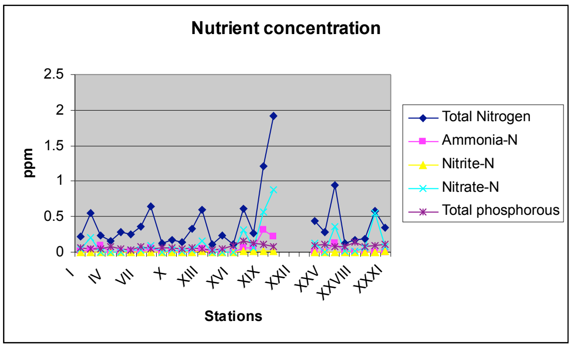


Fig 6.1.1.6 Nutrient concentration distribution along Myitsone Dam environment.

LASA:

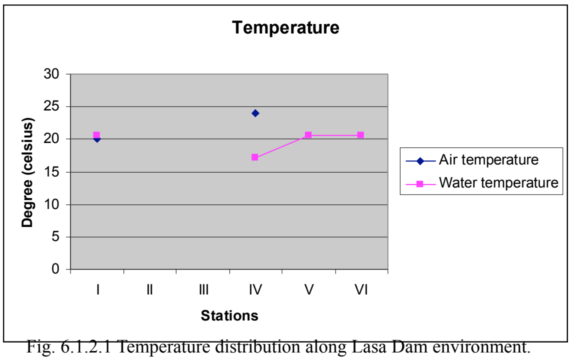


Fig. 6.1.2.1 Temperature distribution along Lasa Dam environment.

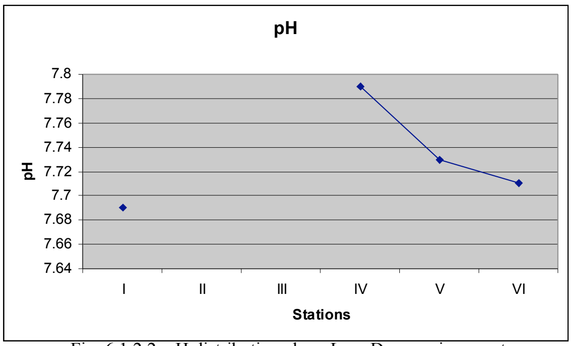


Fig. 6.1.2.2 pH distribution along Lasa Dam environment.

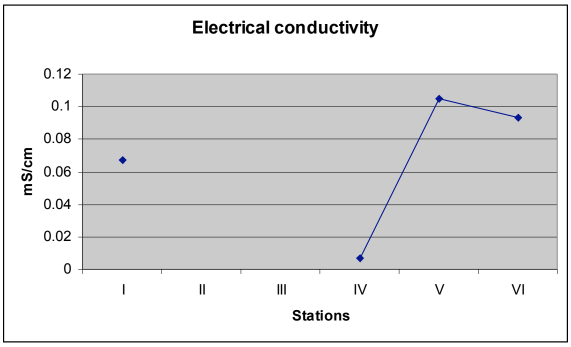


Fig. 6.1.2.3 Electrical conductivity distribution along Lasa Dam environment.

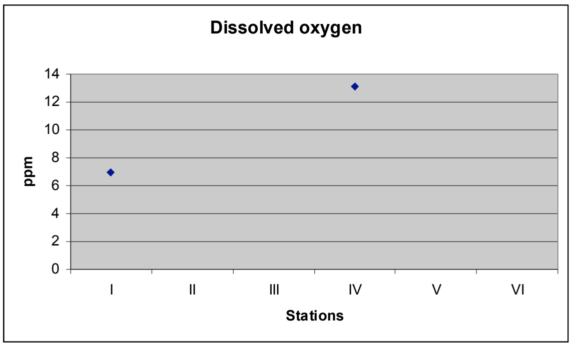


Fig. 6.1.2.4 Dissolved oxygen distribution along Lasa Dam environment.

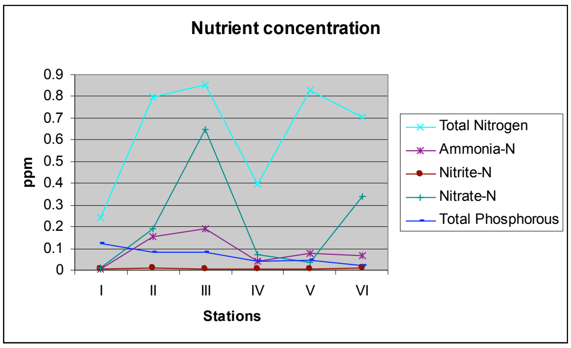


Fig. 6.1.2.5 Nutrient concentration distribution along Lasa Dam environment.

YENAM:

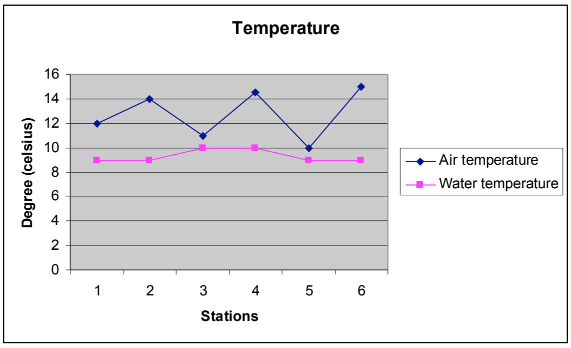


Fig. 6.1.3.1 Temperature distribution along Yenam Dam environment.

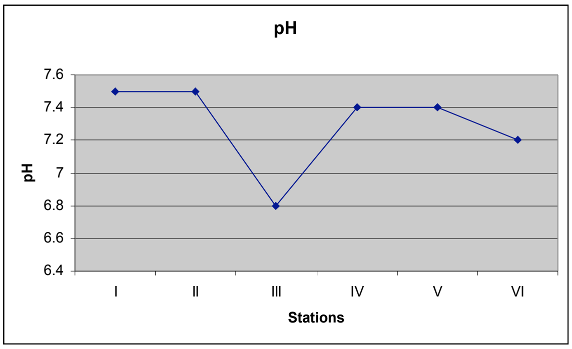
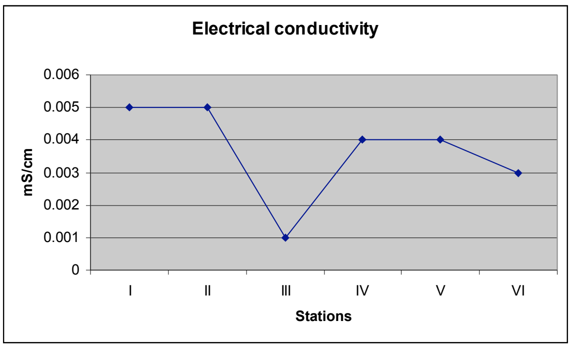


Fig. 6.1.3.2 pH distribution along Yenam Dam environment.



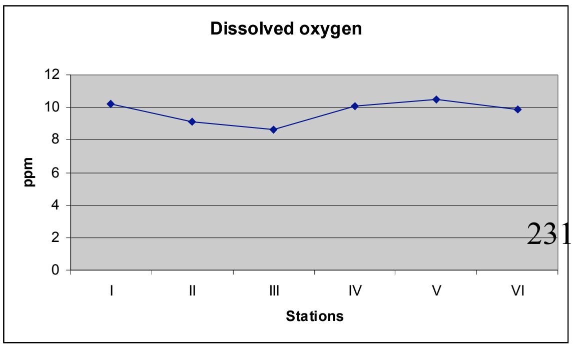


Fig. 6.1.3.3 Electrical conductivity distribution along Yenam Dam environment. Fig. 6.1.3.4 Dissolved oxygen distribution along Yenam Dam environment.

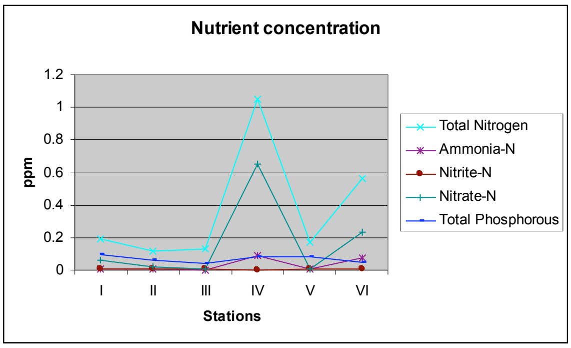


Fig. 6.1.3.5 Nutrient concentration distribution along Yenam Dam environment.

KAUNGLANGHPU:

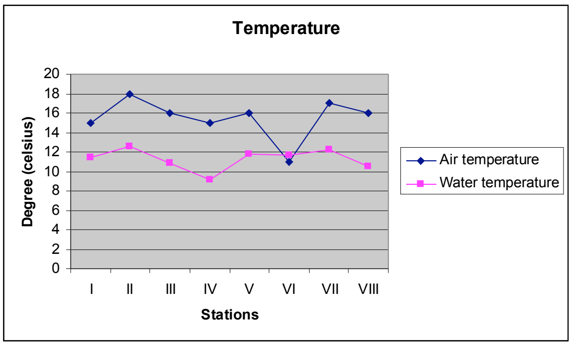


Fig. 6.1.4.1 Temperature distribution along KaunglanghpuDdam environment.

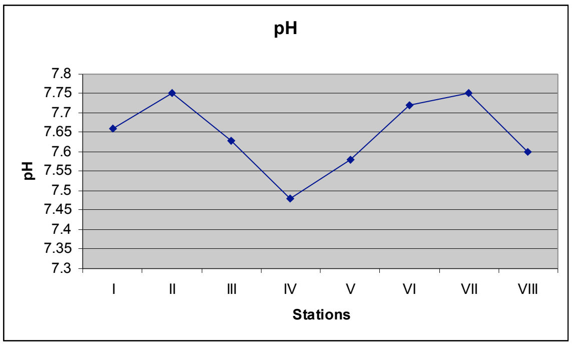


Fig. 6.1.4.2 pH distribution along Kaunglanghpu Dam environment.

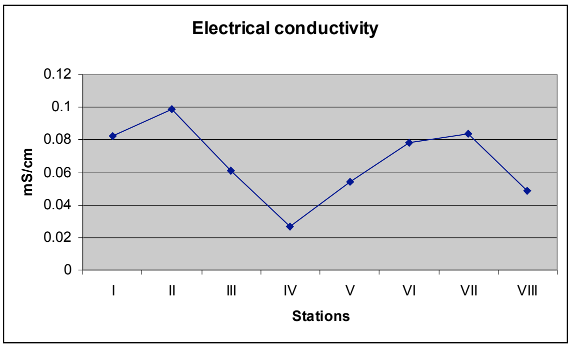


Fig. 6.1.4.3 Electrical conductivity distribution along Kaunglanghpu Dam.

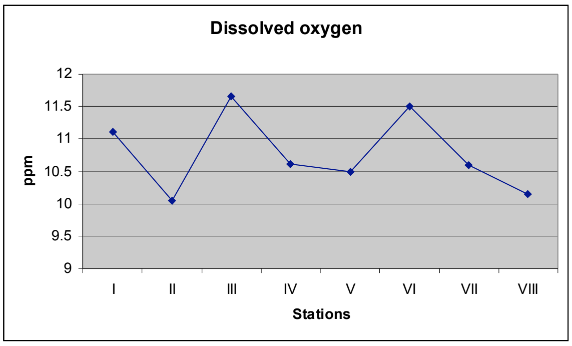


Fig. 6.1.4.4 Dissolved oxygen distribution along Kaunglanghpu Dam environment.

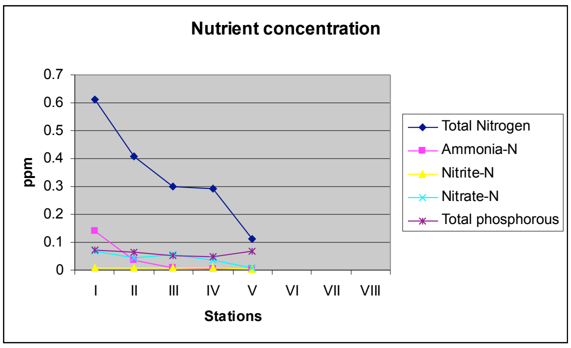


Fig. 6.1.4.5 Nutrient concentration distribution along Kaunglanghpu Dam environment.

PISA:

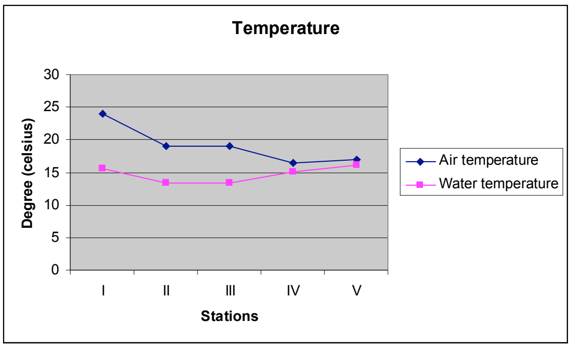


Fig. 6.1.5.1 Temperature distribution along Pisa Dam environment.

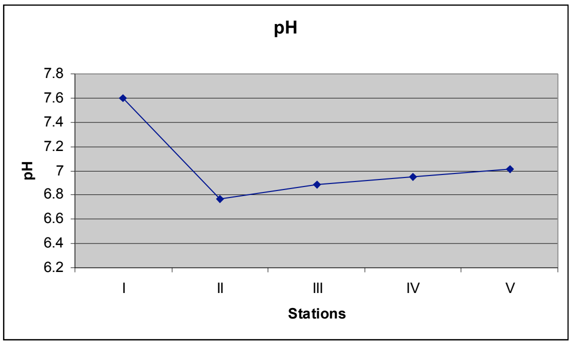


Fig. 6.1.5.2 pH distribution along Pisa Dam environment.

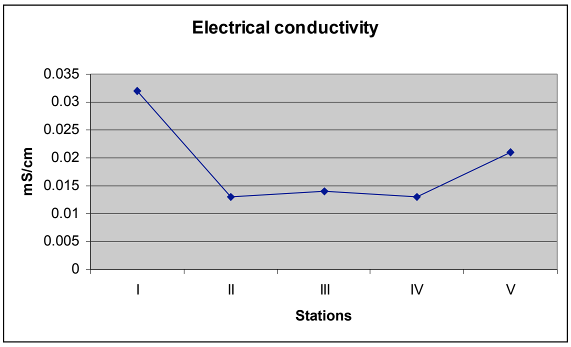


Fig. 6.1.5.3 Electrical conductivity distribution along Pisa Dam environment.

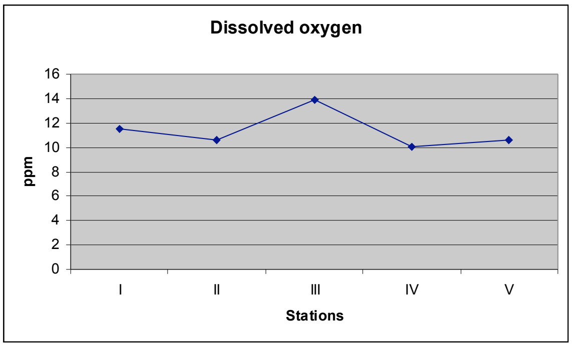


Fig. 6.1.5.4 Dissolved oxygen distribution along Pisa Dam environment.

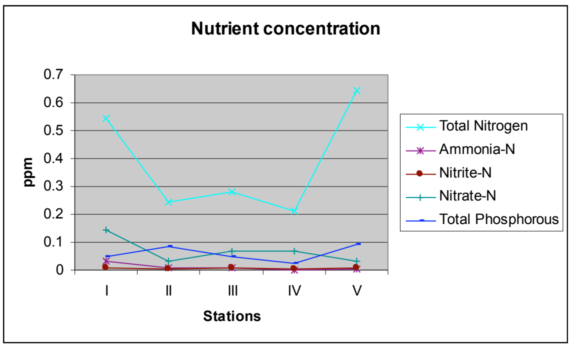


Fig. 6.1.5.5 Nutrient concentration distribution along Pisa Dam environment.

WUSOK:

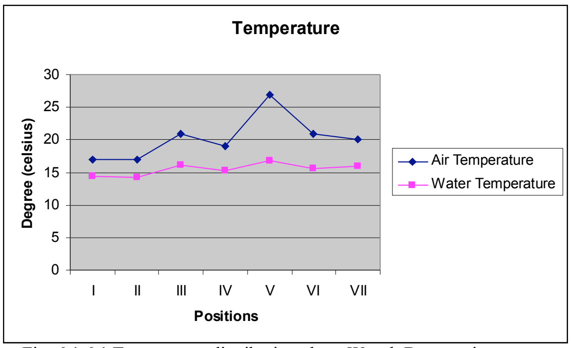


Fig. 6.1.6.1 Temperature distribution along Wusok Dam environment.

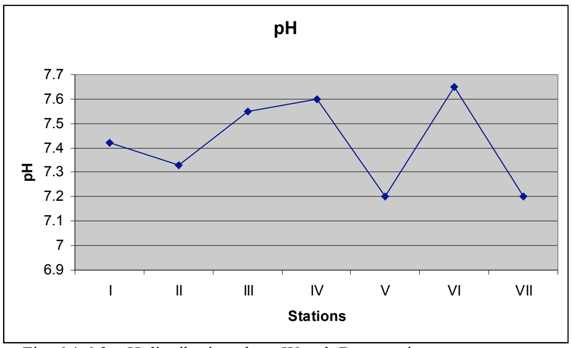


Fig. 6.1.6.2 pH distribution along Wusok Dam environment.

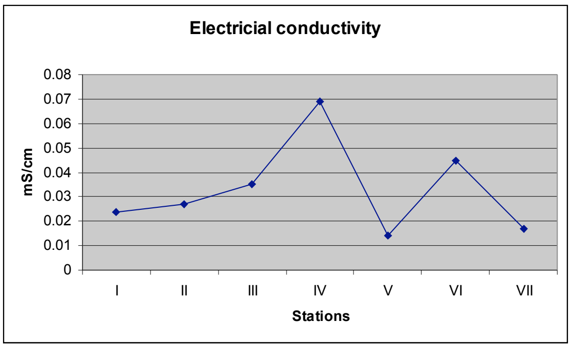


Fig. 6.1.6.3 Electrical conductivity distribution along Wusok Dam environment.

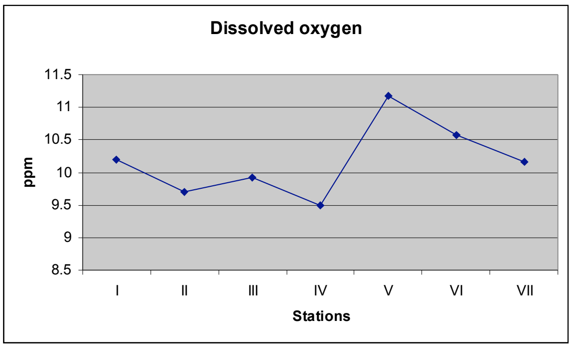


Fig. 6.1.6.4 Dissolved oxygen distribution along Wusok Dam environment.

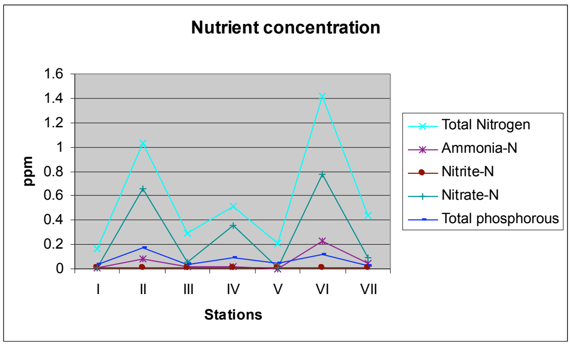


Fig. 6.1.6.5 Nutrient concentration distribution along Wusok Dam environment

CHIBWE:

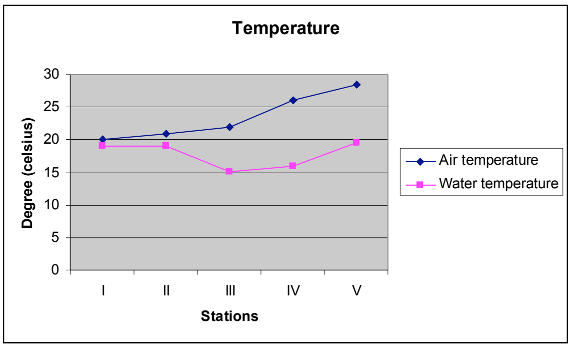


Fig. 6.1.7.1 Temperature distribution along Chibwe Dam environment.

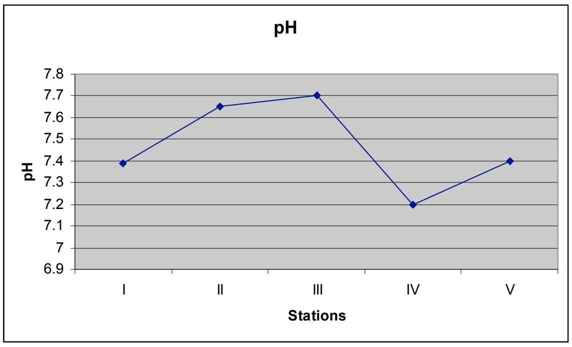
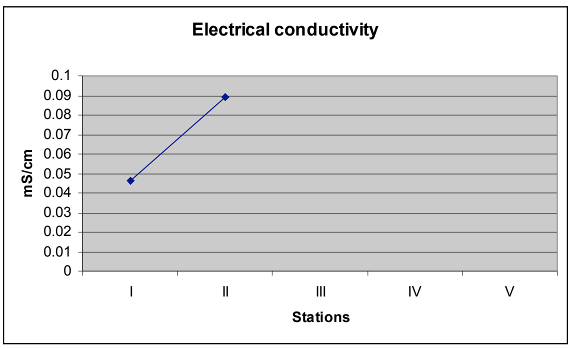


Fig. 6.1.7.2 pH distribution along Chibwe Dam environment.



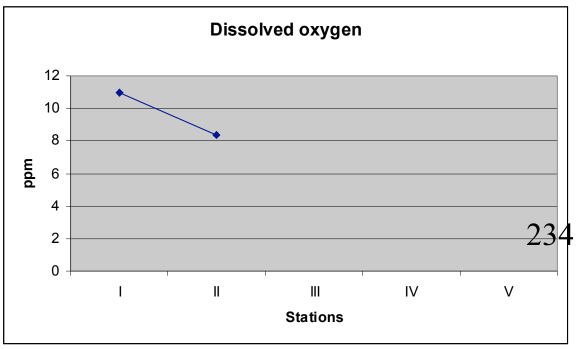


Fig. 6.1.7.3 Electrical conductivity distribution along Chibwe Dam environment.

Fig. 6.1.7.4 Dissolved oxygen distribution along Chibwe Dam environment.

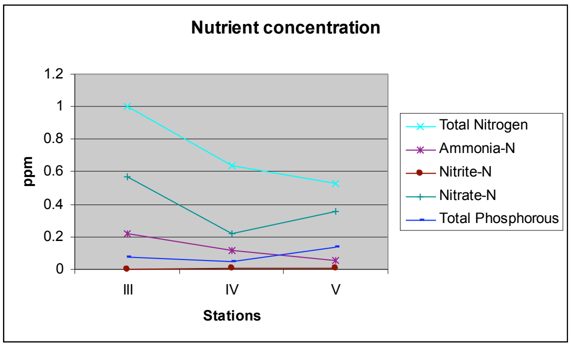


Fig. 6.1.7.5 Nutrient concentration distribution along Chibwe Dam environment.

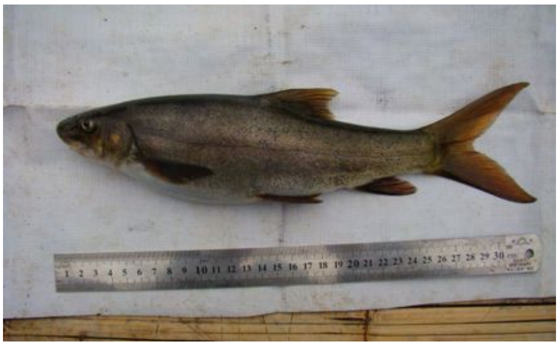


Fig. 6.3.1 Critically endangered species recorded in surveyed areas. *Schizothorax grahami* (Regan)

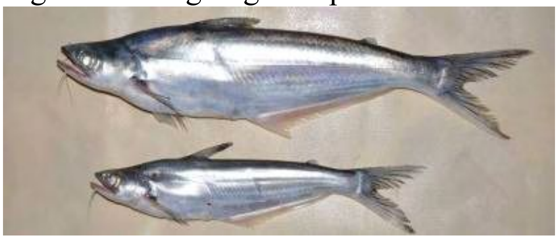
Fig. 6.3.2 Data deficient species recorded in surveyed areas. *Macrognathus aral* (Bloch & Schneider 1801)

Fig. 6.3.3 *Schizothorax* sp. carried matured eggs in Wusok Dam area in April.

Anguilla nebulosa

Tor putitora

Fig. 6.3.4 Long migrant species recorded in surveyed areas.



Eutropiichthys vacha

Pangasius pangasius

Neolissochilus hexagonolepis

Tor putitora

Bangana devdevi

Garra qiaojiensis

Fig. 6.3.5 Economically important fish species recorded in surveyed areas.

Fig. 6.3.6 Cray fish, one kind of possible species for aquaculture in Kachin State.

Report

on

Preliminary Investigation of Environment Baseline

on

Hydropower Development of Ayeyarwady River above Myitkyina, Myanmar

Glossary of Environmental Terms

Abatement

Reducing the degree or intensity of, or eliminating, pollution.

Abiotic

Non-Living.

Absorption

The passage of one substance into or through another; an operation in which one or more soluble components of a gas mixture are dissolved in a liquid.

Accident site

The location of and unexpected occurrence, failure, or loss, either at a plant or along a transportation route, resulting in a release of hazardous materials.

Acid deposition

A complex chemical and atmospheric phenomenon that occurs when emissions of sulfur and nitrogen compounds and other substances are transformed by chemical processes in the atmosphere, often far from the original sources, and then deposited on earth in either a wet or a dry form. The wet forms, popularly called " acid rain", can fall as rain, snow or fog. The dry forms are acidic gases or particulates.

Acute toxicity

The ability of a substance to cause poisonous effects resulting in severe biological harm or death soon after a single exposure or dose; also, any severe poisonous effect resulting from a single short-term exposure to a toxic substance. See also Chronic toxicity; Toxicity.

Aerobic

Life or process that require, or are not destroyed by, the presence of oxygen. See also anaerobic.

Agricultural Pollution

A liquid and solid wastes from farming, including runoff and leaching of pesticides and fertilizers; erosion and dust from plowing; animal manure and carcasses; and crop residues and debris.

Air Pollution

The presence of contaminant or pollutant substances in the air that do not disperse properly and interfere with human health or welfare or produce other harmful environmental effects.

Ambient Air

Any unconfined portion of the atmosphere; open air, surrounding air.

Aquifer

An underground geological formation, or group of formations, containing usable amounts of groundwater that can supply wells and springs.

Atmosphere (as a measurement)

A standard unit of pressure representing the pressure exerted by a 29.92 inch column of mercury at sea level at 45 degree latitude and equal to 1000 grams per square centimeter.

Bacteria (singular bacterium)

Microscopic living organism that can aid in pollution control by consuming or breaking down organic matter in sewage or by similarly acting on oil spills or other water pollutants. Bacteria in soil, water, or air can cause human, animal and plant health problems.

Benthic Organism (benthos)

A form of aquatic plant or animal life found on or near the bottom of a stream, lake, or ocean.

Biochemical Oxygen Demand (BOD)

A measure of the amount of oxygen consumed in the biological processes that break down organic matter in water. The greater the BOD, the greater the degree of pollution.

Biodiversity Hot Spots

Areas with exceptionally high numbers of endemic species.

Biological Oxidation

The way bacteria and microorganism feed on and decompose complex organic materials; used in self-purification of water bodies and in activated sludge wastewater treatment.

Biological Treatment

A treatment technology the uses bacteria to consume waste and thus break down organic materials.

BOD_5

The amount of dissolved oxygen consumed in five days by biological process breaking down organic matter.

Cadmium (Cd)

A heavy metal element that accumulates in the environment.

Carbondioxide (CO_2)

A colourless, odorless, nonpoisonous gas that results from fossil fuel combustion and is normally apart of the ambient air.

Carbonmonoxide (CO)

A colourless, odorless, poisonous gas produced by incomplete fossil fuel combustion.

Carcinogen

Any substance that can cause or contribute to the production of cancer.

Chemical oxygen demand (COD)

A measure of the oxygen require to oxidize all compounds in water, both organic and inorganic.

Chlorofluorocarbons (CFCs)

A family of inert, nontoxic and easily liquefied chemicals used in refrigeration air conditioning, packaging, and insulation or as solvents and aerosol propellants. Because CFCs are not destroyed in the lower atmosphere, they drift into the upper atmosphere, where their chlorine components destroyed ozone.

Chromium See heavy metals

Chronic toxicity

The capacity of a substance to cause long term poisonous human health effects. See also Acute toxicity.

Climate

A description of the long-term pattern of weather in a particular area.

Coagulation

A clumping of particles in waste water to settle out impurities; often induced by chemicals such as lime, alum and iron salts.

Compound

A molecule made up of two or more kinds of atoms held together by chemical bonds.

Compensation measures

Alternative resources (land, property or money) provided to displaced people or others adversely affected by a project as mitigation for losses suffered.

Contaminant

Any physical, chemical, biological, radiological substance or matter that has an adverse affect on air, water, or soil.

Corrosion

The dissolving and wearing away of metal caused by a chemical reaction the occurs between water and the pipes that the water contracts, or when chemicals touching a metal surface, or when two metals are in contact.

Cultural heritage

The cultural practices and resources of current populations (religions; languages; ideas; social; political and economic organizations) and their material expressions in the forms of sacred elements of natural sites or artifacts and building; landscaper resulting from cultural practices over historical and prehistoric times; and archaeological resources; including artifacts, plant and animal remains associated with human activities, burial sites and architect rural elements.

Decomposition

The breakdown of matter by bacteria and fungi; changes the chemical makeup and physical appearance of materials.

Degradation

The process by which a chemical reduced to a less complex form.

Delta

Fan-shaped sediment deposit found at the mouth of a river.

Discharge

The amount of water that passes a fixed point in a given amount of time, usually expressed as liters or cubic feet of water per second.

Decommissioning

Removing a dam from service and, where appropriate, physically dismantling it.

Dissolved solids

Disintegrated organic and inorganic material contained in water. Excessive amounts make water unfit for drinking or for use in industrial processes.

Ecofeminism

A pluralistic, nonhierarchical, relationship-oriented philosophy that suggests how humans could reconceived themselves and their relationships to nature in nondominating ways as an alternative to patriarchal systems of domination.

Ecosystem

The interacting system of a biological community and its nonliving environmental surroundings.

Effluent

Wastewater treated or untreated that flows out of a treatment plant, sewer, or industrial outfall; generally refers to wastes discharged into surface waters.

Emission

Pollution discharged into the atmosphere from smokestacks, other vents, and surface areas of commercial or industrial facilities, from residential chimneys; and from motor vehicle, locomotive, or aircraft exhausts.

Emission factor

The relationship between the amount of pollution produced and the amount of raw material processed. For example, an emission factor for a blast furnace making iron would be the number of pounds of particulates per ton of raw material.

Emission standard

The maximum amount of air polluting discharge legally allowed from a single source, mobile or stationary.

Environmental flow

The specific release of water from a dam to ensure the maintenance of downstream aquatic ecosystems and key species. The flows may include seasonal or annual flows and/or regular or irregular pulses to meet ecosystem needs. They may also be linked to livelihood needs of downstream affected people.

Estuary

A bay or drowned valley where a river empties into the sea.

Eutrophication

The slow aging process during which a lake, estuary, or bay evolves into a bog or marsh and eventually disappears. During the later stages of eutrophication the water body is choked by abundant plant life as the results of increased amounts of nutritive compounds such as nitrogen and phosphorus. Human activities can accelerate the process.

Evapotranspiration

The loss of water from the soil both by evaporation and by transpiration from the plants growing in the soil.

Exposure

A potential health threat to the living organisms in the environment due to the amount of radiation or pollutant present in the environment.

Famines

Acute food shortages characterized by large-scale loss of life, social disruption, and economic chaos.

Fertilizer

Materials such as nitrogen and phosphorus that provide nutrients for plants. Commercially sold fertilizers may contain other chemicals or may be in the form of processed sewage sludge.

Flood management

A broad concept that focuses on reducing flood hazards through a combination of policy, institutional, regulatory and project measures (such as replanting catchment areas), while recognizing that they can never be fully controlled. This takes into account the beneficial uses of natural floods, which are more difficult to quantify in human and economic terms but which sustain natural systems that also have economic, social, cultural and ecosystem values and functions.

Fluorocarbon (FCs)

Any of a number of organic compounds analogous to hydrocarbons in which one or more hydrogen atoms are replaced by fluorine. Once used in the United States as a propellant in aerosols, they are now primarily used in coolants and some industrial processes. FCs containing chlorine are called chlorofluorocarbons (CFCs). They are believed to be modifying the ozone layer in the stratosphere, thereby allowing more harmful solar radiation to reach the Earth's surface.

Fly ash

Noncombustible residual particles from the combustion process carried by flue gas.

Fossil Fuels

Petroleum, natural gas, and coal created by geological forces from organic wastes and dead bodies of formerly living biological organisms.

Fresh Water

Water other than seawater, covers only about 2 percent of earth's surface, including streams, rivers, lakes, ponds, and water associated with several kinds of wetlands.

Fuelwood

Branches, twigs, logs, wood chips, and other wood products harvested for use as fuel.

Greenhouse effect

The warming of the Earth's atmosphere caused by a buildup of carbon dioxide or other trace gases; many scientists believe that this buildup allows light from the sun's rays to heat the Earth but prevents a counterbalancing loss of heat.

Green Plans

Integrated national environmental plans for reducing pollution and resoource consumption while achieving sustainable development and environmental restoration.

Groundwater

The supply of fresh water found beneath the Earth's surface (usually in aquifers), which is often used for supplying wells and springs. Because groundwater is a major source of drinking water leaching agricultural or industrial pollutants or substances from leaking underground storage tanks are contaminating it.

Heavy metals

Metallic elements with atomic number greater than 20, such as mercury and lead. They can damage living things at low concentrations and tend to accumulate in the food chain.

Hydrocarbons (HC)

Chemical compounds that consist entirely of carbon and hydrogen.

Hydrogen sulfide (HS)

Gas emitted during organic decomposition and as a by-product of oil refining and burning. It smells like rotten eggs and, in heavy concentration, can cause illness.

Impoundment

A body of water or sludge confined by a dam, dike, floodgate, or other barrier.

Indirect discharge

Introduction of pollutants from a nondomestic source into a publicly owned waste treatment system. Indirect dischargers can be commercial or industrial facilities whose wastes go into the local sewers.

Infiltration

The penetration of water through the ground surface into subsurface soil or the penetration of water from the soil into sewer or other pipes through defective joints, connections, or manhole walls. 2. A land application technique whereby large volumes of wastewater are applied to land and allowed to penetrate the surface and percolate through the underlying soil. See also Percolation.

Inorganic chemicals

Chemical substances of mineral origin, not of basically carbon structure.

Insecticide

A pesticide compound specifically used to kill or control the growth of insects.

Irrigation

Technique for applying water or wastewater to land areas to supply the water and nutrient needs of plants.

Large dam

A dam with a height of 15m or between 5-15m high and have a reservoir volume of more than 3 million m^3, they are also classified as large by the International Commission on Large Dams. In this report everything else is considered a small dam.

Leaching

The process by which soluble constituents are dissolved and carried down through the soil by a percolating fluid. Leaching may occur in farming areas, feedlots, and landfills and may result in hazardous substances entering surface water, groundwater, or soil. See also Leach ate.

Main-stem

The main course of a river, characterized by its middle and lower reaches.

Marine

Living in or pertaining to the sea.

Marsh

Wetland without trees; in North America, this type of land is characterized by cattails and rushes.

Methane

A colorless, nonpoisonous, flammable gas created by anaerobic decomposition of organic compounds.

Microbes

Microscopic organisms such as algae, viruses, bacteria, fungi, and protozoa, some of which cause disease.

Monitoring

Periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements or pollutant levels in various media or in humans, animals, and other living things.

Moonsoon

A seasonal reversal of wind patterns caused by the different heating and cooling rates of the oceans and continents.

Natural resources

Goods and serveces supplied by the environment.

Nitrate

A compound containing nitrogen that can exist in the atmosphere or as a dissolved gas in water and can have harmful effects on humans and animals. Nitrates in water can cause severe illness in infants and cows.

Nitric oxide (NO)

A gas formed by combustion under high temperature and high pressure in an internal combustion engine. It changes to nitrogen dioxide in the ambient air and contributes to photochemical smog.

Nitrogendioxide (NO_2)

The result of nitric oxide combining with oxygen in the atmosphere; a major component of photochemical smog.

Nitrogenous wastes

Animal or vegetable residues that contain significant amounts of nitrogen.

Nonpoint sources

Pollution sources that are diffuse and do not introduced into a receiving stream from a specific outlet. The pollutants are generally carried off the land by storm-water runoff. The commonly used categories for non-point sources are agriculture, forestry, urban, mining, construction, dams and channels, land disposal, and saltwater intrusion.

Nutrient

Any substance assimilated by living things that promotes growth. The term is generally applied to nitrogen and phosphorus in wastewater but is also applied to other essential and trace elements.

Optimum

The most favorable condition in regard to an environmental factor.

Organic

Referring to or derived from living organisms. 2 .In chemistry, any compound containing carbon.

Organic chemicals/compound

Animal - or plant-produced substances containing mainly carbon, hydrogen, and oxygen.

Organophosphates

Pesticide chemicals that contain phosphorus; used to control insects. They are short-lived, but some can be toxic when first applied.

Overharvesting

Harvesting so much of a resource that it threatens its existence.

Oxidation

1. The addition of oxygen, which breaks down organic waste or chemicals such as cyanides, phenols, and organic sulfur compounds in sewage by bacterial and chemical means.

2. Oxygen combining with other elements. 3 . The process in chemistry whereby electrons are removed from a molecule.

Ozone (O_3)

Found in two layers of the atmosphere, the troposphere and the stratosphere. In the troposphere (the layer extending 7 to 10 miles up from the Earth's surface), ozone is a chemical oxidant and major component of photochemical smog. In the stratosphere (the atmospheric layer beginning 7 to 10 miles above the Earth's surface), ozone is a form of oxygen found naturally that provides a protective layer shielding the Earth from the harmful health effects of ultraviolet radiation on humans and the environment.

Ozone depletion

Destruction of the stratospheric ozone layer that shields the Earth from ultraviolet radiation harmful to biological life. This destruction of ozone is caused by the breakdown of certain chlorine-or bromine-containing compounds (chlorofluorocarbons or halons) that break down when they reach the stratosphere and catalytically destroy ozone molecules.

Particulates

Fine liquid or solid particles, such as dust, smoke, mist, fumes, or smog, found in air or emissions.

Permeability

The rate at which liquids pass through soil or other materials in a specified direction.

Pesticide

Substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest. Also, any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant. Pesticides can accumulate in the food chain or contaminate the environment if misused.

Phenols

Organic compounds that are by-products of petroleum refining, tanning, and textile, dye, and resin manufacturing. Low concentration cause taste and odor problems in water; higher concentrations can kill aquatic life and humans.

Phosphates

Certain chemical compounds containing phosphorus.

Phosphorus

An essential chemical food element that can continue to the eutrophication of lakes and other water bodies. Increased phosphorus levels result from discharge of phosphorus containing materials into surface waters.

Photosynthesis

The manufacture of carbohydrates and oxygen by plants from carbon dioxide and water in the presence of chlorophyll, using sunlight as an energy source.

Phytoplankton

That portion of the plankton community comprised of tiny plants, e.g., algae, diatoms.

Point source

A stationary location or fixed facility from which pollutants are discharged or emitted; any single identifiable source of pollution, e.g., a pipe, ditch, ship, ore pit, or factory smokestack.

Policy

A societal plan or statement of intentions intended to accomplish some social good.

Pollution

To make foul, unclean, dirty; any physical, chemical, or biological change that adversely affects the health, survival, or activities of living organisms or that alters the environment in undesirable ways.

Potable water

Water that is safe for drinking and cooking.

ppm/ppb

Parts per million/parts per billion, a way of expressing tiny concentrations of pollutants in air, water, soil, human tissue, and food and or other products.

Precipitation

Removal of solids from liquid waste so that the hazardous solid portion can be disposed of safely; removal of particles from airborne emissions.

Prevention

Measures taken to minimize the release of wastes to the environment.

Primary waste water treatment

First steps in wastewater treatment; screens and sedimentation tanks are used to remove most materials that float or will settle. Primary treatment results in the removal of about 30% of carbonaceous biochemical oxygen demand (BOD) from domestic sewage. See also secondary wastewater treatment; tertiary wastewater treatment.

Rainforest

A forest with high humidity, constant temperature, and abundant rainfall (generally over 380 cm [150 in] per year); can be tropical or temperate.

Raw sewage Untreated wastewater.

Reclamation

Chemical, biological, or physical clean-up and reconstruction of severely contaminated or degraded sites to return them to something like their original topography and vegetation.

Residual

Amount of a pollutant remaining in the environment after a natural or technological process has taken place, e.g., the sludge remaining after initial wastewater treatment, or particulates remaining in air after the air passes through a scrubbing or other pollutant removal process.

Resource

In economic terms, anything with potential use in creating wealth or giving satisfaction.

Riparian

Lying on or adjacent to a river or lake. Used to denote people, plants or wildlife living along the water's edge.

Runoff

That part of precipitation, snowmelt, or irrigation water that runs off the land into streams or other surface water; can carry pollutants from the air and land into the receiving waters.

Salinity

Amount of dissolved salts (especially) sodium chloride) in a given volume of water.

Sedimentation

Letting solids settle out of waste water by gravity during wastewater treatment.

Sewage

The waste and wastewater produced by residential and commercial establishments and discharged into sewers.

Sewage sludge

Sludge produced at a municipal treatment works.

Silt

Fine particles of sand or rock that can be picked up by the air or water and deposited as sediment.

Sludge

A semisolid residue from any of a number of air or water treatment processes. Sludge can be hazardous waste.

Smog

Fog made heavier and darker by smoke. Air pollution associated with oxidants. See also Photochemical oxidants.

Smoke

Particles suspended in air after incomplete combustion of materials.

Soil

A complex mixture of weathered mineral materials from rocks, partially decomposed organic molecules, and a host of living organisms.

Solid wastes

Nonliquid, nonsoluble materials, ranging from municipal garbage to industrial wastes, that contain complex, and sometimes hazardous, substances. Solid wastes include sewage sludge, agricultural refuse, demolition wastes, and mining residues. Technically, solid wastes also refer to liquids and gases in containers.

Stack

A chimney or smokestack; a vertical pipe that discharges used air.

Sulfur dioxide (SO_2)

A heavy, pungent, colorless, gaseous air pollutant formed primarily by processes involving fossil fuel combustion.

Sustainable development

A real increase in well being and standard of life for the average person that can be maintained over the long-term without degrading the environment or compromising the ability of future generations to meet their own needs.

Surface water

All water naturally open to the atmosphere (rivers, lakes, reservoirs, streams, impoundments, seas, estuaries, etc.); also refers to springs, wells, or other collectors that are directly influenced by surface water.

Suspended solids

Small particles of solid pollutants that float on the surface of or are suspended in sewage or other liquids. They resist removal by conventional means. See also Total suspended solids.

Swamp

Wetland with trees, such as the extensive swamp forests of the southern United States.

Terracing

shaping the land to create level shelves of earth to hold water and soil; requires extensive hand labor or expensive machinery, but it enables farmer to farm very steep hillsides.

Thermal pollution

Discharge of heated water from industrial processes that can affect the life processes of aquatic organisms.

Total suspended solids (TSS)

A measure of the suspended solids in wastewater, effluent, or water bodies. See also Suspended solids

Toxic pollutants

Materials contaminating the environment that cause death, disease, or birth defects in organisms that ingest or absorb them. The quantities and length of exposure necessary to cause these effects can vary widely.

Toxic substance

A chemical or mixture that may present an unreasonable risk of injury to health or the environment.

Toxicity

The degree of danger posed by a substance to animal or plant life. See also Acute toxicity; Chronic toxicity

Urban runoff

Storm water from city streets and adjacent domestic or commercial properties that may carry pollutants of various kinds into sewer systems or receiving waters.

Vector

1. An organism, often an insect or rodent, that carries disease.

2. An object (e.g. plasmids, viruses, or other bacteria) used to transport genes into a host cell. A gene is placed in the vector; the vector then "infects" the bacterium.

Wastes

1. Unwanted materials left over from a manufacturing process.

2. Refuse from places of human or animal habitation.

Wastewater treatment plant

A facility containing a series of tanks, screens, filters, and other processes by which pollutants are removed from water.

Wastewater

Spent or used water from individual homes, communities, farms, or industries that contains dissolved or suspended matter.

Water pollution

The presence in water of enough harmful or objectionable material to damage water quality.

Water quality criteria

Specific levels of water quality that, if reached, are expected to render a body of water suitable fore its designated use. The criteria are based on specific levels of pollutants that would make the water harmful if used for drinking, swimming, farming, fish production, or industrial processes.

Water table

The top layer of the zone of saturation; undulates according to the surface topgraphy and subsurface structure.

Wilderness

An area of undeveloped land affected primarily by the forces of nature; an area where humans are visitors who do not remain.

Wildlife

Plants, animals and microbes that live independently of humans; plants, animals, and microbes that are not domesticated.

Woodland

A forest where tree crows cover less than 20 percent of the ground; also called open canopy.

1. INTRODUCTION

The development of seven hydropower stations in Nmai Hka and Mali Hka of Ayeyarwady is a mega project in Myanmar planned to meet the future needs of the national economy. The purpose is to generate hydropower, to control flood and to improve navigation. The hydropower dams will have total installed capacity of16500 MW and total annual power production will be 90.85 billion kWh. The two rivers are of high conservation importance. Height of the dams ranges from 100 meter to over 200 meter having storage capacity of 321 to 12400 million m^3 respectively. Most of the dams fall in the high dam category according to WCD standard. Feasibility studies were undertaken by China Power Investment Corporation. This assessment is aimed to avoid reckless exploitation of renewable power potentials as required by Myanmar Government. Biodiversity And Nature Conservation Association (BANCA) was assigned for the EIA study of the project.

2. OBJECTIVES

The study aims to collect baseline data of water, atmospheric, acoustic environment, point and non point pollution sources of the project area at present.

The basic data will anticipate and appraise impacts of this hydropower development. Follow up monitoring will give results as to whether there are significant changes compared to these baseline data which make necessary rectification possible.

Most of the investigation sites are at the proposed hydropower station sites but some are at specific river stations. The environmental baseline study is to fulfill part of the EIA requirements.

3. SCOPE OF WORK

In cooperation and in accordance with the BANCA group, survey teams performed the preliminary assessment of the water quality survey at low flow and high flow of the said river systems at selected river stations once in summer and another in rainy season of 2009.

The proposed project areas have a complex river ecosystem situated at the apex of the mighty Ayeyarwady river of Myanmar.

To carry out the works efficiently and comprehensively, BANCA established one survey team including soil and water scientists and engineers under the leadership of an experienced and qualified person.

An independent group of experts verified and analysed the collected data to study the present situation of environmental quality of the water, air and sound in the project area. This type of baseline survey is a prerequisite work. By implementing the project in Myanmar it is required to compare the pre-project baseline data with the post-project monitoring results. The purpose is to assess the changes and impacts caused by natural and man-made interventions in the natural river basins and to observe its ecosystem in both upstream and downstream of the Ayeyarwady river. As part of Environmental Impact Assessment, special investigation of the present surface water quality survey was made in the area above Myitkyina where hydropower development of Ayeyarwady River Basin has yet to be implemented. The investigations were done at low flow period starting from January to March in 2009 and at high flow period starting from June to August in 2009. Periodic monitoring of the same river station should be done successively before and after the implementation of the projects to get comprehensive results. But the survey team was able to assess the water quality of the said rivers within the limited time of one year in 2009 and analyze these data efficiently.

The team carried out the monitoring of surface water qualities at low flow and high flow consisting pH, water temperature, total suspended solids, BOD, COD, nitrogen, phosphorus, phenol, cyanide, oil and grease, arsenic, chromium, mercury and zinc in 18 river stations of proposed dam sites and the key tributaries of the river system.

The survey team's effort of monitoring the present water quality where hydropower projects are yet to be formulated in the uppermost part of Ayeyarwady river is a giant step forward for the future monitoring along the course of the Ayeyarwady inside Myanmar and up to the rice bowl of Ayeyarwady Delta.

3.1. Hydrology

3.1.1. Climate

Climate classification of the project area is made based on the rainfall and temperature data of the two meteorological stations, Myitkyina and Putao.

The warmest month of Myitkyina is August. It has a mean temperature 28.2°C. That of Putao is also August and it has the same temperature 28.2°C. The warmest month of both stations has a mean temperature above 10°C.

The coldest month of Myitkyina is January. It has a mean temperature 18.2°C. That of Putao is also January and it has a mean temperature 13.9°C. It can be said that the temperature of the coldest month of the area is between 18°C and 0°C.

According to this temperature basis, the area is in the main climatic group C, **humid mesothermal.**

For verifying the climatic subgroup, the temperature of the warmest month is the basic. That of both stations is over 22°C. The area is in the subgroup Ca, **humid subtropical, hot summers.**

The rainfall of Myitkyina in the wettest summer month, June, is 536 mm. The rainfall in the driest winter month, December, is 5 mm. At Putao, the rainfall in the summer month, July, is 1202 mm. That in the driest winter month, December, is 6 mm. It can be seen that the wettest rain is much more than 10 times the driest rain. The area is in the climatic subgroup Caw, **dry winters.**

The climatic group of the area is Caw, humid mesothermal, humid subtropical, hot summers and dry winters.

(Ref. Tropical Soil Manual, The Koppen Climate Classification, P. 381)

3.1.2. Rainfall and Runoff

The normal rainfall of the five stations in the project are as follows.

Table. 1

	Station	Annual rainfall (inches)	(mm)
1.	Putao	156.84	3984
2.	Sumprabum	136.67	3471
3.	Myitkyina	84.41	2144
4.	Htawgaw	82.98	2108
5.	Sadon	119.70	3040

The catchment area rainfall is computed to be 3352 mm, based on the above data. Then, the annual runoff is estimated as 114000 million cubic meters. The estimate of CISPDR, CWRC is 144500 million cubic meters, which is 127 percent of the present estimate.

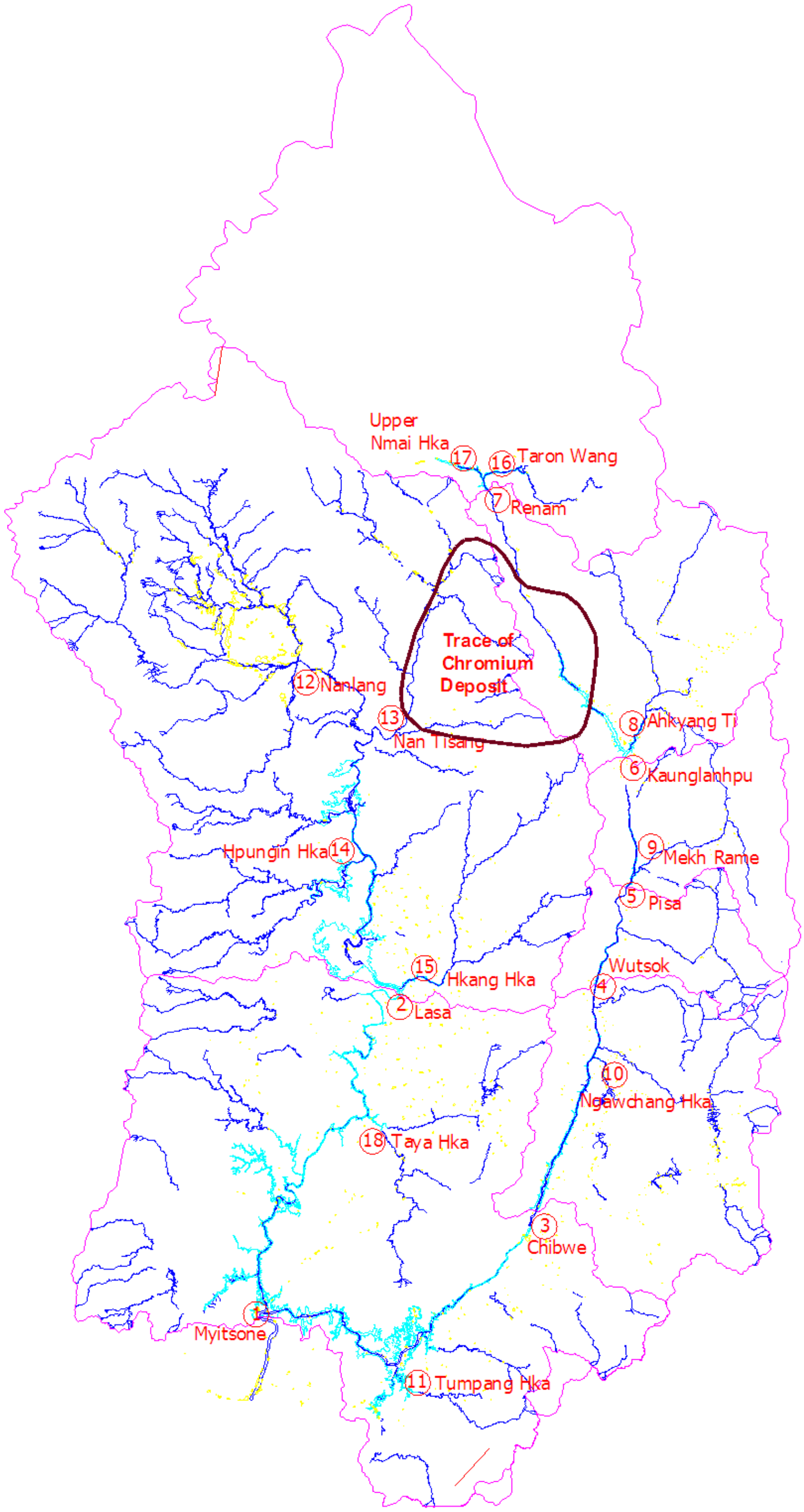
The average annual rainfall at two stations in the area, the period being 1999 to 2008 are as follows.

	Station	Annual Rainfall (mm)
1.	Myitkyina	2268
2.	Putao	4687

These rainfall values are a little higher than the normal values. Based on these data, the catchment area rainfall is again computed to be 3805 mm. The annual runoff is estimated as 133000 million cubic meters. The estimate of CISPDR becomes 108.5 percent of this estimate.

The estimate of CISPDR is considered acceptable in the prefeasibility or feasibility design.

FIG (1) LOCATION MAP OF HYDROPOWER STATION & TRIBUTARIES



3.2. Description of Hydropower Stations

Yenam Hydropower Station

1. Designation of Cascade - Yenam
2. Catchment Area - 11123 km^2
3. Average Discharge - 950 m^3/s
4. Average Run-Off - 302 Gm^3
5. Normal Tank Level - 1010 m
6. Total Storage Capacity - 12.37 Gm^3
7. Install Capacity - 1200 MW
8. Average Annual Power Generation -66.5 GkWh

Fig. 2 Proposed Hydropower Station Site of Yenam

Kaunglanhpu Hydropower Station

1. Designation of Cascade - Kaunglanhpu
2. Catchment Area - 14655 km^2
3. Average Discharge - 1300 m^3/s
4. Average Run-Off - 415 Gm^3
5. Normal Tank Level - 875 m
6. Total Storage Capacity - 31.72 Gm^3
7. Install Capacity - 2700 MW
8. Average Annual Power Generation -147.3 GkWh

Fig. 3 Proposed Hydropower Station Site of Kaunglanhpu

Pisa Hydropower Station

1. Designation of Cascade - Pisa
2. Catchment Area - 16689 km^2
3. Average Discharge - 1490 m^3/s
4. Average Run-Off - 472 Gm^3
5. Normal Tank Level - 665 m
6. Total Storage Capacity - 3.35 Gm^3
7. Install Capacity - 2000 MW
8. Average Annual Power Generation - 110.8 GkWh

Fig. 4 Proposed Hydropower Station Site of Pisa

Wutsok Hydropower Station

1. Designation of Cascad - Wutsok
2. Catchment Area - 18225 km^2
3. Average Discharge - 1610 m^3/s
4. Average Run-Off - 512 Gm^3
5. Normal Tank Level - 525 m
6. Total Storage Capacity - 3.21 Gm^3
7. Install Capacity - 1800 MW
8. Average Annual Power Generation - 101.4 GkWh

Fig. 5 Proposed Hydropower Station Site of Wutsok

Chibwe Hydropower Station

1. Designation of Cascade - Chibwe
2. Catchment Area -21734 km
3. Average Discharge- 1880 m^3/s
4. Average Run-Off- 598 Gm^3
5. Normal Tank Level- 400 m
6. Total Storage Capacity - 19.39 Gm^3
7. Install Capacity - 2800 MW
8. Average Annual Power Generation -152.1 GkWh

Fig.6 Proposed Hydropower Station Site of Chibwe

Lasa Hydropower Station

1. Designation of Cascade - Lasa
2. Catchment Area - 15291 km^2
3. Average Discharge - 1560 m^3/s
4. Average Run-Off - 945 Gm^3
5. Normal Tank Level - 370 m
6. Total Storage Capacity - 123.28 Gm^3
7. Install Capacity - 1940 MW
8. Average Annual Power Generation -104.4 GkWh

Fig. 7 Proposed Hydropower Station Site of Lasa

Myitsone Hydropower Station

1. Designation of Cascade - Myitsone
2. Catchment Area - 48782 km^2
3. Average Discharge - 4540 m^3/s
4. Average Run-Off - 1445 Gm^3
5. Normal Tank Level - 230 m
6. Total Storage Capacity - 99.37 Gm^3
7. Install Capacity - 4100 MW
8. Average Annual Power Generation - 226 GkWh

Fig. 8 Proposed Hydropower Station Site of Myitsone

3.3. Survey Team

U Nyo, Team Leader

Table. 2

Sr. No.	Designation	Team No. 1	Team No. 2	Team No. 3	Team No. 4
1	Leader Scientist	U Htay Kyawl	U Aung Myo Thu	U Than Tun Aung	U Soe Naing
2	Senior Scientist	U Kyaw Myo Khaine	U Htay Aung	U Aung Bo Bo Kyaw	U Zaw Win Myint
3	Assistant Scientist	U Thet Htun	U Thein Zaw	U Than Htut Win	U Thein Htay Aung

3.4 . Survey Area and Investigation Period

Table. 3

Sr. No.	Team No.	Location	GPS Value	Duration	
				Low flow	High flow
1	Team No.1			31.1.09 - 18.2.09	25.6.09 - 9.8.09
		Chibwe (Chibwi)	N- 25 54 ' 01" E - 98 07' 38"	5.2.09	1.8.09
		Wutsok (Pade)	N- 26 25' 54.5" E- 098 17' 34.5"	12.2.09	7.8 09
		Ngawchang Hka	N- 26 18' 50.8" E - 98 17' 26.0"	14.2.09	5.8.09
		Myitsone	3494313 903673	4.2.09	1.7.09
2	Team No.2.			23.1.09 - 15.2.09	1.7.09 - 11.8.09
		Yenan (Renam)	N- 27 41 13" E- 98 01' 43"	5.2.09	24.7.09
		Putao	N- 27 21' 26.5" E - 97 24' 09.6"	27.1.09	8.8.09
		Nan Tisang	N - 27 04' 54.4" E- 97 45' 58.3"	25.1.09	6.8.09
		Taron Wang	N - 27 42' 18.5" E - 98 03' 40.1"	5.2.09	23.7.09
		Upper Nmai Hka	N- 27 43' 21.1" E- 97 52' 23.3"	7.2.09	26.7.09
		Nan Lang	N- 27 15' 12.7" E- 97 35' 18.3"	26.1.09	7.8.09

3	Team No.3			23.1.09 - 24.2.09	8.7.09 - 18.8.09
		Ahkyan Ti	3571774 1055704	5.2.09	23.7.09
		Kaunglanhpu	3570968 1058630	4.2.09	21.7.09
		Pisa	3575643 1024533	11.2.09	7.8.09
4	Team No.4			4.2.09 - 24.2.09	24.6.09 - 1.7.09
		Hkang Hka	N - 26 28' 64.8" E - 97 49' 82.1"	21.2.09	30.6.09
		Taya Hka	N - 26 18' 75.2" E - 97 41' 72.1"	8.2.09	30.6.09
		Lasa	N - 26 28' 43.6" E - 97 49' 81.5"	22.2.09	29.6.09
		Hpunging Hka	N- 26 40' 93.1" E - 97 35' 65.8"	20.2.09	26.6.09

3.5. Notes on Exploration and Experiences of Field Survey Team

The survey team experienced a lot of difficulties in remote area of Kachin State while conducting the survey. Notes on their exploration and experiences were outlines in Appendix-1.

4. MATERIALS AND METHODS

4.1. Materials

4.1.1. Instruments used

(1) pH meter, water proof pH tester 2, microprocessor-based pH meter with ATC that (9816) floats, OAKTON Instrument, Germany. This is used for measuring of pH value.

(2) E.C Meter and Temperature Meter, OAKTON Instrument, Germany. This is meter is used for measuring of temperature at the time of samples.

(3) G.P.S. GARMIN (Trex-H) (Sr. 16Q 315917). It is used to be known for the locations of investigation site in GPS value.

(4) Sound Level Meter (TES - 1356 A Taiwan)

(5) Digital Camera, 71007984 Nikon, Japan (Cool pix). This is used for taking for photographs as record.

(6) Digital Camera, Panasonic, WR 8FACD 1162, Lumix, China. This is used for taking for photographs as record.

(7) Potable High Volume Air Sampler. The samples were taken to analysis the PM_{10} & SO_2. It is suitable for remote area.

(8) High Volume Air Sampler (Respirable Dust Sampler). This sampler is suitable for measurement of PM_{10} & SO_2 at Myitkyina and Myitsone site.

(9) Barometer - Measuring of elevation.

4.2. Methods

4.2.1. Methods of surface water sampling

Surface water samples for analyses were collected within the top 5 cm to 100 cm from the water surface (Water Quality Surveys - UNESCO , WHO). According to TOR, all investigation sites were specified by Changjiang Institute of Survey Planning, Design and Research The investigations were already carried out as the preliminary study of the surface water quality.

Plastic (polythene) containers of 8-litre capacity were used for collection of water samples. They were rinsed three times with water before collecting the sample. The simplest form of water sampling is taking water in a plastic bottle manually.

The sample bottles are labeled as follows:

(1) Location of water sample taken
(2) Date
(3) Time of Sampling
(4) Type of water

The samples were kept in tightly capped containers well marked by permanent marker. The samples were covered in black polythene bags to protect light and sent to the corresponding laboratories within specified period.

4.2.2. Field methods

Parameters like temperature and pH were measured by water proof pH tester 2, EC and Temperature meter. (The concentrations could be affected by temperature changes.)

Air pollution tests were carried out with high volume air sampler, for particulate matter and sulphur dioxide during the day from 07:00 hr - 22:00 hr and at night from 22:00 hr - 07:00 hr. The high volume air sampler was used at Myitkyina site. The portable air samplers were used at investigation sites in remote areas.

Sound level tests were carried out with sound level meter (TES - 1350 A) during the day 07:00 hr - 22:00 hr and at night from 22:00 hr - 07:00 hr.

4.2.3. Water quality analysis at laboratories

Table. 4

		Laboratory				
Sr. No.	Parameter	Myanma Scientific Technological Research Department	Water Quality Laboratory, Irrigation Department	Toxicology and Environmental Health Laboratory, Department of Health	Plant Protection Myanmar Agriculture Service	Land Use Laboratory, Myanmar Agriculture Service
1	pH		x			
2	Temperature		x			
3	Biochemical Oxygen Demand	x				
4	Chemical Oxygen Demand	x				
5	Total Suspended Solids	x				
6	Oil and Grease			x		
7	Phenol			x		
8	Cyanide	x				

9	Nitrogen					x
10	Phosphorus	x				
11	Arsenic	x				
12	Chromium				x	
13	Mercury			x		
14	Nickel				x	
15	Zinc	x				
16	Particulate Matter $_{10}$			x		
17	Sulphur dioxide			x		
18	Sound Levels			x		
19	Alkalinity		x			
20	Hardness		x			
21	Total Dissolved Solids		x			
22	Pesticides				x	
23	Turbidity		x			

4.2.4. Laboratory analysis methods

The water samples were tested in the laboratories by routine methods as described below.

(1) Total hardness - By EDTA titration method

(2) Total alkalinity - The estimation is based on simple titration using different indicator

(3) pH - Measured by water proof pH tester 2, Microprocessor based with ATC, OAKTON Instrument.

(Association of official analytical Chemists, AOAC Knick pH meter 765 Germany)

(4) Turbidity - Measured by U_{10} Checker meter

(5) Temperature - Measured by E.C meter and Temperature meter, OAKTON Instrument.

(6) Total Dissolved Solids - Measured by TDS meter

(7) Nickel - Measured by Atomic Absorption Spectrometer

- The bottles are rinsed with nitric acid (1:1 with distilled deionized water)
- Preservation, added 2 ml conc. HNO_3/l of water sample.

Model : A Analyst 200, Technique:

(8) Chromium - Measured by Atomic Absorption Spectrometer

- The bottles were rinsed with nitric acid (1:1 with distilled deionized water)
- Preservation added 2 ml conc. HNO_3/l of water sample

Model : A Analyst 200, Technique: AAFlame

(9) Pesticides - Analyzed by Clarus 500, GC with FFD Perkin Elemer

(1) Malathion — Analytical method of pesticides and plant Growth Regulator

(2) Chlorpyrifos "

(3) Diazinon "

(4) Fenitrothion "

(5) Diamethoate "

(6) Dichlorvos "

(7) Methomyl "

(8) Trizophos "

(10)Total Suspend Solids is determined by evaporating method

(11)Zinc - Zinc content is determined using following apparatus. The bottles were rinsed with nitric acid (1:1 with distilled deionized water) preservation added 2ml/concentrate HNO_3/l of water sample.

(1) Atomic Absorption Spectrophotometer

(2) Burner

(3) Recorder

(4) Hollow Cathode Lamps

(5) Pressure - Reducing values

(6) Vent

(12)Arsenic - by silver diethyl dithiocarbonate method. The bottles were rinsed with nitric acid (1:1 with NaOH to rinsed pH 11.0 for preservation.

(13)Cyanide (CN)

By Spectrophotometer or Filterphotometer using following reagents:

(1) Chloromine - T solution

(2) Stock cyanide solution

(3) Standard cyanide solution

(4) Pyride-barbituric acid reagent

(5) Sodium dihydrogen phosphate

(6) Sodium hydroxide solution

(14)Phosphorus - Digestion method was used for Phosphorus. The collected sample was preserved with adding 1ml 30% H_2SO_4/100 ml of water.

(15)Biochemical oxygen demand (BOD) was measured by the following apparatus

(1) Incubation bottles, 250 to 300 ml capacity, with ground glass stoppers.

(2) Air incubator or water bath, thermostatically controlled at 20ü C+ 1C, air tight to prevent formation of DQ by algae in the sample.

Reagents used for BOD analysis are :

(1) Distilled water

(2) Phosphate buffer solution

(3) Magnesium sulfate solution
(4) Calcium Chloride solution
(5) Ferric Chloride solution
(6) Acid and alkali solutions
(7) Sodium sulfite solution
(8) Seeding

(16) Chemical Oxygen Demand (C.O.D)

By Reflux apparatus :

Reagent used are

(1) Standard potassium dichromate
(2) Sulfuric reagent
(3) Standard Ferrous ammonium sulfate titration

(17) Nitrogen - Spectrophotometer .The water sample was preserved by adding. 8ml. H_2SO_4/l of sample.

(18) Phenols - Stem-distillable phenolic compounds react with 4-amino antipyrine at pH 7.9 in the presence of potassium ferricyanide to form a coloured antipyrine dye, which is then measured photometrically.

The water samples preservation was done by caustic soda (NaOH) and glass bottles.

The apparatus used for phenols analysis are:

(1) Spectrophotometer
(2) pH meter
(3) Reagent buffer P.1 (0.5 N Ammonium hydroxide)
(4) Reagent solution P.2 (Phosphate buffer solution pH 7.9
(5) Reagent solution P-3 (4-ammino antipyrine solution)
(6) Reagent solution P-4 (Potassium Ferricyanide solution)

(19) Oils and Grease

(petroleum ether and concentrated H_2SO_4)

(20) Mercury - By Dithizone Methods. Preservation was done by treating with HNO_3 to reduce the pH < 2.0.

The apparatus used are :

(1) Spectrophotometer
(2) Reparatory funnels
(3) Glass ware

The Reagents used are:

(1) Mercury-free water
(2) Stock mercury solution
(3) Standard mercury
(4) Potassium permanganate solution ($K Mn O_4$)

(5) Potassium per sulfate solution ($K_2 S_2 O_8$)

(6) Hydroxylamine hydrochloride solution (NH_2 OH-HCL)

(7) Dithizone solution ($CHCL_3$)

(8) Sulfuric acid (H_2SO_4) concentration

(9) Sulfuric acid (H_2SO_4) dilute

(10) Potassium bromite solution (KBr)

(11) Chloroform ($CHCI_3$)

(12) Phosphate-carbonate (Na_2HPO_4 - $12H_2O$)

(13) Sodium sulphate (Na_2SO_4)

(21) Suspended Particulate Matter (SPM)

By High Volume Sampling Method - The apparatus body is composed of :

(1) Upper portion - filter holder and adopter,

(2) Second portion - flow controller with timer assembly (with resettable running time meter), and

(3) The third portion - motor, orifice and flow recorder.

High volume sampling unit consists of :

(1) HVS shelter

(2) Flow recorder

(3) Flow controller

(4) Elapsed Time Meter

(5) Barometer

(6) Calibration system for flow rate measurement

- Orifice calibration unit
- Differential manometer
- Calibrated positive displacement meter (roots meter)

(7) Filter Conditioning Chamber or Desicator

(8) Analytical Balance

(9) Light Source

(10) Numbering Device

(22) Sulphur Dioxide (SO_2) - Central Laboratory Test Method (modified West and Gaeke method)

The reagents and apparatus used are :

(1) A solution of potassium tetrachloro-mercurate (TCM)

(2) A dichloro sulphilo mercurate complex

(3) Paraosamiline and formaldehyde

(4) A suitable spectrophotometer

(23) Ambient Noise By TES sound Level Meter (TES - 1350 A)

Environment conditions required for the apparatus are :

(1) Altitude up to 2000 meters

(2) Relative humidity 90% max

(3) Operation Ambient 0 - 40 °C

Measuring level range 35 dB to 130 dB.

5. RESULT AND ANALYSIS

5.1. Surface Water

The water samples were tested at relevant laboratories in Yangon. The detailed analytical results are shown in the following Table 5 to 22.

Table 5. Laboratory Result of Surface Water at Myitsone

Parameter	Unit	Limit	Low flow period	High flow period	Remark
pH		6-9	7.88	7.04	
Temperature (A)	C	max 3 C<	29.7	28.7	
Temperature (B)	C	max 3 C<	14.8	22.5	
BOD	mg/l	50	0.6	N.D	
COD	mg/l	250	3.04	3.68	
TSS	mg/l	50	13	550	
Oil and Grease	mg/l	10	2	192	
Phenol	mg/l	0.5	0	3.5	
Cyanide	mg/l	1	< 0.10	< 0.10	
Nitrogen	mg/l	10	22.4	33.2	
Phosphorus	mg/l	2	< 0.05	2.5	
Arsenic	mg/l	0.1	< 0.01	< 0.01	
Chromium	mg/l	0.5	N.D	N.D	
Mercury	mg/l	0.01	0.007	0.0065	
Nickel	mg/l	0.5	N.D	N.D	
Zinc	mg/l	2	< 1.0	< 1.00	

Note Limits for Process Wastewater, Domestic Sewage, and Contaminated Storm water Discharged to Surface Waters, for General Application (Pollution Prevention and Abatement Handbook 1998 Toward Cleaner Production -The World Bank).

Temperature(A) At Laboratory

Temperature(B) At Field

TSS	At high flow, TSS increased more than standard limit due to increased flow. It includes clay, silt, plant -fibre and biological solids.
Phenol	At high flow the level is higher than standard limit due to high volume flow. It includes decomposition of some species of higher plants and reed, rotting vegetables and coal.
Nitrogen	Nitrogen level is higher than standard limit, due to polluted discharge both at low flow and high flow situations. The source is agricultural run-off or animal waste and decomposition of plants at high flow.
Phosphorus	Slightly higher than standard limit. It is due to constituent of plants or animal tissues and municipal wastewater. It appears exclusively as phosphate in aquatic environment. The other sources are agricultural fertilizer and manure through ground water.
N.D	Not detected

Table 6. Laboratory Results of Surface Water at Lasa

Parameter	Unit	Limit	Low flow period	High flow period	Remark
pH		6-9	7.49	7.15	
Temperature (A)	˚C	max 3˚C<	31.1	28.7	
Temperature (B)	˚C	max 3˚C<	25.4	20.9	
BOD	mg/l	50	N.D	N.D	
COD	mg/l	250	2	N.D	
TSS	mg/l	50	5	5	
Oil and Grease	mg/l	10	10	3.5	
Phenol	mg/l	0.5	0	5.3	
Cyanide	mg/l	1	< 0.1	< 0.10	
Nitrogen	mg/l	10	19.6	30.24	
Phosphorus	mg/l	2	< 0.50	2.50	
Arsenic	mg/l	0.1	< 0.01	< 0.01	
Chromium	mg/l	0.5	0.545	N.D	
Mercury	mg/l	0.01	0.005	0	
Nickel	mg/l	0.5	N.D	N.D	
Zinc	mg/l	2	< 1.0	< 1.00	

Note	Limits for Process Wastewater, Domestic Sewage, and Contaminated Storm water Discharged to Surface Waters, for General Application (Pollution Prevention and Abatement Handbook 1998 Toward Cleaner Production-The

World Bank).

Temperature (A) -	At Laboratory
Temperature (B) -	At Field
Phenol	At high flow the level is higher than standard limit due to high volume flow. It includes decomposition of some species of higher plants and reeds, rotting vegetables and coal.
Nitrogen	Nitrogen level is higher than standard limit, due to polluted discharge both at low flow and high flow situations. The source is agricultural run - off or animal waste and decomposition of plants at high flow.
Phosphorus	Slightly higher than standard limit. It is due to constituent of plants or animal tissues.
N.D	Not detected

Table 7. Laboratory Results of Surface Water at Chibwe (Chibwi)

Parameter	Unit	Limit	Low flow period	High flow period	Remark
pH		6-9	7.53	7.46	
Temperature (A)	˚C	max 3˚C<	30.3	28.7	
Temperature (B)	˚C	max 3˚C<	23.5	33.1	
BOD	mg/l	50	0.2	N.D	
COD	mg/l	250	N.D	N.D	
TSS	mg/l	50	< 5.00	430	
Oil and Grease	mg/l	10	3	3.13	
Phenol	mg/l	0.5	0	5.1	
Cyanide	mg/l	1	< 0.1	< 0.10	
Nitrogen	mg/l	10	19.6	21.16	
Phosphorus	mg/l	2	< 0.50	< 0.10	
Arsenic	mg/l	0.1	< 0.01	< 0.01	
Chromium	mg/l	0.5	0.542	N.D	
Mercury	mg/l	0.01	0.0038	0.0032	
Nickel	mg/l	0.5	N.D	N.D	
Zinc	mg/l	2	< 1.0	< 1.00	

Note	Limits for Process Wastewater, Domestic Sewage, and Contaminated Storm water Discharged to Surface Waters, for General Application (Pollution Prevention and Abatement Handbook 1998 Toward Cleaner Production - The World Bank).
Temperature (A)	At Laboratory
Temperature (B)	At Field
TSS	At high flow, TSS increased more than standard limit due to increased flow. It includes clay, silt, plant -fiber and biological solids.
Phenol	At high flow the level is higher than standard limit due to high volume flow. It includes decomposition of some species of higher plants and reeds, rotting vegetables and coal.
Nitrogen	Nitrogen level is higher than standard limit, due to polluted discharge both at low flow and high flow situations. The source is agricultural run-off or animal waste and decomposition of plants at high flow.
N.D	Not detected

Table 8. Laboratory Result of Surface Water at Wutsok

Parameter	Unit	Limit	Low flow period	High flow period	Remark
pH		6-9	7.54	7.36	
Temperature (A)	˚C	max 3˚C<	30.4	27.7	
Temperature (B)	˚C	max 3˚C<	22.9	21.8	
BOD	mg/l	50	0.8	0.2	
COD	mg/l	250	N.D	52.8	
TSS	mg/l	50	< 5.00	200	
Oil and Grease	mg/l	10	6	16.6	
Phenol	mg/l	0.5	0	4.8	
Cyanide	mg/l	1	< 0.1	< 0.10	
Nitrogen	mg/l	10	36.4	40.32	
Phosphorus	mg/l	2	< 0.50	< 0.10	
Arsenic	mg/l	0.1	< 0.01	< 0.01	
Chromium	mg/l	0.5	0.508	N.D	
Mercury	mg/l	0.01	0.0055	0.001	
Nickel	mg/l	0.5	N.D	N.D	
Zinc	mg/l	2	< 1.0	< 1.00	

Note	Limits for Process Wastewater, Domestic Sewage, and Contaminated Storm water Discharged to Surface Waters, for General Application (Pollution Prevention and Abatement Handbook 1998 Toward Cleaner Production-The World Bank).
Temperature (A) -	At Laboratory
Temperature (B) -	At Field
TSS	At high flow, TSS increased more than standard limit due to increased flow. It includes clay, silt, plant-fibre and biological solids.
Oil and Grease	At high flow, oil and grease level is higher than standard limit. It includes hydrocarbon, fatty acid, soaps, fats, waxes and coal.
Phenol	At high flow the level is higher than standard limit due to high volume flow. It includes decomposition of some species of higher plants and reeds, rotting vegetables and coal.
Nitrogen	Nitrogen level is higher than standard limit, due to polluted discharge both at low flow and high flow situations. The source is agricultural run-off or animal waste and decomposition of plants at high flow.
N.D	Not detected

Table 9. Laboratory Result of Surface Water at Pisa

Parameter	Unit	Limit	Low flow period	High flow period	Remark
PH		6-9	7.54	7.51	
Temperature (A)	˚C	max 3˚C<	31.3	27.4	
Temperature (B)	˚C	max 3˚C<	24.2	22.3	
BOD	mg/l	50	N.D	N.D	
COD	mg/l	250	N.D	3.52	
TSS	mg/l	50	20	120	
Oil and Grease	mg/l	10	2	6.19	
Phenol	mg/l	0.5	0	4.3	
Cyanide	mg/l	1	< 0.1	< 0.10	
Nitrogen	mg/l	10	16.8	25.2	
Phosphorus	mg/l	2	< 0.50	< 0.10	
Arsenic	mg/l	0.1	< 0.01	< 0.01	
Chromium	mg/l	0.5	0.585	N.D	
Mercury	mg/l	0.01	0.006	0.0047	
Nickel	mg/l	0.5	N.D	N.D	
Zinc	mg/l	2	< 1.0	< 1.00	

Note	Limits for Process Wastewater, Domestic Sewage, and Contaminated Storm water Discharged to Surface Waters, for General Application (Pollution Prevention and Abatement Handbook 1998 Toward Cleaner Production - The World Bank)
Temperature (A) -	At Laboratory
Temperature (B) -	At Field
TSS	At high flow, TSS increased more than standard limit due to increased flow. It includes clay, silt, plant-fibre and biological solids.
Phenol	At high flow the level is higher than standard limit due to high volume flow. It includes decomposition of some species of higher plants and reeds, rotting vegetables and coal.
Nitrogen	Nitrogen level is higher than standard limit, due to polluted discharge both at low flow and high flow situations. The source is agricultural run-off or animal waste and decomposition of plants at high flow.
N.D	Not detected

Table 10. Laboratory Result of Surface Water at Kaunglanhpu

Parameter	Unit	Limit	Low flow period	High flow period	Remark
PH		6-9	7.6	7.1	
Temperature (A)	˚C	max 3˚C<	31.6	27.9	
Temperature (B)	˚C	max 3˚C<	14.5	26.8	
BOD	mg/l	50	N.D	N.D	
COD	mg/l	250	N.D	N.D	
TSS	mg/l	50	5	100	
Oil and Grease	mg/l	10	3	3.43	
Phenol	mg/l	0.5	0	3.5	
Cyanide	mg/l	1	< 0.1	< 0.10	
Nitrogen	mg/l	10	16.8	69..00	
Phosphorus	mg/l	2	< 0.50	2.5	
Arsenic	mg/l	0.1	< 0.01	< 0.01	
Chromium	mg/l	0.5	0.588	N.D	
Mercury	mg/l	0.01	0.005	0	
Nickel	mg/l	0.5	N.D	N.D	
Zinc	mg/l	2	< 1.0	< 1.00	

Note	Limits for Process Wastewater, Domestic Sewage, and Contaminated Storm water Discharged to Surface Waters, for General Application (Pollution Prevention and Abatement Handbook 1998 Toward Cleaner Production - The World Bank).
Temperature (A) -	At Laboratory
Temperature (B) -	At Field
TSS	At high flow, TSS increased more than standard limit due to increased flow. It includes clay, silt, plant-fibre and biological solids.
Phenol	At high flow the level is higher than standard limit due to high volume flow. It includes decomposition of some species of higher plants and reeds, rotting vegetables and coal.
Nitrogen	Nitrogen level is higher than standard limit, due to polluted discharge both at low flow and high flow situations. The source is agricultural run-off or animal waste and decomposition of plants at high flow.
N.D	Not detected

Table 11. Laboratory Result of Surface Water at Yenam

Parameter	Unit	Limit	Low flow period	High flow period	Remark
pH		6-9	7.43	7.04	
Temperature (A)	˚C	max 3˚C<	30.1	27.1	
Temperature (B)	˚C	max 3˚C<	13.9	21.4	
BOD	mg/l	50	0.02	N.D	
COD	mg/l	250	4	1.84	
TSS	mg/l	50	< 5.00	15	
Oil and Grease	mg/l	10	2	2.2	
Phenol	mg/l	0.5	0	4.3	
Cyanide	mg/l	1	< 0.1	< 0.10	
Nitrogen	mg/l	10	19.6	15.12	
Phosphorus	mg/l	2	< 0.50	< 0.10	
Arsenic	mg/l	0.1	< 0.01	< 0.01	
Chromium	mg/l	0.5	0.547	N.D	
Mercury	mg/l	0.01	0.006	0.0024	
Nickel	mg/l	0.5	N.D	N.D	
Zinc	mg/l	2	< 1.0	< 1.00	

Note	Limits for Process Wastewater, Domestic Sewage, and Contaminated Storm water Discharged to Surface Waters, for General Application (Pollution Prevention and Abatement Handbook 1998 Toward Cleaner Production - The World Bank).
Temperature (A) -	At Laboratory
Temperature (B) -	At Field
TSS	At high flow, TSS increased more than standard limit due to increased flow. It includes clay, silt, plant -fibre and biological solids.
Phenol	At high flow the level is higher than standard limit due to high volume flow. It includes decomposition of some species of higher plants and reeds, rotting vegetables and coal.
Nitrogen	Nitrogen level is higher than standard limit, due to polluted discharge both at low flow and high flow situations. The source is agricultural run-off or animal waste and decomposition of plants at high flow.
N.D	Not detected

Table 12. Laboratory Result of Surface Water at Ahkyang Ti

Parameter	Unit	Limit	Low flow period	High flow period	Remark
pH		6-9	7.54	7.2	
Temperature (A)	˚C	max 3˚C<	32.0	27.8	
Temperature (B)	˚C	max 3˚C<	16.1	26.2	
BOD	mg/l	50	N.D	N.D	
COD	mg/l	250	N.D	N.D	
TSS	mg/l	50	5	400	
Oil and Grease	mg/l	10	1	11.13	
Phenol	mg/l	0.5	0	3.2	
Cyanide	mg/l	1	< 0.1	< 0.10	
Nitrogen	mg/l	10	19.6	32.76	
Phosphorus	mg/l	2	< 0.50	< 0.10	
Arsenic	mg/l	0.1	< 0.01	< 0.01	
Chromium	mg/l	0.5	0.56	N.D	
Mercury	mg/l	0.01	0.0047	0	
Nickel	mg/l	0.5	N.D	N.D	
Zinc	mg/l	2	< 1.0	< 1.00	

Note	Limits for Process Wastewater, Domestic Sewage, and Contaminated Storm water Discharged to Surface Waters, for General Application (Pollution Prevention and Abatement Handbook 1998 Toward Cleaner Production-The World Bank).
Temperature (A) -	At Laboratory
Temperature (B) -	At Field
TSS	At high flow, TSS increased more than standard limit due to increased flow. It includes clay, silt, plant -fiber and biological solids.
Oil and Grease	At high flow, oil and grease level is higher than standard limit. It includes hydrocarbon, fatty acid, soaps, fats, waxes and coal.
Nitrogen	Nitrogen level is higher than standard limit, due to polluted discharge both at low flow and high flow situations. The source is agricultural run-off or animal waste and decomposition of plants at high flow.
N.D	Not detected

Table 13. Laboratory Result of Surface Water at Mekh Rame

Parameter	Unit	Limit	Low flow period	High flow period	Remark
pH		6-9	7.65	7.5	
Temperature (A)	˚C	max 3˚C<	30.7	27.8	
Temperature (B)	˚C	max 3˚C<	15.9	23.7	
BOD	mg/l	50	N.D	N.D	
COD	mg/l	250	N.D	N.D	
TSS	mg/l	50	15	80	
Oil and Grease	mg/l	10	3	4.57	
Phenol	mg/l	0.5	0	4.5	
Cyanide	mg/l	1	< 0.1	< 0.1	
Nitrogen	mg/l	10	19.6	30.2	
Phosphorus	mg/l	2	< 0.50	< 0.50	
Arsenic	mg/l	0.1	< 0.01	< 0.01	
Chromium	mg/l	0.5	0.585	N.D	
Mercury	mg/l	0.01	0.0062	0.0057	
Nickel	mg/l	0.5	N.D	N.D	
Zinc	mg/l	2	< 1.0	< 1.0	

Note	Limits for Process Wastewater, Domestic Sewage, and Contaminated Storm water Discharged to Surface Waters, for General Application (Pollution Prevention and Abatement Handbook 1998 Toward Cleaner Production - The World Bank).
Temperature (A) -	At Laboratory
Temperature (B) -	At Field
TSS	At high flow, TSS increased more than standard limit due to increased flow. It includes clay, silt, plant -fiber and biological solids.
Phenol	At high flow the level is higher than standard limit due to high volume flow. It includes decomposition of some species of higher plants and reeds, rotting vegetables and coal.
Nitrogen	Nitrogen level is higher than standard limit, due to polluted discharge both at low flow and high flow situations. The source is agricultural run-off or animal waste and decomposition of plants at high flow.
Phosphorus	Slightly higher than standard limit. It is due to constituent of plants or animal tissues and municipal wastewater. It appears exclusively as phosphate in aquatic environment. The other sources are agricultural fertilizer and manure through ground water.
N.D	Not detected

Table 14. Laboratory Result of Surface Water at Ngawchang Hka

Parameter	Unit	Limit	Low flow period	High flow period	Remark
pH		6-9	7.56	7.24	
Temperature (A)	˚C	max 3˚C<	30.7	27.6	
Temperature (B)	˚C	max 3˚C<	24.8	21.9	
BOD	mg/l	50	0.4	N.D	
COD	mg/l	250	N.D	5.28	
TSS	mg/l	50	250	170	
Oil and Grease	mg/l	10	4	3.9	
Phenol	mg/l	0.5	0	4.8	
Cyanide	mg/l	1	< 0.1	< 0.10	
Nitrogen	mg/l	10	22.4	7.75	
Phosphorus	mg/l	2	< 0.50	< 0.10	
Arsenic	mg/l	0.1	< 0.01	< 0.01	
Chromium	mg/l	0.5	0.565	N.D	
Mercury	mg/l	0.01	0	0.0059	
Nickel	mg/l	0.5	N.D	N.D	

Zinc	mg/l	2	< 1.0	< 1.00	

Note — Limits for Process Wastewater, Domestic Sewage, and Contaminated Storm water Discharged to Surface Waters, for General Application (Pollution Prevention and Abatement Handbook 1998 Toward Cleaner Production (The World Bank).

Temperature (A) — At Laboratory

Temperature (B) — At Field

TSS — At high flow, TSS increased more than standard limit due to increased flow. It includes clay, silt, plant -fiber and biological solids.

Phenol — At high flow the level is higher than standard limit due to high volume flow. It includes decomposition of some species of higher plants and reeds, rotting vegetables and coal.

Nitrogen — Nitrogen level is higher than standard limit, due to polluted discharge both at low flow and high flow situations. The source is agricultural run-off or animal waste and decomposition of plants at high flow.

N.D — Not detected

Table 15. Laboratory Result of Surface Water at Tumpang Hka

Parameter	Unit	Limit	Low flow period	High flow period	Remark
pH		6-9	7.61	7.52	
Temperature (A)	˚C	max 3˚C<	30.3	28.7	
Temperature (B)	˚C	max 3˚C<	21.8	33.6	
BOD	mg/l	50	0.6	N.D	
COD	mg/l	250	2.0	3.68	
TSS	mg/l	50	< 5.00	100	
Oil and Grease	mg/l	10	4.0	3.4	
Phenol	mg/l	0.5	0	5.2	
Cyanide	mg/l	1	< 0.1	< 0.10	
Nitrogen	mg/l	10	33.6	42.12	
Phosphorus	mg/l	2	< 0.50	< 0.10	
Arsenic	mg/l	0.1	< 0.01	< 0.01	
Chromium	mg/l	0.5	0.548	N.D	
Mercury	mg/l	0.01	0.0044	0.0038	
Nickel	mg/l	0.5	N.D	N.D	
Zinc	mg/l	2	< 1.0	< 1.0	

Note	Limits for Process Wastewater, Domestic Sewage, and Contaminated Storm water Discharged to Surface Waters, for General Application (Pollution Prevention and Abatement Handbook 1998 Toward Cleaner Production (The World Bank).
Temperature (A) -	At Laboratory
Temperature (B) -	At Field
TSS	At high flow, TSS increased more than standard limit due to increased flow. It includes clay, silt, plant -fiber and biological solids.
Phenol	At high flow the level is higher than standard limit due to high volume flow. It includes decomposition of some species of higher plants and reeds, rotting vegetables and coal.
Nitrogen	Nitrogen level is higher than standard limit, due to polluted discharge both at low flow and high flow situations. The source is agricultural run-off or animal waste and decomposition of plants at high flow.
N.D	Not detected

Table 16. Laboratory Result of Surface Water at Nan Lang

Parameter	Unit	Limit	Low flow period	High flow period	Remark
pH		6-9	7.51	7.38	
Temperature (A)	˚C	max 3˚C<	29.7	27.6	
Temperature (B)	˚C	max 3˚C<	18.9	26.4	
BOD	mg/l	50	N.D	0.2	
COD	mg/l	250	N.D	8.8	
TSS	mg/l	50	< 5.00	60	
Oil and Grease	mg/l	10	1	3.03	
Phenol	mg/l	0.5	0	4.8	
Cyanide	mg/l	1	< 0.1	< 0.10	
Nitrogen	mg/l	10	31.4	17.64	
Phosphorus	mg/l	2	< 0.50	< 0.10	
Arsenic	mg/l	0.1	< 0.01	< 0.01	
Chromium	mg/l	0.5	N.D	N.D	
Mercury	mg/l	0.01	0.0063	0.0021	
Nickel	mg/l	0.5	N.D	0.011	
Zinc	mg/l	2	< 1.0	< 1.0	

Note	Limits for Process Wastewater, Domestic Sewage, and Contaminated Storm water Discharged to Surface Waters, for General Application (Pollution Prevention and Abatement Handbook 1998 Toward Cleaner Production (The World Bank).
Temperature (A) -	At Laboratory
Temperature (B) -	At Field
TSS	At high flow, TSS increased more than standard limit due to increased flow. It includes clay, silt, plant -fiber and biological solids.
Phenol	At high flow the level is higher than standard limit due to high volume flow. It includes decomposition of some species of higher plants and reeds, rotting vegetables and coal.
Nitrogen	Nitrogen level is higher than standard limit, due to polluted discharge both at low flow and high flow situations. The source is agricultural run-off or animal waste and decomposition of plants at high flow.
N.D	Not detected

Table 17. Laboratory Result of Surface Water at Nan Tisang

Parameter	Unit	Limit	Low flow period	High flow period	Remark
pH		6-9	7.6	6.64	
Temperature (A)	˚C	max 3˚C<	27.9	27.6	
Temperature (B)	˚C	max 3˚C<	18	23.8	
BOD	mg/l	50	N.D	0.4	
COD	mg/l	250	N.D	5.28	
TSS	mg/l	50	< 5.00	20	
Oil and Grease	mg/l	10	8	2.3	
Phenol	mg/l	0.5	0	4.5	
Cyanide	mg/l	1	< 0.1	< 0.1	
Nitrogen	mg/l	10	20.4	63.0	
Phosphorus	mg/l	2	< 0.50	< 0.1	
Arsenic	mg/l	0.1	< 0.01	< 0.01	
Chromium	mg/l	0.5	N.D	N.D	
Mercury	mg/l	0.01	0	0.0018	

Nickel	mg/l	0.5	N.D	N.D	
Zinc	mg/l	2	< 1.0	< 1.0	

Note	Limits for Process Wastewater, Domestic Sewage, and Contaminated Storm water Discharged to Surface Waters, for General Application (Pollution Prevention and Abatement Handbook 1998 Toward Cleaner Production - The World Bank)
Temperature (A) -	At Laboratory
Temperature (B) -	At Field
Phenol	At high flow the level is higher than standard limit due to high volume flow. It includes decomposition of some species of higher plants and reeds, rotting vegetables and coal.
Nitrogen	Nitrogen level is higher than standard limit, due to polluted discharge both at low flow and high flow situations. The source is agricultural run-off or animal waste and decomposition of plants at high flow.
N.D	Not detected

Table 18. Laboratory Result of Surface Water at Hpungin Hka

Parameter	Unit	Limit	Low flow period	High flow period	Remark
PH		6-9	7.56	7.21	
Temperature (A)	˚C	max 3˚C<	31.2	28.7	
Temperature (B)	˚C	max 3˚C<	22.4	28.7	
BOD	mg/l	50	N.D	N.D	
COD	mg/l	250	N.D	1.84	
TSS	mg/l	50	5	15	
Oil and Grease	mg/l	10	3	1.7	
Phenol	mg/l	0.5	0	5.4	
Cyanide	mg/l	1	< 0.1	< 0.1	
Nitrogen	mg/l	10	16.8	48.38	
Phosphorus	mg/l	2	< 0.50	7.5	
Arsenic	mg/l	0.1	< 0.01	< 0.01	
Chromium	mg/l	0.5	0.575	N.D	
Mercury	mg/l	0.01	0	0	

Nickel	mg/l	0.5	N.D	N.D	
Zinc	mg/l	2	< 1.0	< 1.0	

Note — Limits for Process Wastewater, Domestic Sewage, and Contaminated Storm water Discharged to Surface Waters, for General Application (Pollution Prevention and Abatement Handbook 1998 Toward Cleaner Production (The World Bank)).

Temperature (A) - At Laboratory

Temperature (B) - At Field

Phenol — At high flow the level is higher than standard limit due to high volume flow. It includes decomposition of some species of higher plants and reeds, rotting vegetables and coal.

Nitrogen — Nitrogen level is higher than standard limit, due to polluted discharge both at low flow and high flow situations. The source is agricultural run-off or animal waste and decomposition of plants at high flow.

Phosphorus — Slightly higher than standard limit. It is due to constituent of plants or animal tissues and municipal wastewater. It appears exclusively as phosphate in aquatic environment. The other sources are agricultural fertilizer and manure through ground water.

N.D — Not detected

Table 19. Laboratory Result of Surface Water at Hkang Hka

Parameter	Unit	Limit	Low flow period	High flow period	Remark
pH		6-9	7.53	7.14	
Temperature (A)	˚C	max 3˚C<	29.7	28.7	
Temperature (B)	˚C	max 3˚C<	21.7	20.9	
BOD	mg/l	50	0.2	N.D	
COD	mg/l	250	2	N.D	
TSS	mg/l	50	< 5.00	105	
Oil and Grease	mg/l	10	2	3.45	
Phenol	mg/l	0.5	0	4.8	
Cyanide	mg/l	1	< 0.1	< 0.10	
Nitrogen	mg/l	10	33.6	24.19	
Phosphorus	mg/l	2	< 0.50	< 0.10	
Arsenic	mg/l	0.1	< 0.01	< 0.01	
Chromium	mg/l	0.5	0.477	N.D	

Mercury	mg/l	0.01	0.0047	0.0047	
Nickel	mg/l	0.5	N.D	N.D	
Zinc	mg/l	2	< 1.0	< 1.00	

Note — Limits for Process Wastewater, Domestic Sewage, and Contaminated Storm water Discharged to Surface Waters, for General Application (Pollution Prevention and Abatement Handbook 1998 Toward Cleaner Production-The World Bank).

Temperature (A) - At Laboratory

Temperature (B) - At Field

TSS — At high flow, TSS increased more than standard limit due to increased flow. It includes clay, silt, plant -fibre and biological solids.

Phenol — At high flow the level is higher than standard limit due to high volume flow. It includes decomposition of some species of higher plants and reeds, rotting vegetables and coal.

Nitrogen — Nitrogen level is higher than standard limit, due to polluted discharge both at low flow and high flow situations. The source is agricultural run-off or animal waste and decomposition of plants at high flow.

N.D — Not detected

Table 20. Laboratory Result of Surface Water at Taron Wang

Parameter	Unit	Limit	Low flow period	High flow period	Remark
pH		6-9	7.52	6.53	
Temperature (A)	˚C	max 3˚C<	31.0	27.7	
Temperature (B)	˚C	max 3˚C<	20.64	19.5	
BOD	mg/l	50	0.2	N.D	
COD	mg/l	250	N.D	5.28	
TSS	mg/l	50	< 5.00	10	
Oil and Grease	mg/l	10	3	4.5	
Phenol	mg/l	0.5	0	4.7	
Cyanide	mg/l	1	< 0.1	< 0.10	
Nitrogen	mg/l	10	22.6	42.84	
Phosphorus	mg/l	2	< 0.50	< 0.10	
Arsenic	mg/l	0.1	< 0.01	0.01	
Chromium	mg/l	0.5	0.572	N.D	

Mercury	mg/l	0.01	0.0065	0.0028	
Nickel	mg/l	0.5	N.D	N.D	
Zinc	mg/l	2	< 1.0	< 1.0	

Note — Limits for Process Wastewater, Domestic Sewage, and Contaminated Storm water Discharged to Surface Waters, for General Application (Pollution Prevention and Abatement Handbook 1998 Toward Cleaner Production (The World Bank).

Temperature (A) - At Laboratory

Temperature (B) - At Field

Phenol — At high flow the level is higher than standard limit due to high volume flow. It includes decomposition of some species of higher plants and reeds, rotting vegetables and coal.

Nitrogen — Nitrogen level is higher than standard limit, due to polluted discharge both at low flow and high flow situations. The source is agricultural run-off or animal waste and decomposition of plants at high flow.

N.D — Not detected

Table 21. Laboratory Result of Surface Water at Upper Nmai Hka

Parameter	Unit	Limit	Low flow period	High flow period	Remark
pH		6-9	7.53	7.18	
Temperature (A)	˚C	max 3˚C<	30.5	27.6	
Temperature (B)	˚C	max 3˚C<	11.4	20.7	
BOD	mg/l	50	0.6	0.2	
COD	mg/l	250	N.D	3.52	
TSS	mg/l	50	< 5.00	300	
Oil and Grease	mg/l	10	5	4.19	
Phenol	mg/l	0.5	0	4.3	
Cyanide	mg/l	1	< 0.1	< 0.10	
Nitrogen	mg/l	10	14	45.36	
Phosphorus	mg/l	2	< 0.50	< 0.10	
Arsenic	mg/l	0.1	< 0.01	< 0.01	
Chromium	mg/l	0.5	0.549	N.D	
Mercury	mg/l	0.01	0.0057	0.0024	

Nickel	mg/l	0.5	N.D	N.D	
Zinc	mg/l	2	< 1.0	< 1.00	

Note — Limits for Process Wastewater, Domestic Sewage, and Contaminated Storm water Discharged to Surface Waters, for General Application (Pollution Prevention and Abatement Handbook 1998 Toward Cleaner Production-The World Bank).

Temperature (A) - At Laboratory

Temperature (B) - At Field

TSS — At high flow, TSS increased more than standard limit due to increased flow. It includes clay, silt, plant -fiber and biological solids.

Phenol — At high flow the level is higher than standard limit due to high volume flow. It includes decomposition of some species of higher plants and reeds, rotting vegetables and coal.

Nitrogen — Nitrogen level is higher than standard limit, due to polluted discharge both at low flow and high flow situations. The source is agricultural run-off or animal waste and decomposition of plants at high flow.

N.D — Not detected

Table 22. Laboratory Result of Surface Water at Taya Hka

Parameter	Unit	Limit	Low flow period	High flow period	Remark
pH		6-9	7.5	7.34	
Temperature (A)	˚C	max 3˚C<	29.8	28.7	
Temperature (B)	˚C	max 3˚C<	27.9	26.9	
BOD	mg/l	50	0.2	N.D	
COD	mg/l	250	4.0	N.D	
TSS	mg/l	50	< 5.0	5	
Oil and Grease	mg/l	10	0	1.97	
Phenol	mg/l	0.5	0	5	
Cyanide	mg/l	1	< 0.1	< 0.10	
Nitrogen	mg/l	10	28	27.2	
Phosphorus	mg/l	2	< 0.50	2.5	
Arsenic	mg/l	0.1	< 0.01	< 0.01	
Chromium	mg/l	0.5	0.413	N.D	
Mercury	mg/l	0.01	0.0036	0.0065	

Nickel	mg/l	0.5	N.D	0.007	
Zinc	mg/l	2	< 1.0	< 1.00	

Note — Limits for Process Wastewater, Domestic Sewage, and Contaminated Storm water Discharged to Surface Waters, for General Application (Pollution Prevention and Abatement Handbook 1998 Toward Cleaner Production (The World Bank).

Temperature (A) - At Laboratory

Temperature (B) - At Field

Phenol — At high flow the level is higher than standard limit due to high volume flow. It includes decomposition of some species of higher plants and reeds, rotting vegetables and coal.

Nitrogen — Nitrogen level is higher than standard limit, due to polluted discharge both at low flow and high flow situations. The source is agricultural run-off or animal waste and decomposition of plants at high flow.

Phosphorus — Slightly higher than standard limit. It is due to constituent of plants or animal tissues and municipal wastewater. It appears exclusively as phosphate in aquatic environment. The other sources are agricultural fertilizer and manure through ground water.

N.D — Not detected

Table 23. Five specific Water Quality Parameters observed at some stations

Sr. No.	Station Observed	Water Quality Parameter				
		T.S.S	Oil and Grease	Phenol	Nitrogen	Phosphorus
A	**Mali Hka Basin**					
1	Nanlang	✓	—	✓	✓	—
2	Nan Tisang	—	—	✓	✓	—
3	Hpungin Hka	—	—	✓	✓	✓
4	Hkang Hka	✓	—	✓	✓	—
5	Lasa	—	—	✓	✓	✓
6	Taya Hka	—	—	✓	✓	✓
B	**Nmai Hka Basin**					
1	Upper Nami Hka		—	✓	✓	—

2	Toron Wang	—	—	✓	✓	—
3	Renam	—	—	—	✓	—
4	Ahkyang Ti	✓	✓	✓	✓	—
5	Kaunglanhpu	✓	—	—	✓	✓
6	Mekh Rame	✓	—	✓	✓	—
7	Piza	✓	—	✓	✓	—
8	Wutsok	✓	✓	✓	✓	—
9	Ngawchang Hka	✓	—	✓	✓	—
10	Chibwe	✓	—	✓	✓	—
11	Tumpang Hka	✓	—	✓	✓	—
C	**Myitsone**	✓	✓	✓	✓	✓

5.2 Evaluation of Parameters of the Project Area

5.2.1. pH

pH is a measure of the acidity or alkalinity of a liquid or solid material. The pH value of natural water is an important index of acidity or alkalinity. Under natural conditions, the value of pH in the surface water ranges from 5.0 and 8.6, while in some cases, the value may be considerably higher or lower than this range.

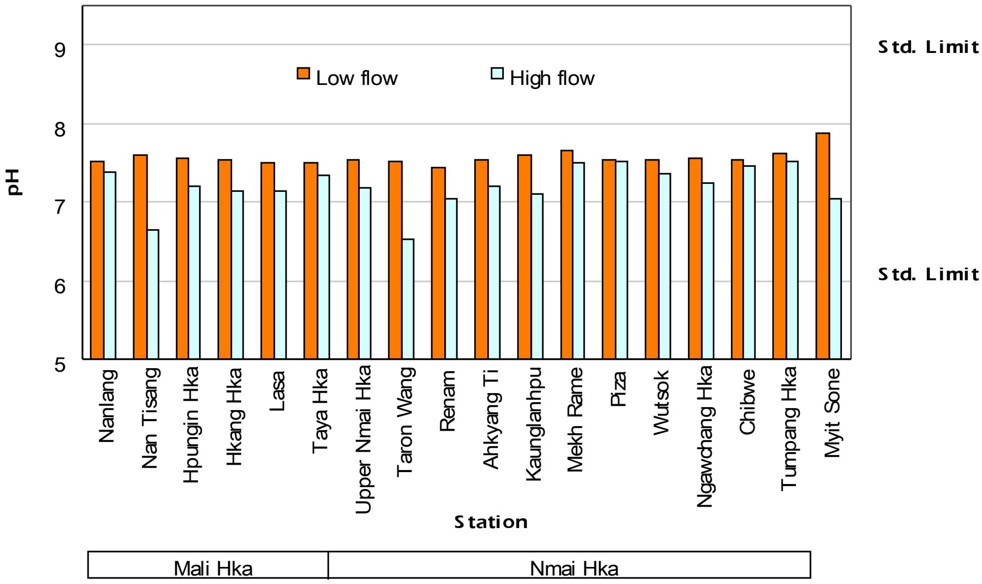
Numeric value of pH indicates the relative acidity or alkalinity. The specified range is 0 to 14 and 7 indicates neutral, less than 7 shows acidity while more than 7.0 is alkalinity.

The pH value of water may be determined by a wide variety of pH meter which are battery-operated or by simple electric current power. They are equipped with glass and reference electrodes. Before use, calibration of pH meter is important. This can be obtained by using standard buffered solutions. pH meters should be stored in a dry place to prevent moisture.

The pH may also be measured by comparison with standard indicators and buffered solutions using various comparators or colourimeters as described in standard method publications (APHA, 1971; IBP No. 8, 1971).

Being the important criterion of the quality of water, pH also serves as an auxiliary value when calculating a number or other characteristics of the quality of water such as free carbonic acid and free hydrogen sulphide. The pH value is affected by the increase in the content of coloured humus substances, i.e. humic acids and fulvic acids, a number of hydrolyzing compounds as well as various acid and alkalis which can penetrate the body of water along with industrial waste waters. In pure or slightly polluted water, the values of pH are determined mainly by the correlation between the concentrations of free carbondioxide and bicarbonate ions. The pH value is determined by the interaction of numerous substances contained in water, including those which are chemically and biochemically unstable.

Fig. 7.1 pH Value of Surface Water



Findings

The pH of study area is found to be between 7 and 8 in low flow period while 6.5 to 7.5 in high flow period. The low pH may be due to dilution of water body in rainy season. It is within standard limit 6.0 - 9.0 both in low and high flow period.

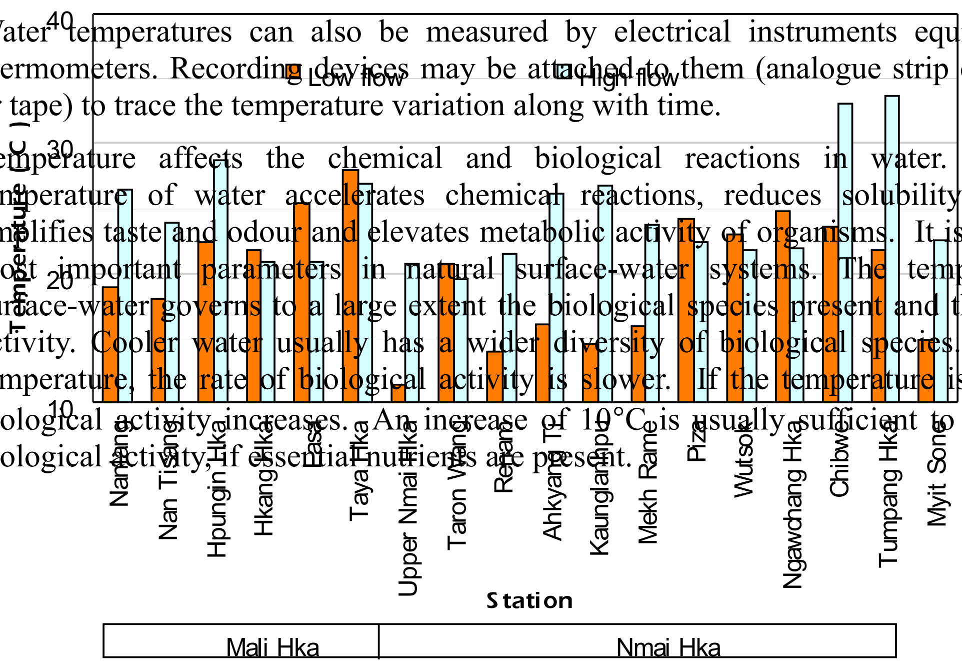
5.2.2. Temperature

Temperatures were measured on-site by a standard laboratory thermometer armoured by metal protective casings. These are calibrated in scales suitable for normal water temperatures.

Water temperatures can also be measured by electrical instruments equipped with thermometers. Recording devices may be attached to them (analogue strip chart paper or tape) to trace the temperature variation along with time.

Temperature affects the chemical and biological reactions in water. A rise in temperature of water accelerates chemical reactions, reduces solubility of gases, amplifies taste and odour and elevates metabolic activity of organisms. It is one of the most important parameters in natural surface-water systems. The temperature of surface-water governs to a large extent the biological species present and their rate of activity. Cooler water usually has a wider diversity of biological species. At lower temperature, the rate of biological activity is slower. If the temperature is increases, biological activity increases. An increase of 10°C is usually sufficient to double the biological activity, if essential nutrients are present.

Fig. 7.2 Temperature of Surface Water



Findings

Temperature of surface water at low flow is always lower than the high flow in all observed stations. Low flow temperature ranges from 11.4°C to 27.9°C while high flow temperature ranges from 19.5°C to 33.6°C. This may be due to ice melting and several changes in the upstream area in the low flow season.

The temperature of water is one of the most important characteristics which determines to a considerable extent the trends and tendencies of changes in water quality. Temperature is an important factor affecting ions and phase equilibrium and influence the rate of biochemical processes which accompany the changes of concentration and content of organic and mineral substances. It is generally known that the rate of numerous chemical reactions including catalytic and enzymatic ones depends, considerably on changes in temperature (on the average 2 to 3 times for every 10°C). Consequently, when discussing parameters such as sedimentation, mobilization of undissolved substances, solution of gas and their escape from water into the atmosphere, the processes of chemical and biochemical self-purification, formation of secondary pollutants and others, it is necessary to know the temperature of the water, air and in some cases the bottom deposits. The shifting of various dynamic equilibrium such as concentrations of carbonates, sulphides, or degree of alkalinity, or electrical conductivity are also affected by temperature changes.

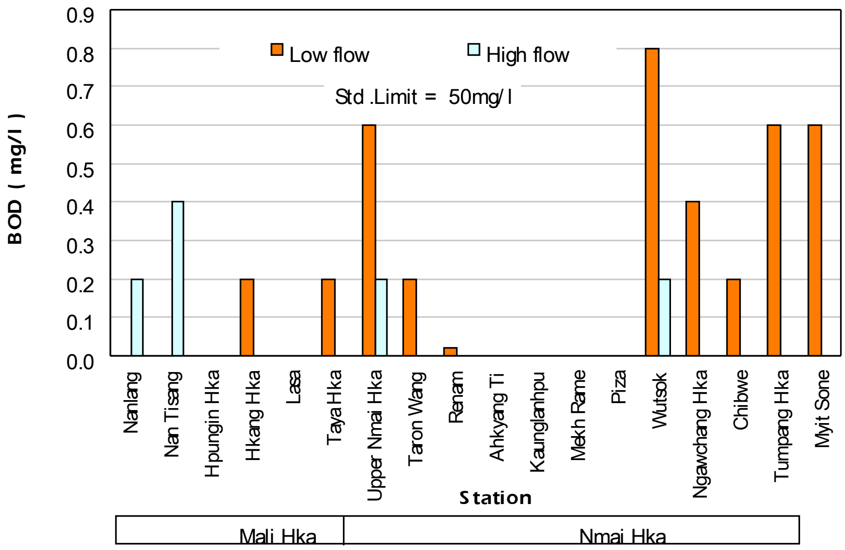
In some cases temperature is direct index of the influence of man-made factors on the quality of water (Thermal pollution). Temperature measurements may also become useful in the studies of such parameters as volume distribution of water or evaporation.

5.2.3. BOD

BOD is a measure of the amount of oxygen consumed in the biological processes that break down organic matter in water. The greater the BOD, the greater the degree of pollution.

Biochemical Oxygen Demand has a direct relation to life of organic compounds which are main causes of pollutions. Micro organisms need oxygen, when they divide organic compound. If there has a lot of organic compounds, oxygen demand is increased. Animal manure and plant residues are sources of organic compounds. BOD is defined basically as the amount of oxygen required by bacteria, while stabilizing decomposable organic matter under aerobic condition.

Fig. 7.3 BOD of Surface Water



Findings

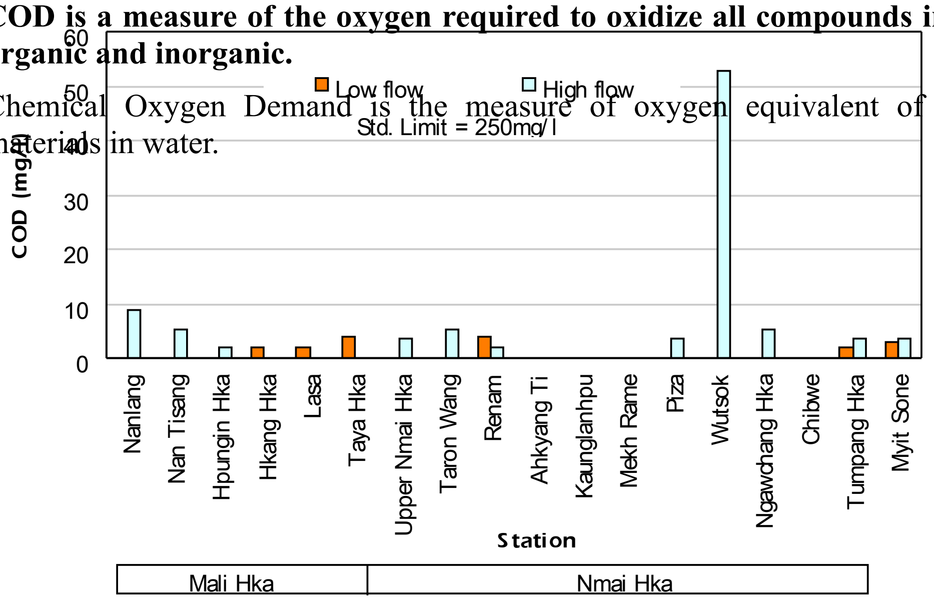
According to the laboratory results the level of BOD is lower than the limit 50 mg/l specified for general application. BOD of high flow at Myitsone, Lasa, Chibwe, Kaunglanhpu, Yenan, Ahkyang Ti, Tumpang Hka, Hpungin Hka and Taya Hka is not detected at present. At low flow, BOD of Myitsone, Hkang Hka, Taya Hka, Upper Nmai Hka, Toron Wang, Wutsok, Ngwacahan Hka, Chibwe, Tupang Hka is found to be between 0.2 to 0.8 mg/l. The water at Yenam site has the negligible amount in BOD.

5.2.4. COD

Fig. 7.4 COD of Surface Water

COD is a measure of the oxygen required to oxidize all compounds in water, both organic and inorganic.

Chemical Oxygen Demand is the measure of oxygen equivalent of most organic materials in water.



Findings

COD in surface water is found to be less than 2.0 mg/l at low flow. The COD of all station observed at high flow period is lower than 10 mg/l except at Wutsok station but it is still very much lower than the specified limit of 250 mg/l. The level of COD is not in a critical condition at present situation. The high level in Wutsok area may be due to chemical reaction of organic materials from the forest.

5.2.5. Total suspended solids (TSS)

TSS is a measure of the suspended solids in wastewater, effluent, or water bodies.

Total suspended solids exist in water in both suspended and dissolved form.

Total Suspended Solids in water may consist of inorganic or organic particles of immiscible liquids. Inorganic solids such as clay, silt, and other soil constituents are common in surface water. Organic materials such as plant fibers and biological solids (algal cells, bacteria etc.) are also common constituents of surface waters. These materials are often natural contaminant resulting from the erosive action of water. Suspended material is seldom a constituents from the erosive action of water flowing over surfaces.

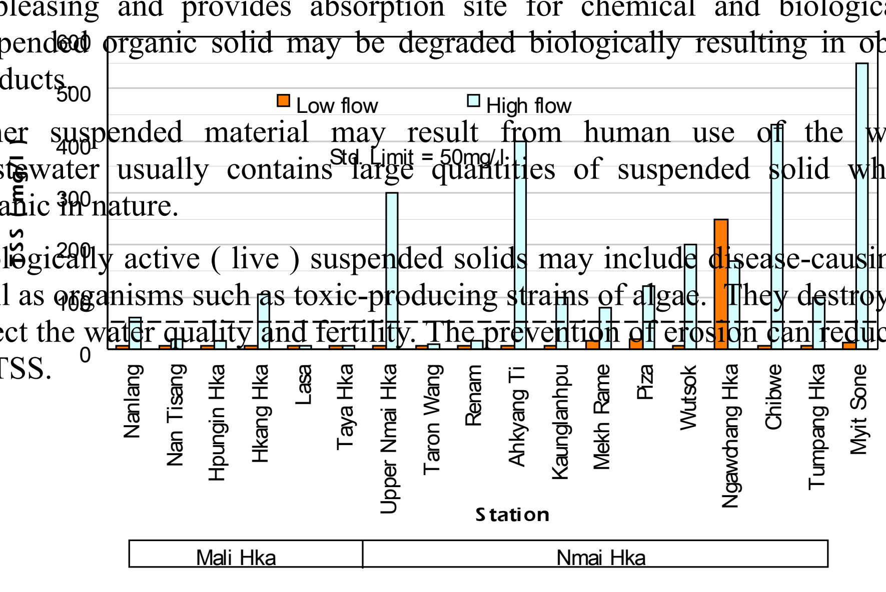
Suspended solids in water are mostly suspended fine particles of insoluble materials including sand, silt, clay, debris from vegetation growth, algae, chlorophyll and other buoycint type substances. These materials originate from shore erosion through wind and wave action, tributary inputs, biological activities and from pollution sources. Suspended solid reduce the transparency of water. These inhibit the penetration of light thereby reducing the photosynthesis processes and the production of oxygen. The photosynthesis is an important sources of oxygen in water.

Suspended material may be objectionable in water for several reasons. It is aesthetically displeasing and provides absorption site for chemical and biological agent. The suspended organic solid may be degraded biologically resulting in objectionable by-products.

Other suspended material may result from human use of the water. Domestic wastewater usually contains large quantities of suspended solid which are mostly organic in nature.

Biologically active (live) suspended solids may include disease-causing organisms as well as organisms such as toxic-producing strains of algae. They destroy ecosystem and affect the water quality and fertility. The prevention of erosion can reduce the formation of TSS.

Fig. 7.5 Total Suspended Solids of Surface Water



Findings

Myitsone, Chibwe, Ahkyang Ti and Upper Nmai Hka stations are extremely high in TSS amounting 300 to 550 mg/l. At Wutsok, Piza, Kaunglanhpu, Mekh Rane, Ngawchan Hka, Tumpang Hka and Hkang Hka sites the amount of TSS is found to be between 80 to 200 mg/l. Myitsone and Chibwe sites are situated in downstream part of the project area and fine particles are deposited at these sites which are polluted by TSS. Other sites are polluted, due to high flow which consists of clay, silt, plant-fiber and biological solids.

TSS level is less than 60 mg/l in the remaining sites. At high flows, different results were obtained for the different flood duration, rain fall pattern, morphology of rivers, time of survey and vegetation. At low flow , the results of all stations are within the specified limit. Soil conservation can help reduction of TSS.

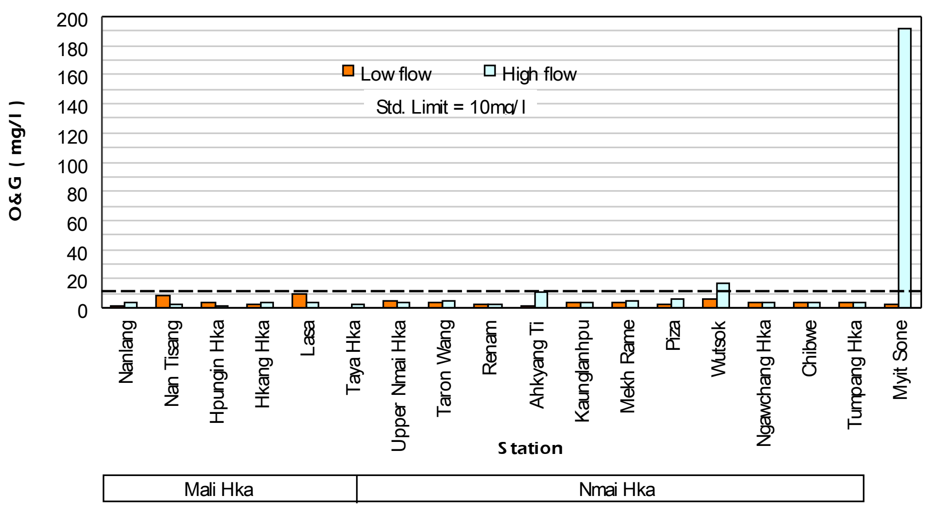
5.2.6. Oil and grease (O & G)

These are also important items for water quality. They include hydrocarbons, fatty acids, soaps, fats, waxes, oils and any other materials .

Oils and Greases are particularly resistant to an aerobic digestion, and when present in sludge they cause excessive scum accumulation in digesters, clog the pores of filter, and deter the use of the sludge as fertilizer.

A knowledge of the quantity of oil and grease present in a waste water is helpful in overcoming difficulties in plant operation.

Fig. 7.6 Oil & Grease of Surface Water



Findings

Oil and grease composition in the surface water of Myitsone site is approximately higher than standard limit of 10.0 mg/l. The O & G of Myitsone is found to be 192 mg/l. O & G of Wutsok and Ahkyang Ti sites found between 11.13 to 16.60 mg/l. It might be the result of fats, waxes, oil and other materials produced from local diesel and gasoline motor boats and different kinds of heavy machineries and engines used in gold mining in the upstream of river.

5.2.7. Phenol

Phenols are organic compounds that are produced from decomposition of some species of plants, and from metabolic process of aquatic organisms and as by-products of petroleum refining, and textile, dye, and resin manufacturing. Low concentrations cause taste and odor problems in water; higher concentrations can kill aquatic life and human.

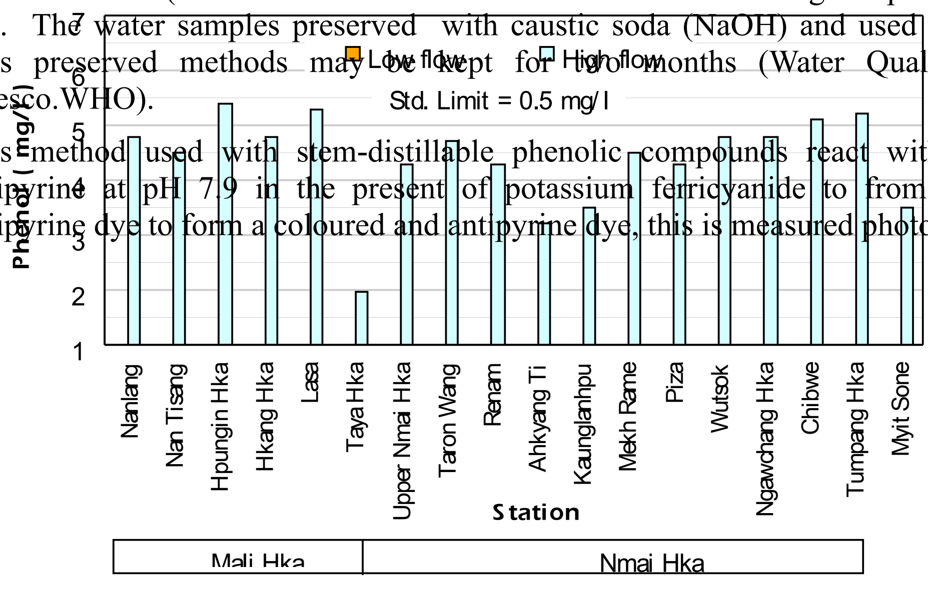
The properties of phenols and their influence on organisms also differ considerably. All this hinders the control and the evaluation of the quality of Phenols-containing waters. When the phenols concentration is several milligrams or more per litre, the phenols may exert an osmotic pressure effect on the aquatic organisms and become dangerous for warm-blooded animals and man. At much lower concentrations (one or more ü g/l), the phenol odour and taste. It is therefore recommended to purify such water with chlorination before treatment.

Under natural conditions, phenols are formed during metabolic processes of aquatic organisms, particularly during the biochemical break down and transformation of organic substances from dead algae. Phenols may also enter the water during the decomposition of some species of higher plants and reeds. They are often detected in water in contact with fallen leaves of some species on trees, oak or in the overgrowth of seeds. It is known that some of these phenols also form compounds which import chlorophenol odour during the chlorination.

In ground water particularly in the oil-bearing areas, the concentration of phenol is often increased (a fact which is used as one of the indices during the prospecting for oil). The water samples preserved with caustic soda (NaOH) and used glass bottle. This preserved methods may be kept for two months (Water Quality Surveys Unesco.WHO).

This method used with stem-distillable phenolic compounds react with 4 -amino antipyrine at pH 7.9 in the present of potassium ferricyanide to from a coloured antipyrine dye to form a coloured and antipyrine dye, this is measured photometrically.

Fig. 7.7 Phenol of Surface Water



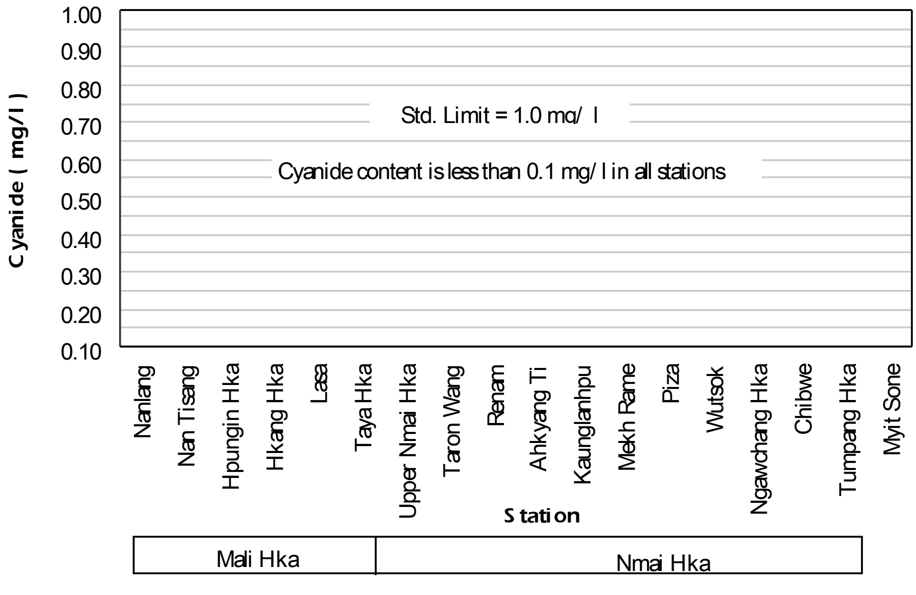
Findings

The content of phenol in surface water in high flow of all proposed hydropower station sites and tributaries observed is found to be mush higher than standard limit of 0.5 mg/l. Phenol in surface water of all sites is found to be between 2 to 5.4 mg/l. The reason of higher content of phenol during high flood period may be due to the decomposition of some species of higher plants in water, and fallen leaves of some tree species, and reeds from the forest in the catchment area.

5.2.8. Cyanide (CN)

"Cyanide" refers to all of the CN groups in cyanide compounds can be determined as the cyanide ion. Cyanide are found in a number of foods and plants. These are found, although in small amounts, in apple seeds, mango stones, peach stones and bitter almonds. In plants, cyanides are usually bound to sugar molecules in the form of cyanogenic glycosides. Cyanides are produced by certain bacteria, fungi and algae. Many cyanide-containing compounds are highly toxic but some are not. The most dangerous cyanides are hydrogen cyanides (HCN). The sample treated with caustic soda (NaOH) to raise to pH 11.0 for preservation.

Fig. 7.8 Cyanide of Surface Water



Findings

The CN level in all station observed is less than 0.1 mg/l while specified standard limit of cyanide is 1.0 mg/l. Therefore it can be said that there is no problem of cyanide at present in the project area.

5.2.9. Nitrogen (N)

Sources of Nitrogen in aquatic systems is decomposition of plants, animal waste, chemical fertilizers and wastewater discharges.

Nitrogen from these sources may enter directly into waterways through surface run-off or through the groundwater. Nitrogen compounds can be oxidized to nitrate by soil bacteria .

Ammonia is found as a gas at normal temperature and pressures in natural water systems. The presence of ammonium ions in unpolluted water is connected with the process of the biochemical decomposition of protein substances. An increase in the concentration of ammonium ions therefore, is observed when aquatic organisms are dying-off, especially in the zone of the aggregation. The amplitude of seasonal fluctuations of ammonium ions reflects the nutrition of the body of water and its pollution by organic nitrogen containing substances contained in household and industrial sewage.

The nitrates are present in applicable amount in surface water, except for a periods of intensive development of phytoplankton in bodies of water. Increased concentrations of nitrates may indicate faecal pollution of water body in the preceding period. The high nitrate content in potable water also harmful for children.

They cause anaemia (Methaemoglobinaemia)

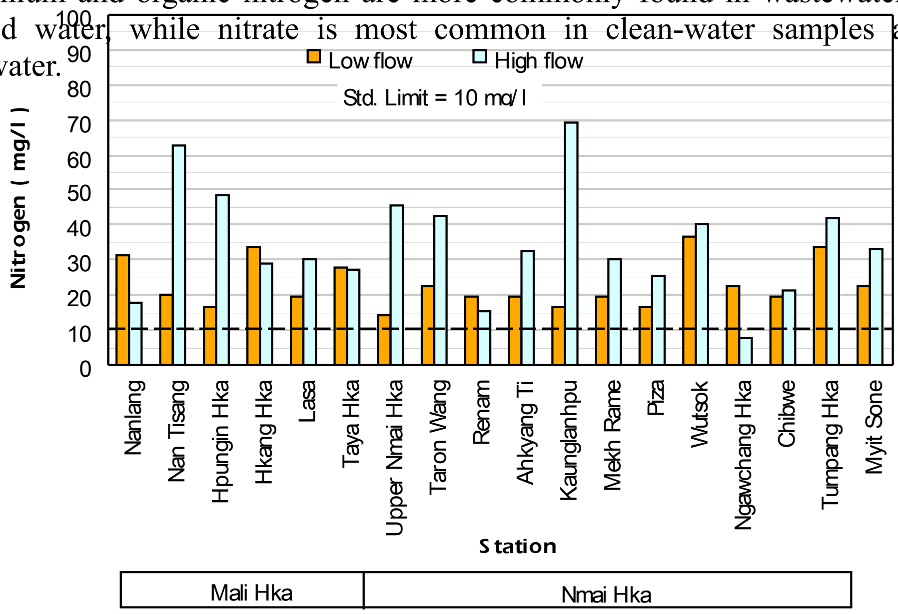
The collected water sample preserved by adding 0.8 ml sulphuric acid per litre of sample.

A task force recommended a 20 to 30 percent decrease in nitrogen loading to reduce the size and effects of this zone similar hypoxic zones occur near mouths of many other rivers that drain agricultural area (Environmental Science Page. 184).

Nitrate poisoning in infant animals, including humans can cause serious problem leading to death. The natural oxidation changes nitrite to nitrate quickly and so significant quantities of nitrites are not found in natural water.

Ammonium and organic nitrogen are more commonly found in wastewater and other polluted water, while nitrate is most common in clean-water samples and treated wastewater.

Fig. 7.9 Nitrogen of Surface Water



Findings

Due to agricultural run-off or animal waste and decomposition of plants, the project area has high content of Nitrogen in surface water. It was found that there is no evidence of chemical fertilizer usage in this area. There was significantly large content of Nitrogen in Kaunglanhpu, Nan Tisang, Hpungin Hka, Upper Hka, Toron Wang, Wutsok, and Tumpang Hka amounting to 40.32 to 69.00 mg/l. These might be due to decomposition of animal waste and plants.

Under natural conditions, the concentration of both organic and mineral nitrogen is subject to regular seasonal fluctuations which are connected with biological development cycles of aquatic organisms, mainly phytoplankton, zooplankton, and bacterioplankton.

Organic nitrogen-containing compound may be formed as a result of photo and biosynthetic processes by aqueous organism and decomposition of plants and enter the river at both low flow and high flow. Another source of nitrogen may come from the natural organic fertilizer from sewage and manure through ground water. The pollution can be reduced by collection feedlot and barnyard run -off in infiltration ponds together with soil conservation practices such as terracing, contour plowing, strip farming, leaving crop residue on fields, ground cover on waterways and cultivation of perennial crops.

5.2.10. Phosphorus (P)

Phosphorus is an essential chemical food element that can contribute to the eutrophication of lakes and other water bodies. Increased phosphorus levels is the result of phosphorus- containing materials which discharged into surface waters.

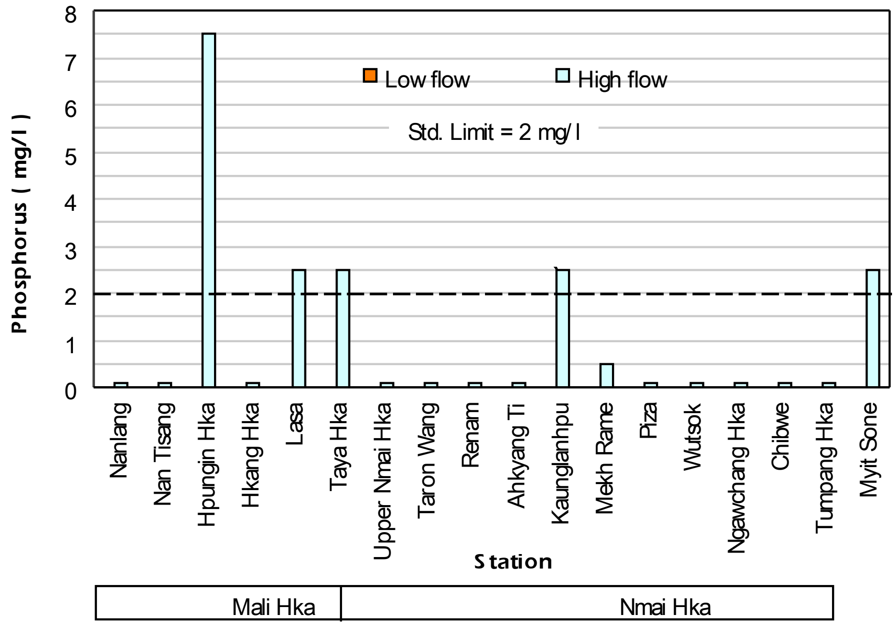
Phosphorus appears exclusively as phosphate (PO_4) in aquatic environments. There are several forms of phosphate, including orthophosphates, condensed phosphates and organically bowed phosphates. Phosphates may exists in soluble state or particulate form or constituents of plant or animal tissue. Runoff from the agricultural areas and municipal wastewater are major contribution of phosphate in surface water.

Phosphate are not toxic and do not represent a direct health threat to human and other organism but make a serious indirect threat to water quality. Phosphate can also interfere with water treatment processes. Concentrations as low as 0.2 mg/l interfere with the chemical coagulations or turbidity.

The phosphorus is an essential constituent in all living organisms. It plays an important part in cellular reproduction and contributes to the transfer of energy in respiration and photosynthesis process. An acceleration in the rate of additions of plant nutrients, such as phosphoris to natural water results in increased biological populations and production. This process known as eutrophication, occurs both naturally and as a result of waste disposal and land use practices. Suspended algae in open waters and attached algae on the bottoms of shallow waters are part of the eutrophication processes in lakes.

The collected sample was preserved by adding 1 ml 30% H_2SO_4 in 100 ml of water.

Fig. 7.10 Phosphorus of Surface Water



Findings

The Phosphorus level in surface water at high flow period at Myitsone, Hpungin Hka, Lasa, Kaunglanhpu and Taya Hka is higher than the standard limit (2.0 mg/l). This might be due to plants and animal tissue and runoff from the agricultural areas near the station and shifting cultivation of remote area.

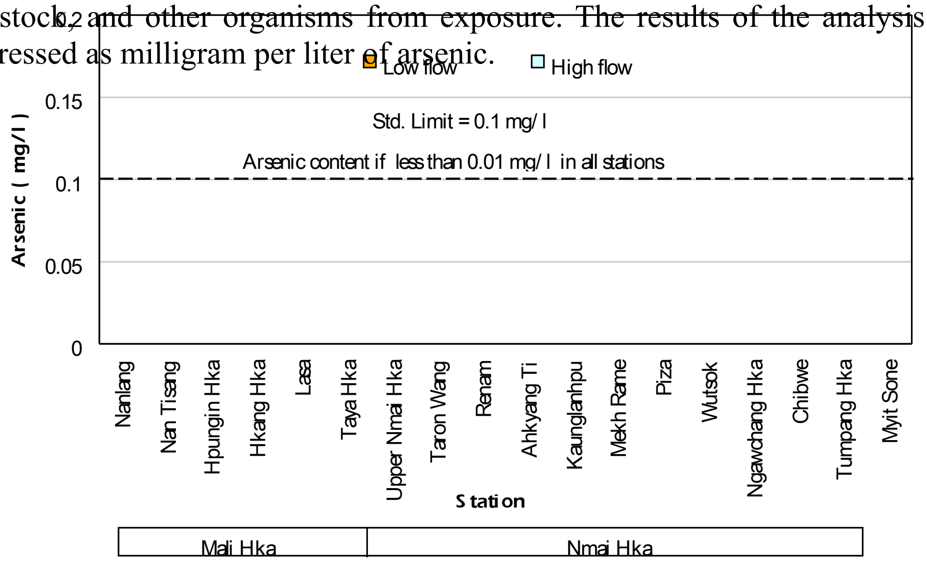
5.2.11. Arsenic (As)

Arsenic occurs widely in the natural environment. The highest mineral concentrations can be found as arsenides or copper, lead, silver and gold, but the high levels may also be found in some coal. The principal natural sources of arsenic in the atmosphere are volcanic activity.

Arsenic can have both active and chronic toxic effect on humans. It affects many organ systems including the respiratory, gastrointestinal, cardiovascular, nervous and hematopoietic systems.

Ambient standards and guidelines for arsenic are aimed at protecting the population, livestock, and other organisms from exposure. The results of the analysis are usually expressed as milligram per liter of arsenic.

Fig. 7.11 Arsenic of Surface Water



Findings

The results of analysis of arsenic both in low flow and high flow in all areas was found to be less than 0.01 mg/l on average in the area at the present. Allowable arsenic limit is 0.1 mg/l and hence no problem of arsenic was found in the area.

5.2.12. Chromium (Cr)

Chromium is an element naturally found in rocks, animals, plants and soil. Chromic and chromate ions are toxic to plants.

The chromium can be found in air, soil and water after disposal of chromium based products during the manufacturing processes. The chromium does not usually remain in the atmosphere, but is deposited in the soil and water. The chromium moved from one place to another in water and soil. The chromium is occasionally detected in ground water, drinking water or soil samples. The collected sample was added with 2 ml concentrate HNO_3/l of water for preservation.

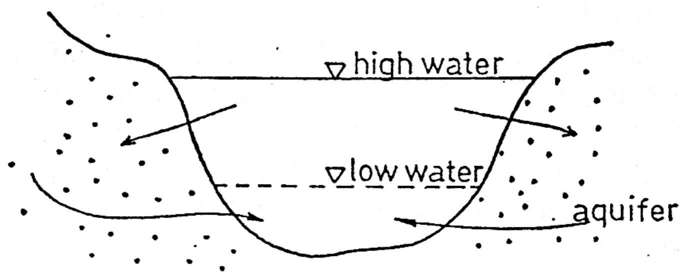
The same water course may have quite a different water quality at the same measuring point due to the different mutual effects between the river water and ground water. The high water levels result in the infiltration of river water into the aquifer while low water levels may lead to ground water depletion.

The International Agency for Research on Cancer (IARC) has determined that chromium compounds are carcinogenic to humans. The workers whose inhalation composed of chromium have been found the trace of lung cancer. And stomach tumors was observed in humans who exposed to chromium in drinking water. Chromium compounds have been found to cause tumors to the stomach, intestinal tract and lung.

A small percentage of ingested chromium will enter the body through the digestive tract. The chromium is a component of tobacco smoke. The smoking should be in enclosed spaces like inside the room or car in order to limit exposure to children and other family members. The chromium is required as a nutrient in the body. It is normally present in food, in blood, urine and body tissues.

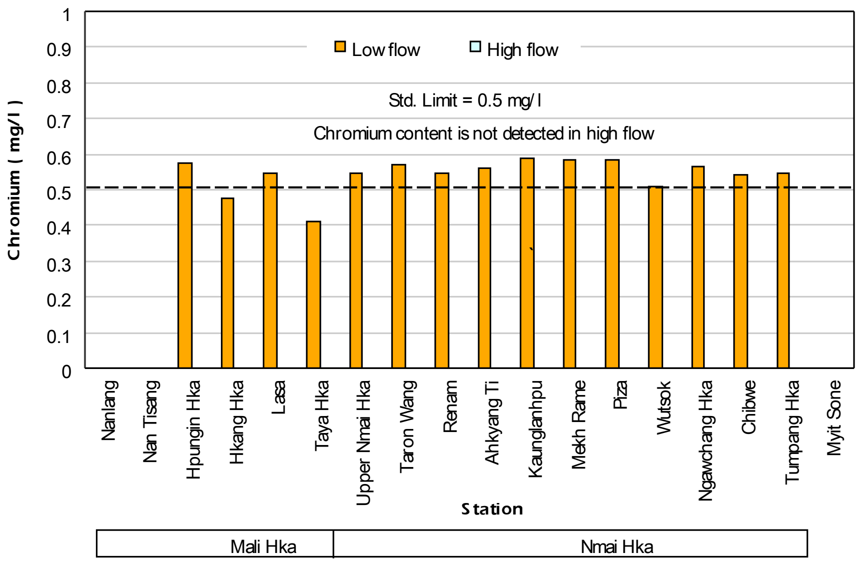
The collected sample was preserved by adding 2ml concentrated HNO_3 /l of water.

Fig. 7.12 Interactions between ground water and a river



Interactions between ground water and a river.

Fig. 7.13 Chromium of Surface Water



Findings

At low flow chromium in the surface water of most of the station observed was found slightly higher than the standard limit of 0.5 mg/l. But at high flow chromium was not detected. There is no problem of chromium in this region at present.

The chromium does not usually remain in the atmosphere but is deposited into the soil and water. The chromium in surface water was found in most of the area. At low flow it was slightly higher than standard limit of 0.5 mg/l. But it was not detected for all sites at high flow period.

The chromium in surface water found at low flow may be due to coming up of ground water seepage flow that contain chromium into the river. Geological investigation of the ground water containing chromium content in the upstream is necessary for future monitoring of the area.

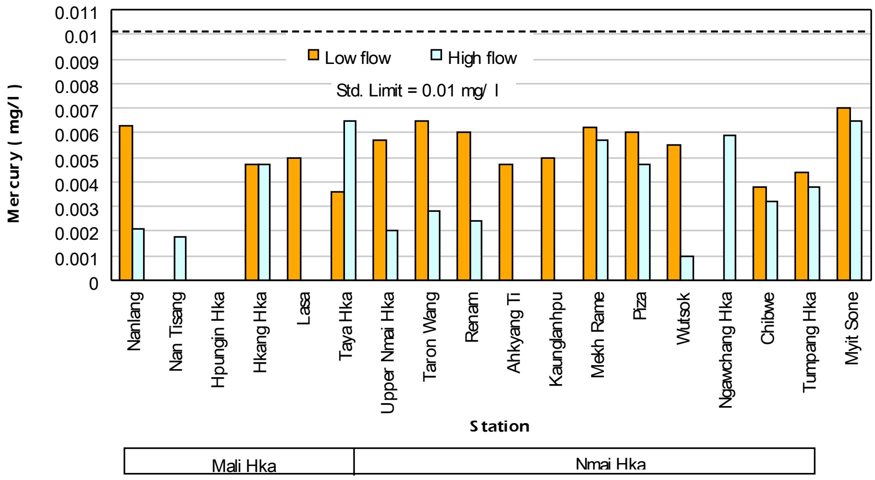
5.2.13. Mercury (Hg)

Mercury is a toxic heavy metal found in Mercuric sulfide and other ores compounds consisting of zinc, tin, and copper; in rocks such as limestone, sandstone, calcareous shale, and basalt, and in fossil fuels such as coal. Mercury can be traced in all environmental media. Typical concentration of mercury in water bodies range from 0.001 to 0.003 micrograms per litre (mg/l). The mercury enters into the environment through disposal of certain products.

The main human health hazard of mercury is associated with exposure to highly toxic organic methyl mercury, primarily through the ingestion of aquatic organisms. Mercury is also highly toxic to animals. Mercury compounds could be retained in tissues for an extended period.

Methyl mercury poisoning affects the central nervous system and the area associated with the sensory, visual, auditory and coordinating functions. Mercuric sulfide is highly toxic to human through ingestion or inhalation of dust and it causes both chronic and acute poisoning. The collected sample was preserved by treating with HNO_3 to reduce the pH < 2.0.

Fig. 7.14 Mercury of Surface Water



Findings

Limit of mercury in surface water for general application is 0.01 mg/l. Results of investigation show that Mercury level is less than standard limit at both flow and high flow situation. At present there is no mercury problem detected in the investigated area.

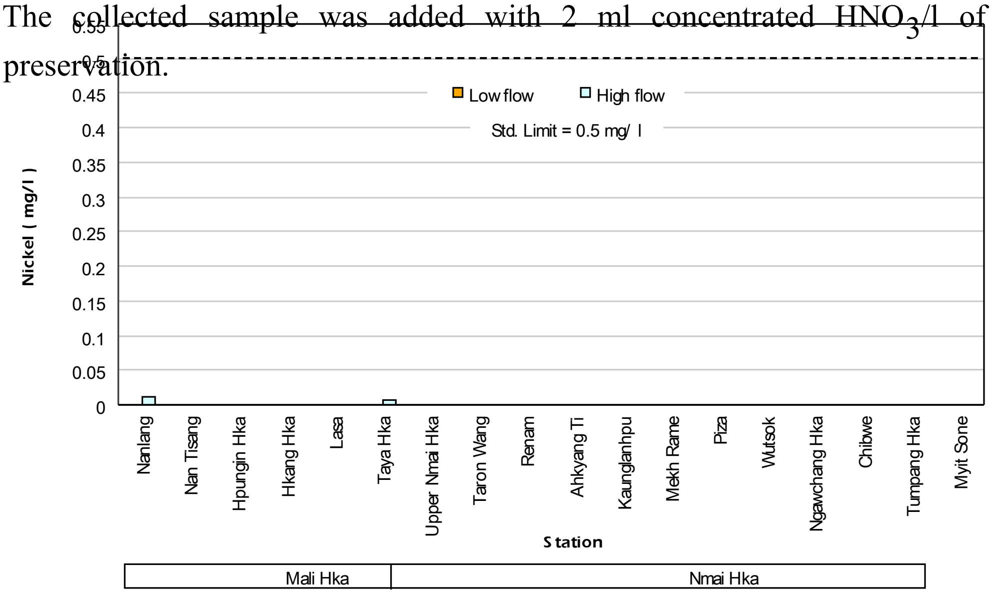
There are many gold mines along the river. The mercury can be deposited at the bottom of the rivers. Further investigation is necessary to analyze the water not only at surface but also at bottom layer. Mercury is heavy metal and hence traces of it may be found at the bottom.

5.2.14. Nickel (Ni)

Nickel is similar to the these elements, chromium, allumium and titanium. Nickel is a very reactive element but is slow to react in air at normal temperatures. High level or low level of nickel can be toxic, especially if associated with high exchangeable Mg:Ca ratios. Nickel sulphide fume and dust is believed to be carcinogenic. The various other nickel compounds may also be the same affect as well. Nickel is an important cause of contact allergy, partly due to its use in jewellery for pierced ears. Limit of Nickel in surface water for general application is 0.5 mg/l.

The collected sample was added with 2 ml concentrated HNO_3/l of water for preservation.

Fig. 7.15 Nickel of Surface Water



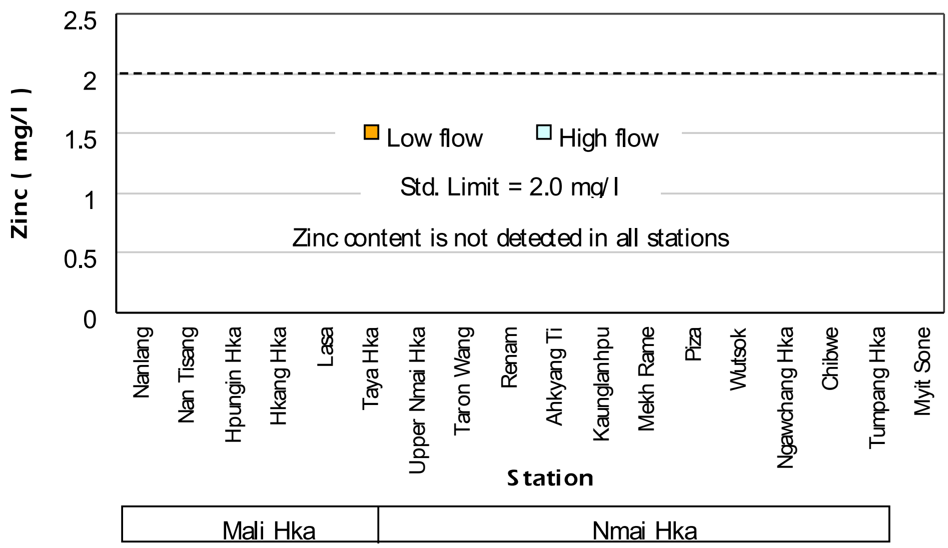
Findings

At present nickel in surface water in all areas was found below the limit of 0.5 mg/l although two stations ,Nanlang and Taya Hka, have Nickel content of less than 0.01mg/l and hence no danger to the region at present.

5.2.15. Zinc (Zn)

Zinc is highly abundant in nature. Zinc ions are readily contained in the sediment particles. Zinc is an essential mineral for the human health and biological environment. Although Zinc is and an essential requirement for good health, excess Zinc can be harmful. It can be chronically and acutely toxic to aquatic organisms especially fish. The bottles were rinsed with nitric acid (1:1 with distilled deionized water). The collected sample was added with 2 ml concentrated HNO_3/l of water sample for preservation.

Fig. 7.16 Zinc of Surface Water



Findings

Zinc content in surface water at all stations was found to be less than 1.0 mg/l. The study area has no problem of Zinc at present. Zinc is heavy metal which can be

deposited at the bottom. Further investigation is necessary to determine the water quality according to depth.

5.2.16. Particulate matter

Most Particulate Matter such as smoke, soot or dusk are easily visible but others are not. The particulates include materials such as airborne asbestos particles and small particles of heavy metals such as arsenic, copper, lead and zinc. They are usually emitted from industrial facilities such as smelters. The most significant of the fine particulate pollutants are sulphates and nitrates. These may combine with water vapor to form sulphuric and nitric acid. The particulate matter is often referred to as total suspended particulate (TSP).

Particulates may effect the human health, natural ecosystems and also to the biosphere. Particulates that enter the lungs may lodge there and have chronic effects on respiration. Dust from road construction may spread and deposited on the surfaces of green plants and interfere with their absorption of carbon dioxide and oxygen. Heavy dust may also affect the breathing of animals.

Finding

Particulate matter of all stations was found between 0.03 to 2.08 µg/m^3 except at Myitkyina which was under the 70µg/m^3, limit of particulate matter for maximum 24 hour average.

5.2.17. Sulphur dioxide

This heavy, pungent, colorless, gaseous air pollutant are formed primarily by processes involving fossil fuel combustion.

Sulphur dioxide is a colourless and odorless gas under normal conditions at Earth's surface. The major sources for the anthropogenic component of sulphur dioxide is burning of fossil fuels, mostly coal in power plants. Another major sources is a variety of industrial processes ranging from refining of petroleum to production of paper, cement etc. Corrosion of paint and metal smoke cause injury or death to plants and animals, especially to crops such as alfalfa, cotton and barley. Sulphur dioxide particularly in the sulphate form is capable of causing severe damage to lungs of human and other animals.

Findings

Sulphur dioxide in all stations was found between 0.06 to 0.79 µg/m^3. Limit of Sulphur dioxide for maximum 24 hour average is 125 micro gram per cubic meter.

5.3. Types and Effects of Water Pollution

Water pollution is any physical, biological, or chemical change in water quality that adversely affects living organisms. Water qualities are grouped according to the nature and findings and comments were outlined as follows.

(Ref. Water Pollution, Chapter 18, P. 380-395)

5.3.1. Acids and bases

pH values show Acid or Base. They are within limit at both flow condition.

Coal and oil combustion leads to formation of atmospheric sulfuric and nitric acids, which are disseminated by long-range transport processes and deposited via precipitation (acidic rain, snow, fog, or dry deposition) in surface waters. Meteorologist suggest that the cloud, 80% of which is made by human could disrupt monsoon weather patterns. They may effect the project area in future. Where soils are rich in such alkaline material as lime stone, these atmospheric acids have a little effect because they neutralized with alkaline. In high mountain areas or recently glaciated regions where crystalline bedrock is closed to the surface and lakes are oligotrophic, there is little buffering capacity (ability to neutralize acids) and aquatic ecosystems can be severely disrupted.

Some fish, amphibians, and sensitive aquatic insects are generally the first to be affected if acid levels in the water increases. If acidification is severe enough, aquatic life is limited to a few acid resistant species of mosses and fungi. Increased acidity may also result in leaching of toxic metals, especially aluminium, from soil and rocks, making water unfit for drinking or irrigation as well. Aquatic damage due to acid precipitation may sometimes occurred and care should be taken by monitoring pH value of the river water in the project area.

5.3.2. Oxygen-demanding wastes

BOD and COD are expressed for quality of surface water, including oxygen-demanding waste. They are within limit in all investigation sites at both flows.

The amount of oxygen dissolved in the surface water is a good indicator of water quality of which it supports the aquatic life. Water with an oxygen content above 6 parts per million (ppm) will support some fish and other forms of aquatic life. Water with oxygen level less than 2 ppm will support mainly worms, bacteria, fungi, and other detritus feeders and decomposers. Oxygen is added to water by diffusion from the air, especially in turbulent water and mixing rates are high at the rapid flow, and by photosynthesis of green plants, algae, and cyanobacteria. Oxygen is removed from water by respiration and chemical processes organisms that consume oxygen in the reservoir. The water quality should be in original state in as much as possible after the damming of the river concerned.

The effects of oxygen-demand on rivers depends great extent on the volume, flow, and temperature of the river water. Aeration occurs readily in a turbulent, rapid flowing water and leads to recover quickly from oxygen-depleting processes.

To keep the river clean, no pollution source should exist along the river or adjacent to the river. Aquatic organism in the upstream of the pollution source gets oxygen levels to support normal populations of clean-water organism. Immediately below the source of pollution, oxygen levels begin to fall as decomposers metabolize waste materials. Some fish species can only survive in this oxygen-poor environment where they eat both decomposer organisms and waste itself. Further downstream, the water may become so oxygen-depleted that only the most resistant microorganisms invertebrates can survive. Eventually, most of the nutrients are used up, decomposer populations are smaller, and the water becomes oxygenated once again. Depending on the volumes and flow rates of the effluent plume and the river receiving it, normal communities may not appear several miles downstream. So, pollution sources should be avoided in the vicinity of the project area.

5.3.3. Organic chemicals

Cyanide, Oil and Grease, and Phenol are organic chemicals. Content of Oil & Grease and Phenol at the observed stations are above the limit, and the remainings are below the limit.

Thousands of different natural and synthetic organic chemicals are used in the chemical industry to make pesticides, plastics, pharmaceuticals, pigments and other products that we used in every day life. Many of these chemicals are highly toxic. Exposure to very low concentrations (perhaps even parts per quadrillion in the case of dioxins) can causes birth defects, genetic disorders, and cancer. Some can persist in the environment because they are resistant to degradation and toxic to organisms that ingest them. Contamination of surface water and ground water by these chemicals is a serious threat to human health.

An example of the most important sources of toxic organic chemicals in water are improper use of fuel in machineries in gold mining and boats in river transportation, and decaying vegetation and plants in the forest. Much of these materials wash away into the nearest river, where it passes through ecosystem and may accumulate and severely affected the certain organism in the polluted water in surveying sites of the project.

5.3.4. Inorganic pollutants

Arsenic, Chromium, Mercury, Nickel and Zinc are inorganic pollutants. At the observed stations chromium content is higher above the permissible limit at low flow at all locations and within the limit at high flow.

Some toxic inorganic chemicals are released from rocks by weathering, percolating into ground water aquifers and then flowing into the river as seepage. This pattern is part of natural mineral cycles. But humans may accelerate the transfer rates in these cycles more through mining processing by using and discarding of minerals. That activities must be prohibited in the project area. In order to avoid the contamination of inorganic pollutants in the river, human activities that affect the environment should be minimize as much as possible.

In many areas, toxic, inorganic chemicals introduced into water as a result of human activities have become the most serious form of water pollution. Among the chemicals of greatest concern are heavy metals, such as mercury, lead, tin, and cadmium. Super toxic elements, such as selenium and arsenic, are more hazardous in waters. Although other inorganic materials, such as acids, salts, nitrates, and chlorine are not toxic normally at low concentrations it may adversely affect biological communities. When concentration is large, proper and good water quality should be maintained in the reservoir and river concerned. Further investigation of Mercury and Arsenic in river bed is required for the monitoring of the river. Present surface water surveying of that parameters is inadequate for water quality. Later monitoring of the river communities is required.

5.3.5. Sediments

Total Suspended Solids (TSS) are sediments and found above the limit at high flow at all the observed stations.

All the rivers have always carried sediments along its courses and finally to the oceans. Erosion rates in many areas have been greatly accelerated by human activities. Some rivers carry astounding loads of sediment. Erosion and runoff from croplands contribute about 25 billion metric tons of soil, sediments, and suspended solids to world surface waters each year. Forests, grazing lands, urban construction sites, and other sources of erosion and runoff add at least 50 billion additional tons. This sediment fills lakes and reservoirs, obstructs shipping rivers, clogs hydroelectric turbines, and polluted the drinking water. Sediments smother gravel beds in which insects take refuge and fish lay their eggs. Suspended sediments particles in the water block sunlight so that plants cannot carry out photosynthesis in a declined oxygen levels. Murky, cloudy water also is less attractive for swimming, boating, fishing, and other recreational activities.

Gold mining in project area and construction of access roads for various purposes are one of the causes of much TSS above the limit in the study area. In other way, sediment also can be beneficial. Mud carried by rivers nourishes floodplain farm lands. Sediment deposited in the ocean at river mouth creates valuable and fertile deltas and islands. The Ganges River, for instance, builds up islands in the Bay of Bengal that are eagerly colonized by land-hungry people of Bangladesh. Louisiana's muddy Mississippi serves to counteract coastal erosion. Thus sediments are pollutants for some way, while valuable in another for agriculture, erosion protection and food web for the project area.

5.3.6. Thermal pollution and thermal shocks

Raising or lowering water temperatures from normal levels can adversely affect water quality and aquatic life that depends upon it.

Water temperatures are usually much more stable than air temperatures. Raising water temperatures can have similar devastating effects on sensitive organisms. Oxygen solubility in water decreases as temperatures increases, so species requiring high oxygen levels are adversely affected by warming water.

Some human activities such as altering vegetation cover and runoff patterns along the river system may cause thermal pollution. To avoid sudden rising or lowering of water temperature in biological communities, strategic location and construction of series of dam and reservoir is an important factor for pollution control of the river system.

5.3.7. Plant nutrients and cultural eutrophication

Nitrogen and Phosphorus are major indicator of plant nutrients at the observed stations. The former is above the limit at both flow and the latter is above the limit at high flow in some locations.

Water clarity (transparency) depend on the sediments, chemicals, and the abundance of plankton organisms, and is a useful measure of water quality. Rivers and lakes that have clear water and low biological productivity are said to be oligotrophic (oligo=little+trophic=nutrition). By contrast, eutrophic (eu+trophic=truly nourished) waters are rich in organisms and organic materials. Eutrophication is an increase in nutrient levels and biological productivity. Some amount of eutrophication is a normal part of successional changes in most lakes. Tributary streams bring sediments and nutrients that stimulate plant growth. Over time, most ponds or lakes tend to fill in and eventually become marshes. The rate of eutrophication and succession depends on water chemistry, depth, volume of inflow, mineral content of the surrounding watershed, and the biota of the lake itself.

Human activities can greatly accelerate eutrophication. An increase in biological productivity and ecosystem succession caused by human activities is called cultural eutrophication. Cultural eutrophication can result from increased nutrient flows, higher temperatures, more sunlight reaching the water surface, or a number of other changes. Increased productivity in an aquatic system sometimes can be beneficial. Fish and other species may grow faster, providing a food web in the river ecosystem.

However, eutrophication has undesirable results. Increased phosphorus and nitrogen levels stimulate "blooms" of algae or thick growths of aquatic plants. Bacterial populations also increase and they are fed by larger amounts of organic matter. The water often becomes cloudy or turbid and has unpleasant tastes and odors. In extreme cases, plants and algae die and decomposers deplete oxygen in the water. Collapse of the aquatic ecosystem can result in some place of reservoirs in the project area. Systematic reservoir operation and maintenance is required to keep the nutrient level acceptable for a balanced environment of the river.

5.3.8. Water pollution control

We have a chance to control water pollution and improve water quality. We can plan in advance environmentally friendly project without ecological degradation. Appropriate land-use practices and proper disposal of different pollutants and waste coming from industries, domestic use and agriculture are required for control of water pollution.

Reduction of point pollution

The cheapest and most effective way to reduce pollution in the first place is to avoid producing it at all or avoid releasing it to the environment.

Careful handling of oil and petroleum products can greatly reduce the amount of water pollution caused by these materials to the environment.

Reduction of non-point pollution and land management

Among the greatest remaining challenges in water pollution control are diffuse and non-point pollution sources. Unlike point sources, non-points sources have many origins and numerous routes by which contaminants enter the ground and seep into river waters. It is difficult to identify all these sources and routes in some cases. Some main sources of non-point pollution may be :

- Construction sites : New buildings and infrastructures, improper land development works and occasional land slide which affect the adjacent small areas but produce vast amounts of sediment to that area.
- Land disposal : Land disposal of certain kinds of waste, sewage sludge, and biodegradable vegetables should be done carefully to dispose of unwanted materials. At some poorly run land disposal sites, abandoned dumps, and leaking septic water systems lead to contaminate the surface waters of the project area.

Generally, soil conservation methods can also help protect water quality. Precise monitoring and managing of oil, grease, and pesticides saves money and reduces contaminants entering into the reservoirs and rivers in the project area.

5.4. Monitoring of Ambient Air Quality

Monitoring is limited to some key pollutants such as suspended particulate matter (SPM). A good air quality management system usually reviews the probable emission sources and environmental receptors in the area concerned and then selects the pollutants to be monitored. One such pollutant is particulate matter of less than 10 microcons in aerodynamic diameter (PM_{10}). Other pollutants normally monitored included Sulphur Dioxide (SO_2).

The particulate matter (PM_{10}) and Sulpur Dioxide (SO_2) test were done in low flow period. The samples were analyzed at Toxicology and Environment at Health Laboratory, Department of Health in Yangon. The results are shown the Table 24.

Ambient air conditions at study areas and particulate matter concentrations are below the limit of 70 micro grams per cubic meter at maximum 24 hour average.

Findings

Pilot test of particulate matter at Myitkyina Camp is 269.87 microgram per cubic meter. Ambient air conditions at all study areas, and Sulphur Dioxide concentration are much lower than below, the limit of 70 micrograms per cubic meter at maximum 24 hour average.

Table 24. Monitoring of Ambient Air and Acoustic Environment

Sr. No.	Location (Monitoring Site)	Unit	TSP (PM_{10})	SO_2	Remarks
1	Myitsone	µg/m³	2.08	0.33	
2	Lasa	µg/m³	0.07	x	
3	Chibwe	µg/m³	0.23	0.13	
4	Wutsok	µg/m³	0.47	0.08	
5	Piza	µg/m³	0.13	0.79	
6	Kaunglanhpu	µg/m³	1.53	0.06	
7	Yenan	µg/m³	x	x	
8	Kaunglanhpu	µg/m³	x	x	
9	ManKyi	µg/m³	0.18	0.18	
10	Tasawlaw	µg/m³	x	x	
11	Sawan	µg/m³	x	x	
12	Acess Road	µg/m³	x	x	
13	Infega	µg/m³	0.46	0.53	
14	Putao	µg/m³	0.03	0.03	
15	Myintkyina	µg/m³	269.87	0.41	

Investigation of Air pollution and sound pollution were done ar Myintkyina, Infega, Putao as pilot tests.

x Most of the tests are quite acceptable except for a few dusts.

- Particulate matter of all stations was found between 0.03 to 2.08 µg/m³ except at Myintkyina station.
- Limit of particulate matter for maximum 24 hour average is 70 µg/m³.
- Sulphur dioxide in all stations was found between 0.06 to 0.79µg/m³.
- Limit of sulphur dioxide for maximum 24 hour average is 125 µg/m³.

5.4.1. Control of air pollution

The following methods are most effective for dealing with the control of air pollution.

(a) Source Correction Methods (c) Diffusion of pollutant in air. (e) Zoning

(b) Pollution Control equipment. (d) Vegetation.

5.5. Monitoring of Acoustic Environment

Noise abatement measures should achieve either the levels given below or a maximum increase in background levels of 3 decibels (Measured on the A scale) [dB(A)]. Measurements were made at the dam sites of the proposed hydropower stations and other places, totaling 7 monitoring sites, using TES sound level meter model TES -1350A.

Table 25.

measurement	Maximum allowable sound level hourly by log equivalent in dB(A)	
	Day (07.00 -22.00)	Night (22.00 -07.00)
Receptor Residential,		
Institutional, educational	55	45
Industrial, commercial	70	70

The results are shown in the following Table 26.

Table 26. Acoustic Environment Monitoring

Sr. No.	Location (monitoring site)	Sound Pressure Level (A-weighted) dB (A)	
		Day (07:00 - 22:00)	Night (22:00 - 07:00)
		Leq	Leq
1	Lasa	83.08	79.50
2	Chibwe (Dam Site)	99.74	91.24
3	Wutsok	100.40	110.42
4	Piza	55.16	-
5	Kaunglanhpu	4.51	-
6	Yenam	92.91	90.76
7	Mankyi	113.14	96.70

The sound level at Kaunglanhpu and Piza station was found between 4.51 to 55.16 dB (A). The sound level at remaining stations are higher than the limit due to the cascades.

5.5.1. Control of acoustic pollution

From the above discussion, it is evident that noise is not merely a nuisance but is a serious environmental problem and a health hazard. Like all other pollutions, noise pollution needs to be controlled by measures which will maintain the acceptable levels of noise pollution for human beings and buildings as indicated in the Para-5.5.

Noise pollution can be effectively controlled by taking the following measures:

(a) Control at Receiver's End

(b) Suppression of Noise at Source

(c) Acoustic Zoning

(d) Sound Insulation at Construction Stages

(e) Planting of Trees

(f) Legislative Measures

5.6. Investigation of Pollution Sources

5.6.1. Investigation of effluent outlet

For investigation of the main effluent outlets of the main stream and key branches of Nmai Hka River and of Mali Hka River, main pollutions tests were done in low-flow period from January 2009 to March 2009.

Total suspended solids (TSS) in Ngawchang Hka site was found to be 250 mg/l. The standard limit of surface water for general application is 50.0 mg/l. The limit of TSS water is 100 mg/l. TSS in all sites was found lower than the above limits except Ngawchang Hka site.

Turbidity in Mekh Rame, Ngawchang Hka, Hpungin Hka and Toron Wang was found very much higher than the limit. The turbidity limit of WHO drinking water standards is between 5.0 to 25.0 J.T.U.

Total dissolved solids (TDS) in all observed sites was found between 17.92 to 87.04 mg/l. These are very much lower than the limit of WHO standard (500 mg/l).

Alkalinity in observed sites was found between 40 to 80 mg/l. The maximum levels of alkalinity have not been set by the EPA for drinking water or wastewater discharges (Water Pollution . Page -19).

Hardness in all observed stations was found between 25.0 to 40.0 mg/l. The public Health Service Standard recommend a maximum of 500 mg/l of hardness in drinking water. A maximum limit is not set by the EPA Standards (Water Pollution , Page -21). The results are very much lower than the EPA Standards.

Water pollutants such as Zn, As, CN, BOD and COD in all sites were found as the negligible amount in water.

Pesticides were not detected as the observed data is less than 0.01 mg/l (LOD).

Chromium in all sites was found to be less than the limit of 0.5 mg/l.

Nitrogen in all observed stations was found to be between 14.0 and 33.6 mg/l. These are higher than the limit of general application (10.0 mg/l). But according to the drinking water standard of WHO, the results are lower than for both of the highest desirable limit and the maximum permissible limit which is 45 mg/l.

Phosphorus in all observed stations was found less than 0.50 mg/l. Phosphorus of general application limit is 2.0 mg/l. There is no problem of phosphorus at present.

Pesticides in all observed sites were not detected in general and found to be less than 0.01 mg/l(LOD).

The detailed results of specific pollutants are described in the following Table 27.

Table 27. Investigation of Effluent Outlet

Sr. No	Effluent Outlet location	Waste Water Discharge Amount	Pollutant Type	Discharge mode	Time interval	Discharging where about
1	Ahkyang Ti	River & Tributary discharge	Water Pollution	River & Tributary Flow	River continual flow	Nmai Hka
2	Mekh Rame	"	"	"	"	"
3	Ngawchang Hka	"	"	"	"	"
4	Tumpang Hka	"	"	"	"	"
5	Nan Lang	"	"	"	"	Mali Hka
6	Nan Tisang	"	"	"	"	"
7	Hpungin Hka	"	"	"	"	"
8	Hknang Hka	"	"	"	"	"
9	Taron Wang	"	"	"	"	"
10	Upper Nmai Hka	"	"	"	"	Nmai Hka
11	Taya Hka	"	"	"	"	"

Sr. No	Effluent Outlet location	Concentration Unit																
		TSS mg/l	Tur NTU	Tem A °c	Tem B °c	TDS mg/l	Alk mg/l	Hard g/l	Zn mg/l	As mg/l	CN mg/l	BOD mg/l	COD mg/l	Hg mg/l	N mg/l	P mg/l	Pes mg/l	Cr mg/l
1	Ahkyang Ti	5	0	30.2	16.10	33.28	108.02	48	<1	<0.01	<0.1	N.D	N.D	0.0047	19.6	<0.50	N.D	0.56
2	Mekh Rame	15	43	30.7	15.90	23.68	61.01	72	<1	<0.01	<0.1	N.D	N.D	0.0062	19.6	<0.51	N.D	0.585
3	Ngawchang Hka	250	116	30.7	24.80	40.95	120.02	44	<1	<0.01	<0.1	0.4	N.D	0.0000	22.4	<0.52	N.D	0.565
4	Tumpang Hka	< 5	3	30.3	21.80	30.08	80.01	34	<1	<0.01	<0.1	0.6	2	0.0044	33.6	<0.53	N.D	0.548
5	Nan Lang	< 5	2	29.7	18.90	53.76	120.00	52	<1	<0.01	<0.1	N.D	N.D	0.0063	31.4	<0.54	N.D	N.D
6	Nan Tisang	< 5	1	27.9	18.00	17.92	60.00	20	<1	<0.01	<0.1	N.D	N.D	0.0000	20.4	<0.55	N.D	N.D
7	Hpungin Hka	5	122	31.2	22.40	51.20	80.01	44	<1	<0.01	<0.1	N.D	2	0.0000	16.8	<0.56	N.D	0.575
8	Hknang Hka	< 5	2	29.7	21.70	32.00	80.00	28	<1	<0.01	<0.1	0.2	2	0.0047	33.6	<0.57	N.D	0.477
9	Taron Wang	< 5	83	31.0	20.64	44.16	80.01	46	<1	<0.01	<0.1	0.2	N.D	0.0065	22.6	<0.58	N.D	0.572
10	Upper Nmai Hka	< 5	1	30.5	11.40	47.36	80.01	44	<1	<0.01	<0.1	0.6	N.D	0.0057	14	<0.59	N.D	0.549
11	Taya Hka	< 5	2	29.8	27.90	87.04	120.00	72	<1	<0.01	<0.1	0.2	4	0.0036	28	<0.60	N.D	0.413

5.6.2. Investigation of pollution source

Total suspended solids (TSS) in all observed sites was found to be less than 5.0 mg/l. These are lower than the standard limit (50 mg/l).

Turbidity in Chibwe site was found 98.0 NTU. According to WHO and drinking water standard highest desirable limit is 5.0 and maximum permissible limit is 25.0 JTU.

Total dissolved solids (TDS) in all observed sites was found between 33.92 to 34.90 mg/l. These are lower than the limit of WHO standards (500 mg/l).

Alkalinity in all observed sites was found between 60.0 and 120.02 mg/l. The maximum levels of alkalinity have not been set by EPA for drinking water or wastewater discharges (Water Pollution , Page -19).

Hardness in all observed stations was found between 20.0 and 52.0 mg/l. The Public Health Service standards recommend a maximum of 500 mg/l of hardness in drinking water. A maximum limit is not set by the EPA standards (Water Pollution , Page -21). These are very much lower than the EPA standard.

Water pollutants such as Zn, As, CN, BOD, COD and Hg in all observed stations were not detected in general and the amount of concentration in the water is negligible at present.

Nitrogen in all observed stations was found to be between 14.0 and 33.6 mg/l. These are higher than the limit of general application (10.0 mg/l).

Phosphorus in all observed stations was found to be less than 0.50 mg/l. Phosphorus limit of general application is 2.0 mg/l. There is no problem of phosphorus at present.

Pesticides were not detected in all observed stations. It was less than 0.01 mg/l (limit of detection)

Chromium in all observed sites were found slightly higher than the standard limit of 0.5 mg/l, except Nan Lang and Nam Tisang. The chromium in Nan Lang and Nam Tisang was not detected at present.

Investigation of pollution sources in large towns include Putao, Nanghkai , Machanbow and Chibwe. At present no serious problems on industrial pollution sources and domestic pollution sources are found. Pollution of stream water as well as waste water have been analyzed. Concentration of these pollutants were indicated in the Table 28.

Table 28. Investigation of Pollution Sources

Sr. No.	Distribution Location of Pollution Sources	The Pollution Sources	Nature of Business	Product Name	Product Output	Waste Water Amount	Existing Waste Water Treatment Facilities	Treatment Technology	Method and Effect
1	Putao	Domes tic	Nil	Nil	Low Flow	Dischar ge	Nil	Nil	Nil
2	Nong Hkai	"	"	"	"	"	"	"	"
3	Machanbaw	"	"	"	"	"	"	"	"
4	Chibwe	"	"	"	"	"	"	"	"

No.	Distrib. Locat. of Pollut. Sources	Type of Wast Water Produce																
		TSS mg/l	Tur NTU	Tem A ˚c	Tem B ˚c	TDS mg/l	Alk mg /l	Har dm g/l	Znm g/l	As mg/l	CN mg/l	BOD mg/l	CO D mg/l	Hg mg/l	N mg/l	P mg/l	Pes mg/l	Cr mg/l
1	Putao	<5	2	29.0	20.0	34.9	50	25	<1	<.01	<0.1	N.D	N.D	0.0	19.0	<0.5	N.D	0.40
2	Nong Hkai	<5	1	29.7	19.0	34.56	40	28	<1	<.01	<0.1	N.D	2.0	0.0	19.6	<0.5	N.D	0.40

3	Machan baw	<5	1	29.6	18.9	34.00	40	27	<1	<.01	<0.1	N.D	2.0	0.0	19.5	<0.5	N.D	0.4
4	Chibwe	<5	98	30.3	23.5	33.92	80	40	<1	<.01	<0.1	0.20	N.D	3.8	19.6	<0.5	N.D	0.5

5.6.3. Investigation of non-point pollution source

Investigation and estimation of the non-point pollution source indexes of Nmai Hka River, Mali Hka River and their main tributaries were carried out. Pollutants include Phosphorus, Nitrogen, Chemical Oxygen Demand, Ammonia, Pesticides and Chemical Fertilizers. These are shown in the following Table 29.

- Chemical Oxygen Demand (COD) in Lasa, Tumpan Hka, Hpungin Hka and Hknang Hka sites was found to be 2.00 mg/l. COD in the remaining sites was not detected at present. These are less than the standard.
- Pesticides include Malathion, Chloropyrifos, Diazinon, Fenitrothion, Diamethorate, Dichlorvos, Methomyl and Trizophos. These pesticides were not detected at present.
- Nitrogen in all observed stations was found to be between 14.0 and 33.6 mg/l. These are higher than the limit of general application which is (10.0 mg/l).
- Phosphorus in all observed stations was found to be less than 0.50 mg/l. Phosphorus of general application limit is 2.0 mg/l. There is no problem of phosphorate at present.

The results are lower than for both of the highest desirable limit and maximum permissible limit, which is 45 mg/l.

Table 29. Investigation of Non-Point Pollution Sources

Sr. No.	Non-Point Pollution Source Indexes	COD	Pesticide	Chemical Fertilizer	
		mg/l	mg/l	N (mg/l)	P(mg/l)
1	Lasa	2.00	N.D	19.6	<0.50
2	Chibwe	N.D	N.D	19.6	<0.50
3	Ahkyang Ti	N.D	N.D	19.6	<0.50
4	Mekh Rame	N.D	N.D	19.6	<0.50
5	Ngawchang Hka	N.D	N.D	22.4	<0.50
6	Tumpang Hka	2.00	N.D	33.6	<0.50
7	Nan Lang	N.D	N.D	31.4	<0.50
8	Nan Tisang	N.D	N.D	20.4	<0.50
9	Hpungin Hka	2.00	N.D	16.8	<0.50
10	Hknang Hka	2.00	N.D	33.6	<0.50
11	Toron Wang	N.D	N.D	22.6	<0.50
12	Upper Nmai Hka	N.D	N.D	14.0	<0.50

Note

<u>Pesticides</u>

(a) Malathion
(b) Chlorpyrifos
(c) Diazinon
(d) Fenitrothion
(e) Diamethoate
(f) Dichlorvos
(g) Methomyl
(h) Trizophos

Pesticides - N.D = Not Detected < 0.01 ppm. LOD = Limit of Detection

6. POTENTIAL IMPACTS

6.1. General

Due to the hydropower project, there would be both positive and negative impacts on the environment. The electricity generated would help industrial developments, and would raise the standard of living of the people which accordingly would make the nation's economy higher. In dry season, the reservoir will help navigation and irrigation at the downstream. On the other hand there may be adverse impacts. Since the project is a gigantic one harnessing the lifeblood river of the country, it is very important to seriously study the possible adverse impacts. In this section, adverse impacts on the baseline studies are mainly forecasted so that mitigation measures could be considered for sustainable development. The forecasts are based on the research works and experiences of similar projects.

6.2. Impacts due to Fragmentation of River

The project is formulated to produce hydropower by building a series of cascade dams on Nmai Hka, Mali Hka and just at the downstream of the confluence of those two rivers. This causes fragmentation of river ecosystems which affects the physical variables such as flow regime and water quality and productivity and composition of species. Within a basin, the greater the number of dams, the greater the fragmentation of river ecosystems.

By adding large dams to a river systems it will result in an increased and cumulative loss of natural resources, habitat quality, environmental sustainability, and ecosystem integrity.

6.3. Impacts on Water Quality

The flowing water becomes stagnant due to impounding by a dam which makes many changes in water quality such as oxygen level, dissolved gases, temperature, chemistry, etc. Water quality parameters recover only slowly when water is released from a dam. Oxygen level may recover within one or two kilometers while temperature changes may still exist 100 km downstream. Where the distance between dams does not allow recovery to natural level, the biology of species at many hundreds of kilometers of river may be affected.

A dam would receive water that is already high in total dissolved gases as a result of upstream dam. Before the levels can be recovered to natural values, if the water from that dam is released or spilled, the problem would be passed on to further downstream which may make impacts on downstream ecosystem and biodiversity.

6.4. Altered Downstream Flow and Sediment Movement

Due to dam built on the river, storage volume is increased and it clearly affects the flood regime at downstream. Flood flows downstream would be significantly reduced. The positive impact of flood reduction is lessening of flood risk at the downstream areas. But flood plains which are habitat of some fauna and flora will disappear. Flood timing, duration and frequency will be completely changed. Complex biological communities at the downstream will not be sustainable due to stable flows and conditions of regulated flow. Besides, natural fertilization of farm land carried by the flood will be lost. Reduction in sediment moving downstream from the dam leads to degradation of the river channel which may result in elimination of bars/banks, riparian vegetation that provides nutrients and habitat for aquatic and waterfowl species. Reduction in sediment input, results in degradation of coastal deltas. It is one of the most severe impacts because it threatens the formation of fertile land. This impact must be seriously considered since some already built dams are being decommissioned to avoid this adverse impact.

6.5. Erosion

The most likely damage to the watershed area may be due to deforestation for the construction sites, roads and wood requirements which may result in soil erosion problems and the destruction of the natural protection of the ground. The erosion of watershed areas would make the reservoir life shorter through the deposition of sediments while erosion along-side of river will create instability of river bank and accordingly affects the water quality.

6.6. Ambient Air

Previously it is conventionally accepted that hydropower produces only positive atmospheric effects such as a reduction in emissions of carbon dioxides, nitrous oxides, sulphuric oxides and particulates when compared with power generation sources that burn fossil fuels. But recent research identified that the emission of greenhouse gases (GHG) from reservoirs due to rotting vegetation and carbon inflows from the catchment creates an ecosystem impact which may account for 1to28 % of the global warming potential of GHG emissions.

There would be no difference in air pollution such as particulate matter (PM_{10}) and Sulphur dioxide with or without hydropower project situations. But during the construction period, air pollution would be affected due to construction equipment which will emit other gases and make a lot of dust. The air pollutants affect plants by entering through stomata of leaf and destroy chlorophyll and photosynthesis while human respiratory system is affected causing serious health problem in the long term.

6.7. Acoustic Environment

The project area is not an industrialized one and at present there is no noise pollution to the environment. Noise can cause temporary or permanent hearing loss depending on the intensity and duration of sound level. The nature of hydropower plants is not noisy compared to diesel power plants and noise level is expected to be lower than 70 dB(A) Leq. But during construction period, significant noise pollution will be sensed at construction sites and along roads.

7. MITIGATION MEASURES

7.1. General

Some impacts of a hydropower project unavoidably have adversed effects on the ecosystem. To be a sustainable project, these adverse impacts should be mitigated or minimized or compensated by some means and measures. The possible mitigation measures are discussed in this section and should seriously be considered in the design, implementation and operation works. Reference for monitoring and control of pollutance in reservoirs and rivers is shown in Appendix-3.

7.2. Watershed Protection

Watersheds are likely to be destroyed not only due to construction works but also due to migrated people who have lost their places because of inundation. Watersheds provides many ecosystems functions ranging from nutrient recycling, water purification to soil replenishment and flood control. So to keep healthy watersheds it is very important that they are always monitored and protected. Educating the local people on the importance of watershed and practicing strict low enforcement are effective means of watershed protection.

7.3. Compensation and Green Plan

As an alternative to mitigation, a compensatory approach could be suggested. Regulations should be set on replantation of forests flooded by reserving. We should learn lessons from the comprehensive "Green Plan" done in the Netherlands to protect the affected area. (Reference No.(8) p 540).

7.4. Control of Pollution in Reservoir and Rivers

The first step to control reservoir and river pollution is to carry out a regular monitoring with regard to the parameters as observed at the proposed dam sites. One of the control measures for reservoir pollution is diversion of nutrients, removing of pollutants and nutrients from waste waters and proper water shed management in the catchment area.

For the control of river pollution, the following approach should be followed.

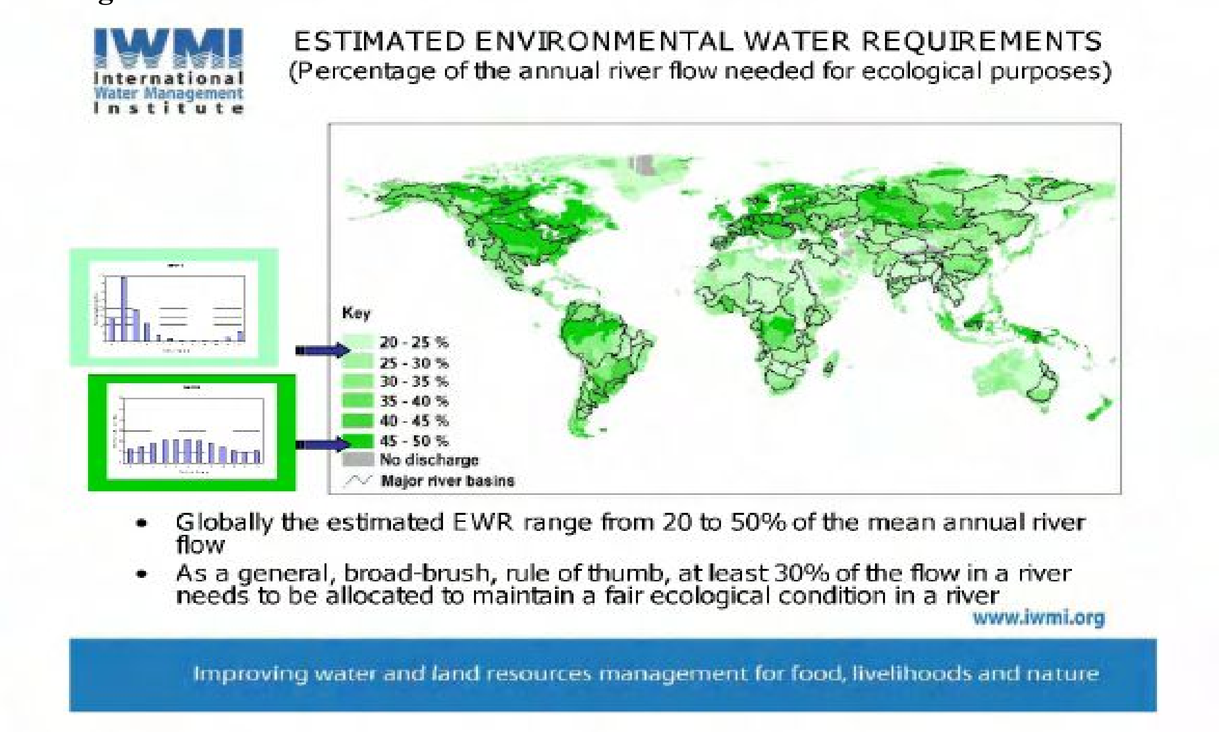
1. The most usual approach for river pollution control is to lay down standards governing the stream water quality and effluents discharged into it. Streams are generally classified according to the major use to which they are likely to be put, i.e., drinking, fish culture, irrigation, bathing etc. Each use requires some minimum water quality for which the standards can be applied.
2. At the time of lean flow seasons, the pollutants are likely to be concentrated in greater quantities, which can be controlled by augmenting the flow of water in the river by extra discharge from the upper reservoir.
3. At certain times in dry season, when the self-purification capacity is reduced considerably, extra oxygen can be provided by artificial aeration at the desired points. However, this method is costly and less feasible, but can be applied in emergency situations.
4. All the waste waters entering into a river system should be allowed only after a proper treatment. This can reduce the pollution load to a desired level calculated on the basis of stream conditions.

7.5. Flow Management

Since flow regime is totally disrupted due to the dam built on the river, the downstream flow should be regulated as similar as possible that of before the project. Operation programme should be planned to manage flood flow considering not only flood alleviation and mitigation but also utilization of flood. Environmental flow requirement (EFR) must be considered in setting operation rule for the project.

As a rule of thumb for the environmental flow at the downstream of the dam after project completion the stream flow runoff should be 30% of annual runoff of the river (before the dam construction) in general when no reliable data for the evaluation of required environmental flow is available at present. (Ref: see table and map for world general environmental flow for different countries).

Fig. 8



7.6. Environmental Requirement Vs Water Resources Management

Since Ayeyarwady River is the lifeblood and main stream of Myanmar and Myanmar people, integrated water resources management of the uppermost Ayeyarwady River Basin, namely Nmai Hka River Basin and Mali Hka River Basin is totally required in accordance with the environmental requirement of the nation as a whole.

According to the Environmental Management Classes (EMC) outlined by the International Water Management Institutes, we recommend the EMC Class where natural river ecosystem is moderately modified in which basic ecosystem functions are intact despite slight disruption/disturbance of habitats and dynamics of the biota.

Since water resources development scheme has yet to be implemented, slight changes in natural pristine condition or minor modification of in stream and riparian habitat is unavoidable. But multiple ecosystem disturbances associated with the building of dam must be avoided in as much as possible by proper management of the river ecosystem in both upstream and downstream of dam after project implementation.

7.7. Trapping Sediments and Nutrients Behind A Dam

The sediments and nutrients flowing along with water are trapped because of the dam built across the river which affects seriously the downstream flood plain, coastal delta morphology and causes the loss of aquatic habitat. The facility such as bottom outlet can be provided at the structure to flush out sediments whenever feasible by managing flood releases and although this measure has some limitations it should be included in the operating programme.

7.8. Blocking Migration of Aquatic Organisms

Some river dwelling species have several migratory patterns. Dams are physical barrier which disrupt migration of species between upstream and downstream. To overcome this impact, fish passes should be provided wherever feasible for migration of aquatic species. To get appropriate fish passes, it should be tailored to specific sites and species.

7.9. Greenhouse Gas Emission

Table 30

International Water Management Institute

ENVIRONMENTAL MANAGEMENT CLASSES (EMC)

TOTAL ENVIRONMENTAL REQUIREMENT DEPENDS UPON THE CATEGORY OF ENVIRONMENTAL PROTECTION – THE MORE PRISTINE THE DESIRED MANAGEMENT CLASS - THE HIGHER THE REQUIREMENT

EMC	ECOLOGICAL DESCRIPTION	MANAGEMENT PERSPECTIVE
A: Natural	Pristine condition or minor modification of in-stream and riparian habitat	Protected rivers and basins. Reserves and national parks. No new water projects allowed.
B: Slightly modified	Largely intact biodiversity and habitats despite water resources development and/or basin modifications.	Water supply schemes or irrigation development present or allowed.
C: Moderately modified	Habitats and dynamics of the biota have been disturbed, but basic ecosystem functions intact.	Multiple disturbances associated with the need for socio-economic development, e.g. dams, diversions, etc
D: Largely modified	Large changes in natural habitat, biota and basic ecosystem functions have occurred. A clearly lower than expected species richness.	Significant and clearly visible disturbances associated with basin and water resources development, including dams, diversions, transfers, habitat modification and water quality degradation
E: Seriously modified	Habitat diversity and availability have declined. A strikingly lower than expected species richness. Alien species invaded the ecosystem.	High human population density and extensive water resources exploitation.
F: Critically modified	Modifications have reached a critical level and ecosystem has been completely modified with almost total loss of natural habitat and biota.	Status is not acceptable. Management interventions are necessary to restore flow pattern, river habitats etc (if still possible / feasible).

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The emission of greenhouse gas will be minimum if the reservoir is small and deep. To lessen the rotting of vegetations, which causes more emission of GHG, all vegetation should be removed before inundation.

7.10. Selection of Alternative Dam Sites

As described in section 6.3, the recovery of water quality to natural level is influenced by the distance between the two adjacent dam on a river. To maintain the existing ecosystem as much as possible, this criteria should be considered in selection of dam sites. In dam site selection, alternative sites should be studied considering not only the structural aspect but from environmental aspects.

7.11. Erosion

To minimize erosion, it is very important not to disturb the natural vegetation cover around the project area and in the watershed area as described in section 7.2. During construction period, it is required to give strict instructions to construction teams not to disturb the ground outside the construction zone.

7.12. Disposal of Waste Material

It is very normal that construction waste such as used oil, tyres, waste construction material, etc. are disposed to the specified area which causes much disturbance to natural environment. So to keep the natural environment undisturbed, it should be instructed to use the specified disposal area only.

7.13. Awareness of People

Some practical suggestions should be given to educate the people for their awareness on environmental conservation, such as how to reduce consumption, organize an environmental campaign, communicate effectively with the media and report to authorities concerned relating to the care of environment of people.

8. CONCLUSION

After the agreement signing on 15 November 2008, the environment baseline team had prepared for its investigation works. According to the Terms of Reference of EIA prepared by CISPDR, the team has gone on field investigation from January, 2009 to March, 2009 for low flow and from June, 2009 to August, 2009 for high flow situations.

Water Quality

The investigations are made at 7 proposed hydropower stations and at 11 sections at tributaries. pH, Temperature, BOD, COD, TSS, Oil and Grease, Phenol, Cyanide, Nitrogen, Phosphorus, Arsenic, Chromium, Mercury, Nickel and Zinc are parameters investigated relating to water quality. TSS, Oil and Grease, Phenol, Nitrogen and Phosphorus are found to be higher than the limit proposed by **"Pollution, Prevention and Abatement Hand book 1998 Toward Cleaner Production (The World Bank Group)"** especially in the high flow period while the other parameters are found to be within limit.

Ambient Air

The ambient air quality was measured from January to March 2009 and found to be within the limit proposed by the above mentioned World Bank Group Hand book.

Acoustic Environment

Investigations are made for acoustic environment from January to March, 2009 at the proposed hydropower station sites. At all sites except in Pisa and KaunglanHpu the sound level was higher than allowable level 70 dB (A) due to the cascades.

Area and Point Pollution

Pollution of water was studied at proposed hydropower station sites and around residential areas. The project area is not an industrialized and densely populated one and no trace of serious pollution was found except in Ngawchang Hka stream which is a transboundary one.

In overall aspect, it could be concluded that no significant adverse values was found relating to water, air, acoustic quality and pollution at present situation.

Fig. 39 TRACE OF CHROMIUM

Sr. No.	Hydropower Station and Tributories		Parameter	Chromium		Geology
			Unit	mg/l		
			Limits	0.5		
1	Upper Mali Hka	Nmai Hka	17	0.549	E	m
2	Torong Wang		16	0.572	D	m
3	Yenan		7	0.547		m
4	Ahkyang Ti	C	8	0.560	C	m
5	Kaung Lanhpu		6	0.588		m
6	Mekh Rame	E	9	0.588	E	m
7	Pisa	D	5	0.588		m
8	Wutsok		4	0.508	C	m
9	Ngawchang Hka	C	10	0.565	D	m
10	Chibwe		3	0.542		m
11	Tunpang Hka	D	11	0.548	D	m
12	Myitsone		1	ND	D	m
13	Taya Hka	D	18	0.413		m
14	Lasa	Mali Hka	2	0.545	C	m
15	[illegible] Hka		15	0.477	D	m
16	Hpungin Hka		14	0.575	C	m
17	Nam Tisang		13	ND	C	g
18	Nam Lang		12	ND		g

Index

Flow Direction

C Concentration

D Dilution

E Equilization

For Chemically Consideration

m Mainly Schist & gneisses

g Granite & other than basic intrusive

General Geology

Chromium concentration of surface water from Yenan becomes higher at Kaung Lan Phyu, and also from Ahkyang Ti to there (see Table). That finding shows that most of the chromium deposit may be among Yenan, Ahkyang Ti and Kaung Lan Phu. Also, surface water from Nam Tisang and Nam Lang begins to accept chromium just before Hpungin Hka. So most chromium deposit mentioned above may extend of upto Hpungin see (Fig -). Further mineral geological investigation should be done in that area.

There were (2) major transboundary rivers bordering China in Kachin State as follows.

Basin	Tran boundary Rivers	Border Country
Nmai Hka River Basin	1. Taron wang	China

2. Ngawchang Hka China

In the water quality survey of the selected observation sites, there were some significant parameters found in two rivers in Nmai Hka Basin the rivers sources of which come from China.

Oil and grease content at Wutsok is found to be 16.6 mg/l which is larger than the general water quality standard. The station observed is the upper most part of the Nawchang Hka river near the border with China.

Other parameters of significance occurrence are Phenol and Nitrogen, Phenol level along the Nawchang Hka river at high flows in the station at Wutsok, Ngawchang Hka and Chibwe (4.8, 4.8 and 5.1 respectively) are much higher than the general limit (0.5 mg/l). Nitrogen level at all three stations observed were also found to be higher at both low flow (36.4, 22.4, 19.6 respectively) and high flow (40.32-Wusok, 21.16-Chibwe) than the general limit (10 mg/l) except only at Ngawchang Hka in high flow measuring 7.75 mg/l. So Ngawchag Hka basin has less vegetative cover.

Also Phenol and Nitrogen level are reletively high at two stations observed (Toron Wang and Yenam) along the river Toron Wang the source of which is inside China. Phenol in Toron Wang and Yenam at high flow is found to be 4.7 and 4.3 which is higher than the general limit of 0.5 mg/l. Nitrogen level is much higher in both low flow and high flow at Toron Wang and Yenam stations (22.6 and 42.84 is Toron Wang, 19.6 and 15.12 is Yenam). So Toron wang basin has more vegetative cover.

Hence monitoring and control measure for Oil and Grease, Phenol and Nitrogen should be accomplished throughout and after the project life and after the project for these transboundary rivers with China.

9. DISCUSSION AND RECOMMENDATIONS

The Ayeyawady is the lifeblood river of Myanmar. It originates from the northernmost part of the country and flows towards Bay of Bengal forming the biggest fertile delta which is the rice bowl of Myanmar in south east Asia. It is navigable through out the year acting as main trunk waterways. Many towns and cities are situated along left and right banks of Ayeyarwady showing that Ayeyarwady plain is a very much dependable area for the livelihood of Myanmar people.

The project area is in that area where the Ayeyarwady originates and is the cultural heritage area of Kachin which is one of the main tribes of Myanmar. Again the area is one of the bio-diversity hot spot areas of Asia.

The Ayeyawady Hydropower Development Project could be said as a gigantic one since it is planning to produce 90.95 billion kW-h annually utilizing water from an estimated catchment area of 49000 km^2.

Since on one hand the water resource used in the project is the lifeblood of the country and on the other hand the development is a very big one, it is very clear and distinct that the development of the project must be considered very thoroughly from various aspects.

As described in Section 6, the fragmentation of river by dams has a very serious problem not only to the upstream of the dam but also to very far downstream till the coastal delta. The impacts of changes in flow regimes, trapping sediments and nutrients behind the dam, downstream aquatic ecosystems and bio-diversity could only be seen in long term. So the impacts are to be anticipated through past experiences and models.

Reliable and sufficient relevant data are indispensable in these anticipations. Enough time and, accordingly, budget is required for thorough investigations.

The investigation works for EIA had been done in a very limited time. A longer investigation time is strongly recommended in such a big and sensitive project which may have very significant adverse impacts. In the past, Myanmar had experienced that it takes more than five years for the feasibility evaluation to implement a project and to get World Bank loan for a medium size multipurpose irrigation and hydropower project.

The baseline study was carried out by the local scientists. Although they have good will for the study and had tried their best for the works, they may need some guidance for analysis and evaluation of some adverse impacts which are complex since the project is a gigantic and sensitive one. Well experienced international expertise is advisable for the guidance of the study.

Thorough sediment-transport studies is not implemented in the present studies. It should be included in the studies since it builds upon a good understanding of the sediment-transport dynamics and helps in estimating or quantifying the lessened amount of sediment downstream. It also serves as the basis for prevention of unwanted sedimentation.

Dam site selection studies and analyses should be done and analyzed thoroughly in all aspects, since there may be complex problems which could cause a lot of adverse effects relating to social, cultural, environmental etc. due to the construction of the dam.

Not only the benefits due to hydropower development, but also those from other developments such as eco-tourism, wild life conservation etc. should be considered in comparison although some of them may be intangible ones. Based on balancing the possible positive and adverse impacts, decision could be made whether all the potential resources or only some part should be used, in other words optimizing potential resources such as integrated water resources management for food, livelihood and nature should be studied. Sometimes, it is found that zero option is the best solution for the development.

Prioritization for implementation should be programmed in cascade dams development. The dam having relatively least adverse effects should be implemented first. Thus it will get more information and time for the development of the remaining dams and more mitigation measures are possible to be included.

Public disclosure about the development is also a useful tool. Different stakeholders, organization and concerned government agencies would get a chance to collaborate and contribute their experiences and knowledge for better developments. Giving education and information to people in the region affected by the project is also important so that they can participate in project development in the correct means.

Apart from the basic line measurements for the surface water quality, monitoring and control of pollutants in the reservoir and rivers before and after project implementation is required (see Annex).

Continued monitoring is essential through out the project life by a special team or committee organized for this particular purpose so that compensation and remedial measures can be taken as necessary. Follow up monitoring works should be planned. As the preliminary investigation team can accomplish baseline study on mainly the surface water quality at low flow and high flow only due to the available resources and time limit, a detailed and comprehensive investigation is urgently required prior to the project implementation. To measure and monitor not only the water quality at the surface but also the water quality at middle and river bed of the water body and also the water quantity (or) runoff of the river at both low flow and high flow to determine the environmental flow after implementing the dam project is required.

General standards for discharge of effluents (CPCB 1995) and observed data at high flow

Table 31

Sr No.	Parameters	Unit	Standard			General application	Observed data range on analytical results	
			Inland surface water	Public sewers	Land for irrigation	Limit	Minimum	Maximum
1	Suspended solids	mg/l max	100	600	200	50.0	5.0 (Lasa)	550.0 (Myitsone)
2	pH		5.5-9.0	5.5-9.0	5.5-9.0	6.0-9.0	6.53 (Toron Wang)	7.52 (Tunpang Hka)
3	Temperature	°C	Shall not exceed 40 °C in any section of the stream within 15 m down stream from the effluent outlet	45 at the point of discharge			19.5 °C (Toron Wang)	33.6 °C (Tunpang Hka)
4	Oil and Grease	mg/l max	10.0	20.0	10.0	10.0	1.7 (Hpungin Hka)	192.0 (Myitsone)
5	Nitrogen	mg/l max	50.0	50.0	50.0	10.0	7.75 (Ngawchang Hka)	69.0 (Kaunglanhpu)
6	BOD	mg/l max	30.0	350	100	50.0	N.D	0.4 (Nan Tisang)
7	COD	mg/l max	250	-	-	250	N.D	52.80 (Wutsok)
8	Arsenic	mg/l max	0.2	0.2	0.2	0.1	< 0.01	< 0.01
9	Mercury	mg/l max	0.01	0.01	0.01	0.01	N.D	0.0065 (Myitsone)
10	Chromium	mg/l max	2.0	2.0	2.0	0.5	N.D	N.D
11	Zinc	mg/l max	5.0	15.0	-	2.0	< 1.0	< 1.0
12	Nickel	mg/l max	3.0	3.0	-	-	N.D	0.011 (Nanlong)
13	Cyanide	mg/l max	0.2	2.0	0.2	0.1	< 0.1	< 1.0
14	Phosphorus	mg/l max	5.0	-	-	2.0	< 0.1	7.5 (Hpungin Hka)
15	Phenolic	mg/l max	1.0	5.0	-	0.5	-	-
16	Pesticides	-	Absent	Absent	Absent	-	N.D	N.D

Ref No.18 - Water Pollution P.50-52

Ref No.1 Pollution Prevention and Abatement P. 438

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APPENDIX-1

Notes on Exploration and Experiences of Field Survey Team

The experiences gained during the investigation trip (Fig. 10) are described below and the photo records are shown in Appendix-2.

Nmai Hka Basin

Transportation on mountain road

On Myitkyina-Chibwe road, 4 wheel drive cars were mostly used with axle height normally 2 feet above the road surface. Peking jeeps were found to be suitable for such roads in those areas. Survey team found logging roads in the area which facilitate access for landless settlers, miners and hunters.

The master of bows

Near Hta Phone village, the survey team found some hunters. They use bows and poisonous arrows and usually neglect the ban imposed by the authorities on hunting. Indigenous people have no knowledge on conservation of nature and they are likely to keep their habitual activities.

Dangerous foot path on mountain slope

A foot path on the steep slope of mountain on the river bank was the only way for investigation and was dangerous for the team. Sometime forest paths are about four thousand feet high from the base. Survey team was much afraid of falling down accidentally. Although they had got much help from the porters, they still experienced falling but luckily there were no fatalities. In the case of climbing steep cliff the investigation team had to hold on to branches of the nearby trees. The project area is really a wilderness.

Weather condition

Since it was raining almost in everyday, the investigation team had to work in the rain. Some team members saw much blood-sucking leeches. Sometimes clouds were seen at a level lower than the mountain. Rain lessened the tiredness of the team. The weather was cold and the team had to resist it by making a fire in their shelter. It is an indoor air pollutant.

At Kaunglanphu

It is a township level administrative place and government offices are situated in Kaunglanhpu. So most of the residents are government staff. Donkeys are used for transport. Diesel generators and micro hydropower are used for electric power. The altitude of Kaunglanhpu is 9680 feet. In 2008, annual rain fall was 104 inches in 174 raining days, Kaunglanhpu is a potential centre for watershed management and conservation works.

Forest on the way

Few big trees were seen in the project area. Bamboos were found and too thick to pass through them. The team found so many kinds of vine and sometimes "scented wood". Banana plants grow in the area. Various orchids were in full bloom. These forests seemed to be properly managed at present time. Proper forest management involves planning for sustainable harvests while paying particular attention to forest regeneration.

Medicinal Herb

In the project area there is a kind of herb, whose leaves are boiled in water and could be used as energy drink. Local people collect and dry these leaves to sell for their use.

Scientists are now trying to make a research on these leaves. It is a non-timber forest product and could provide an income to the villagers without destroying forests.

Hot island

There is an area between Htiyi hotel and Pha Ye village which has a very hot weather like central Myanmar. It is one of the ecologically interesting places in the area.

Wildlife head

The survey team found a head of wildlife animal they had killed which was hung in one room and the skin on a tree. It was learned that one endangered tiger was once killed and sold to China. They are endangered species and irreplaceable if local people continue to kill. Population biology of these species is important.

Scarcity of food

It was noticed in the area that there were no programes and encouragement for food production. The people in the area often had to face problems of food shortage. At that time they used to eat "Eudaing paste". They cut down "Eudaing" plant and sliced it halves and took the paste and sank it in the water. They got a paste, like "mont hnit". The crust was used as gutter, which is long and wide enough to carry water from the spring. Local people should be educated in ways of sustainable agriculture, regenerative farming or agroecology, all of which aimed at food and fibre production on a sustainable basis and prevent unwanted damage caused by destructive practices.

Natural drinking

Along the way of investigation, the team did not need to be worry about drinking water. Water naturally gushing out from the rock fissures was potable. It was natural clean water.

Mountain peak under the feet

Sunlogchat was one of the mountains with an altitude of about 8000 feet at its peak is one that the investigation team had to pass. Being a very cold and windy place, no body could stay there very long. From there is one clouds could be seen at a lower altitude.

Great effort had to be made by the team to pass through that difficult and hard place.

Unforgettable paradise

The team had stove, plates and bowls and firewood. Caretakers gave them boiled water and heated corn. A few could speak Myanmar. Most of them were Lisu and Rawan. Some could even speak Chinese. At night, the party could sleep well inside a shelter and felt like a paradise.

Fishing explosives

Fisherman of the area were not used to using boats because of the rapid. They catch fish by using explosives. The explosives were readily available at a cost of 1500 kyat. This practice should be banned to conserve fish population.

Bamboo bridge

Bamboo bridges are used to cross high valleys. Sometimes one needed to crawl along three Wabo bamboos to reach to the other side. The scene was very frightening while crossing the very deep valleys. The investigation persons could be named as 'Adventurers'. It was also noticed that some infrastructures like bridges should be built for that area.

Deadly bridges

Suspension bridges with steel ropes are built across the rivers and stream. Timber planks of about 8 inches in width are laid in zigzag for a walk way. When one walks on it, it sways. Two ropes on the sides must be held firmly step by step. Pashim suspension bridge is the longest one that the team had passed in the area. By seeing such facilities, one could imagine the difficulty of communication in the area.

Food in the forest

The team often ate fried vegetables and salad. They grew naturally in the forest. They were "Taw-chin-paung" (wild reselle) and "Pusinam" (spear mint). Local porter made food from them. When the investigation period was longer than the estimated, the team had to face shortage of food. Then they had to solve the problem by substituting vegetables which naturally grow in the forest such as 'Taw-chin-paung', 'Pusinam'. The porters who were the local people of that area were very helpful in those situations.

The ruby mountain

It was an unforgettable scene while the sun was going down in the evening through the mountains in the west of Ngawchan Hka. The team had experienced the ruby like red sun in the clear sky. It was a beauty to see the mountain in the west near the Ngawchan Hka where the evening sun was setting in the clear sky. At that time it looked like a ruby mountain in the west. At sunset, Kachin State is a land of beauty.

Automatic pounding machine

In Kyihtan village, the villagers did not need to pound the paddy manually to get rice. They put the paddy under the fall. After two day they get rice. Two wooden arms with full energy from the water fall pound the paddy one after another. The mechanism of pounding was so eco-friendly that there was no gas emission either.

Mali Hka Basin

Famine at Zunparabun

In 1986, there once was too many rats spreading in Sanparabun. They destroyed the crops. So the people did not have enough food for a long time. There was famine and people died. That was recorded on the stone in the school compound at Zunparabun. That kind of incident was a sad ecological niche.

Needy children

It was found that the children of the area have to work for their livelihood. The children collected firewood and the food in the forest. They have not enough clothing to protect from the cold weather. When they were given instant noodles the smile on their faces could not be forgotten. "Ecofeminism reexamined relations with humans and nature. It called for a new ethic of care, reciprocity and kindness". (Ref. 8, P. 38).

Organic farming

Little terrace farming was seen in the surveyed area. Shifting cultivation was mostly practiced. The soil in the area was found to be fertile. In the area the practice of chemical fertilizer was hardly seen. It could be said that natural ecosystem still exists in the area.

The lost tributaries

Near Htan Kha village there was a tributary which flowed under the ground for about one mile. The villagers said that underground river tunnel was wide enough for a man to get along it. This tunnel is famous in the only man with obedience and respect could enter it. Cutting trees is banned. An example of the mistake of deforestation was found in Brazil where native tribal people were threatened by tropical forest destruction. Here in this place, people had lived in harmony with nature for thousands of years. Otherwise, their valuable forest ecosystem would be lost for ever.

Along the Mali Hka

There are rapids in the river Mali Hka which make navigation difficult. The boat man needed skills to pass through rapids and swift flow. By land, survey team once had a car accident on the way at the 140 mile post from Myintkyina to Putao. By a four wheel drive car, Putao could be reached from Myitkyina in 8 hours. Maliyan was a village having about 50 houses situated on the left bank of Mali Hka, 110 miles away from Myitkyina.

National park

Naungmon is a small town accessible to Putao, Kaunglanhpu and Pannandin. The famous Khakaborasi National Park which is the pride of the Kachin State is situated above Pannandin. The northern mountain range in the area looks like that of Annapurna Conservation area of snow capped Himalayan mountains in Nepal.

Control stations

There are seven control stations at the Mali Hka river. Only people and boats who have permission for pass by authorities are allowed to pass through. Due to these control station the number of people were limited which helped conservation of forest ecosystem.

Staple food

Rice is the staple food of the local people in that area. When rice was not produced enough, the natives used maize and banana as their food alternatives. The locals are practicing shifting cultivation in some areas. Agricultural education should be introduced to them for sustainable production of enough food.

Land slides

Land slides are very common and seen at the banks of rivers and tributaries after heavy rains. It is due to the lack of vegetative cover on the steep slopes. Because of land slides the river regime was degraded and turbidity increased. Care should be taken not to destroy the natural vegetative cover.

Gold mining

The gold mining industries are so prosperous that there are many food stalls, and groceries industries. There are also gambling and karaoke bars which might cause crime and AIDS problems. Dredging, pumping in high pressure jets in gold mining might lead to a serious degradation to river ecosystem.

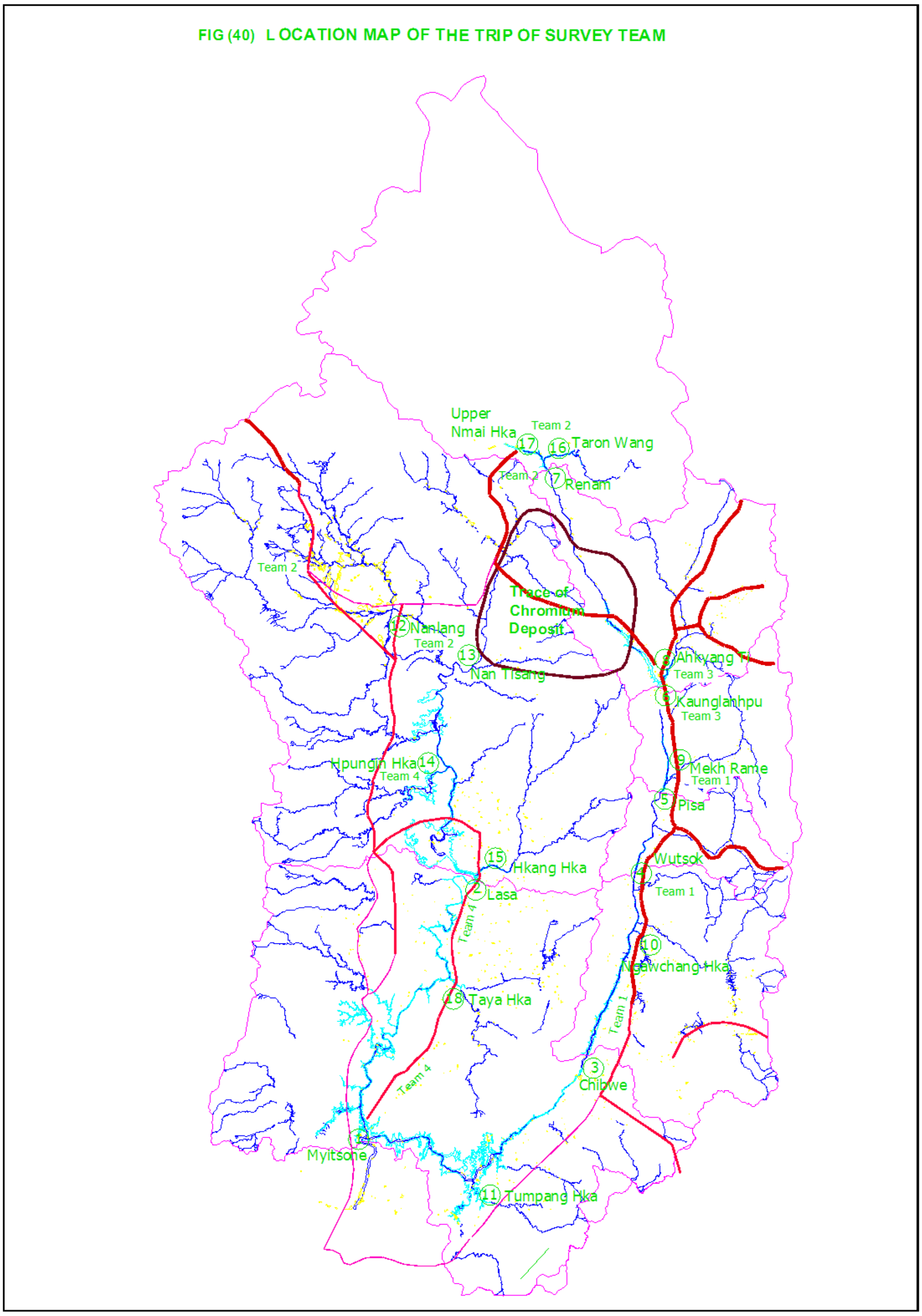
Tourism potential

The project area is a scenic one having beautiful snow capped mountains, and forests. There are also different kinds of wildlife and it is recognized as a biodiversity hot spot area of the region. The area is the best place for sports like skiing, hiking and mountaineering. Since the area is very pleasant it has a high potential for tourism trade.

Pannandin

It is a small village having only 28 houses. Access and communication to Pannandin is very difficult. There are two helipads. Rice, potato, pumpkin and maize are grown in the area for food. Fish and meat of wildlife were also used for the meals. When the rice production was not sufficient, it was imported from Putao and China. Although it is hard to live, Pannandin is really a beautiful place from where snow capped mountains are seen in the distance.

APPENDIX – 2



APPENDIX - 3

Monitoring and Control of Pollutant in Reservoirs and Rivers (Reference 18)

General

Irrespective of the nature, the mode of entry of pollutants into the water systems is often common. Broadly speaking, the pollutants can enter into water bodies by the following ways:

1. Direct discharge in the form of domestic and industrial waste waters into the system
2. Run-off and seepage
3. River flow transport
4. Reactions and transport across the water-sediment interface

Apart from the direct discharges, the major transport of pollutants from land surface to water systems takes place by run-off water which picks-up the materials (both soluble and suspended) from the soil and transport them to the receiving waters. A large quantity of soil itself can move with the run-off (soil erosion) to the bodies of water causing silting. Materials from the soils are removed mainly by leaching due to the force of percolating and run-off waters. Leaching has been reported to remove huge quantities of pollutants from the refuse tips in the cities causing both surface and ground water pollution. The rate of leaching for soil constituents has been found in the following order:

$$Ca > Mg > S > K > N > P$$

On reaching a water body, the fate and behavior of pollutants depend largely upon their nature and a variety of physical, chemical, morphological and morphometric, and biological factors. Monitoring forms an essential part of any management and pollution control programme for water bodies.

Pollution of Reservoirs

Behavior of Pollutants

The behavior and movement of pollutants in lakes, after their entry, depend upon a large number of factors. Wind action tends to circulate the water, but the depth of the mixing is determined by the temperature stratification and the depth of thermo cline. In a highly stratified body of water, the thermo cline puts a resistance to mixing, and allows only the epilimnetic upper layers to be mixed. In isothermal conditions, the mixing of pollutants may be complete, as uniform conditions prevail throughout the water column. However, the ultimate diffusion of the soluble pollutants takes place by a process called molecular diffusion.

The depth of the bodies of water is also an important factor influencing the mixing of pollutants in the whole water column. As the shallow waters are often well mixed, they provide a better mixing for pollutants in contrast to the deeper waters where only a part of the water column is mixed completely.

The transport of pollutants from the mixing point to the other portions of lake may also be influenced by the slope at the mixing point. The velocity of the drain carrying waste waters is immediately checked by the resistance put by stagnant lake water causing the sedimentation of a large quantity of suspended matter at the shore. This results in the formation of a saprobic zone in case of an entry of organic waste due to accumulation of huge quantities of organic matter in the mixing zone.

The nature of the pollutant, whether degradable, non-degradable or persistent, decides its overall accumulation in the body of water over a period of time. A reduction in quantity occurs with time in case of degradable pollutants (both biodegradable and radioactive). Every water body has got a self-purification capacity with regard to the biodegradable pollutants depending upon the mixing characteristics and oxygen regime. The rate of inflow, outflow, seepage, overflow and evaporation are important factors deciding the net accumulation of pollutants in waters.

The pollutants can also get adsorbed onto the sediments in certain conditions, where they can live either temporarily until the conditions are reversed for their adsorptions, or can get permanently buried. Several pollutants like phosphours, ammonia and heavy metals have been found to be immobilized in this manner. A number of pollutants along with nutrients are incorporated into the body of organisms from where they are released only after their death and decomposition.

Monitoring of Reservoir Pollution

Any monitoring programme scheduled for lakes requires firstly the knowledge of morphology and morphometry which can be obtained by outline and bathymetric maps of the water body. The information regarding the catchment area is also very important and can be obtained from already existing records. The morphometric parameters of interest are usually the size, shape, area, depth, volume, length, breadth and shoreline of the water body. The point sources of pollution should be identified and marked on the maps. The samples from these entry points have to be collected regularly and an estimate of total pollution input is to be made with the help of water discharge rates and the chemical analysis data.

Due to uneven distribution of pollutants in lake waters with depth, a single sample can not be representative of the water quality for the whole lake. Several samples are usually required for a worthwhile monitoring of lakes, which should be obtained from mixing zones, downstream point, middle of the lake and some distinctly different sites owing to the peculiarity of shoreline and surroundings. The samples from these sites should be collected at least from three depths, i.e., surface, middle and bottom. The bottom samples give and idea of the accumulation of pollutants near the sediment-interface.

The depth samples can be collected with the help of some suitable depth samplers like Von Dorn bottle or other devices. The collected samples are transferred to the laboratory immediately after collection for the detailed chemical and biological analysis. Some chemical parameters like dissolved oxygen, free carbondioxide and pH are normally analyzed at the field as they rapidly change with time. The common parameters analyzed in any monitoring programme may include the following:

Physical: Temperature, colour, solids, turbidity, conductivity.

Chemical: Dissolved oxygen, BOD, COD, pH, alkalinity, redox potential, ammonia, nitrate, nitrite, sulphate, phosphate, chloride, calcium, magnesium, hardness, sodium, potassium, iron, heavy metals pesticides, detergents and any other pollutant of interest.

Biological: Coli forms, pathogens, plankton (both phytoplankton and zooplankton) macro-invertebrates.

Control of Reservoir Pollution

The first step in any management and control programme of lake pollution is to carry out a regular monitoring with regard to the parameters described above. The data obtained through this monitoring shall help in assessing the current tropic status and level of pollution. Net accumulation of pollutants can be worked out from the input and output data for various pollutants. Long term trends can also be evaluated from a regular and continuous monitoring data.

Some important control measures usually employed for lake pollution are diversion of nutrients, removal of pollutants and nutrients from waste waters, removal of nutrients from lakes, and proper land management in catchment area.

Pollution of Rivers

Behavior and Fate of Pollutants

The most basic characteristic of the river system is the presence of a current which plays a dominant role in habitat conditions, distribution of the constituent, and horizontal movement of water mass. The changing boundary conditions and the catchment area throughout the length of a river system can totally change the characteristics from one section to another. This indicates that no two rivers or the portions of a river are identical, which makes it apparent that each river or each portion is unique in many respects and should be investigated accordingly. A river system provides a very short residence time to water in contrast to the lake which provides usually a long retention time.

The rivers receive pollutants from both point and non-point sources. The point sources are commonly the discharges of sewage and industrial wastes of varying characteristics and load. The flowing nature of rivers imparts them a comparatively higher self-purification capacity. The organic matter is decomposed at a faster rate with flow because of the greater re-aeration of oxygen from the atmosphere by turbulence. Thus, the oxygen which falls suddenly after an organic outfall can be replenished quickly after some distance in a river.

The conservative pollutants (non-degradable) tend to concentrate in the river systems. However, after their entry they get diluted in water with flow, while some are absorbed to the bottom sediments and some get incorporated into the body of organisms. This indicates that, while the concentration of these pollutants in water may dilute, they remain essentially unchanged in quantity in the river system. The conservative pollutants in river progressively increase in concentration with time in case of their continuous discharge by outfalls.

The bacteria and other microorganisms including pathogens, introduced by outfalls, meet the fate of natural death reducing their density with flow. However, if the sources of pollution are spaced near to each other, as often the case when a river passes through a city or an industrial area, a required stretch may not be available to the river for self-purification. This makes the pollutants to accumulate in these areas to dangerous levels. An excessive accumulation of organic matter will result in oxygen depletion, or its complete elimination from the water.

Monitoring of River Waters

The overall monitoring of any river basin shall depend on the basic objective for which it is to be carried out. The major objectives of the river monitoring may include one or more of the following:

1. To assess immediate water quality in the river.
2. To enforce water quality standards, detect offenders and ascertain improvements owing to the abatement measures.
3. To predict future changes in water quality resulting from the developmental activities in the region.

4. To provide an early warning system for downstream users about adverse water quality conditions.
5. To determine timing for flow increase or stream treatment.

The sampling stations in a river are usually decided after a preliminary survey of the stretch of the basin taking following aspects into consideration.
1. Points of entry of waste waters along the river.
2. Points of entry of freshwater tributaries.
3. Points where there is significant changes in the width, velocity, slope or depth of the river.

The selection of sampling points for a routine water quality monitoring has been illustrated in Fig. In a heavily polluted river by organic discharges some additional samples can also be drawn below the outfall representing the zone of recent pollution, saprobic zone, recovery zone and clean water.

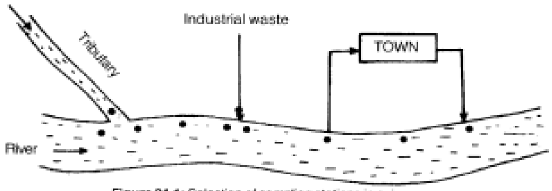
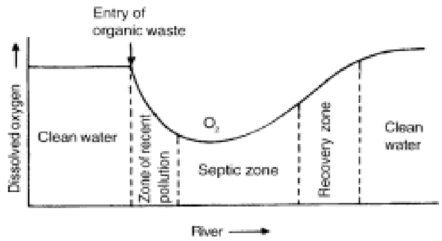


Figure 24.1: Selection of sampling stations in a river.



Various zones in a river after the addition of an organic waste

The collected samples are analyzed for the parameters already indicated earlier for lake monitoring. Besides the usual physico-chemical and biological parameters, additional information is also required on hydrology of the basin, flow rates of both discharges and river, average depth and width of water at the sampling stations, distance between the two sampling stations, and meteorological information, to correctly interpret the results.

Control of River Pollution

Following approaches can be considered for control river pollution:

l. The most usual approach for river pollution control is to lay down standards governing the stream water quality and effluents discharged into it. Streams are generally classified according to the major use to which they are likely to be put, i.e., drinking, fish culture, irrigation, bathing etc. Each use requires some minimum water quality for which the standards can he applied.
2. At the time of lean flow seasons, the pollutants are likely to be concentrated in greater quantities, which can he controlled by augmenting the flow of water in the river by extra discharge from the upper reservoir.
3. At certain times in dry season, when the self-purification capacity is reduced considerably, extra oxygen can be provided by artificial aeration at the desired points. However, this method is costly and less feasible, but can be applied in emergency situations.
4. All the waste waters entering into a river system should be allowed only after a proper treatment. This can reduce the pollution load to a desired level calculated on the basis of stream

The Report

on

the Status of Wildlife Trade in Kachin State, Northern Part of Myanmar

1. Introduction

Myanmar is one of the biologically richest regions in the world as a result of its wide range of physical conditions in a tropical region, covering a total land area of 676,577 square kilometers and it harbours many rare, endangered and endemic species. Being an agricultural-based country, about 80% of the population residing in rural areas, depending very much upon forest resources such for their livelihood (NCEA, 1997). There are 251 known mammal species, 1056 species of birds, 360 species of reptiles and 11,800 species of flora including 1200 tree species are found in Myanmar (Tin Tun, 2009).

Most wildlife sanctuaries / parks in Myanmar are just paper parks and ineffective. Hunting, fishing, and willful disturbance to any animal in a sanctuary and similar activity in a reserved forest without a license was prohibited. But most existing protected areas are understaffed and poorly managed and in general have suffered years of agricultural encroachment, settlement and excessive logging. Wildlife is presently being threatened as a result of habitat loss, hunting and poaching.

Myanmar has been affected in the various situations of economic growth, which leads to cause environmental disturbances. Increasing population and economic pressures have compounded the exploitation of the natural resources from many angles. Major threats on decreasing wildlife and their habitats were due to deforestation, forest fire, timber cutting, flooding, landslides, thunderstorms and other human-related impacts. One of them, wildlife trade is the major threat to sustainable development of wildlife conservation at the present and it may cause endangered and rare wildlife species to be extinct in the future.

Myanmar had to contend with the illegal smuggling of the major and important wildlife species to some extent and Kachin State is no exception. The trade brings benefits through employment and income for rural communities, the business sector and national economies but can also pose serious conservation threats. To minimize risk and maximize benefits in future, it is essential that there is a greater emphasis on multidisciplinary analysis of wildlife trade issues and development of adaptive responses focused on clear conservation and socio-economic goals and the motivating factors.

1.1. Globally threatened species in Myanmar

A significant number of the plant and animal species that occur in Myanmar has been assessed as globally threatened, following the global threat criteria of The World Conservation Union (IUCN) / Species Survival Commission (SSC) (1994). However, in the Indo-Myanmar Hotspot, comprehensive global threat assessments are only available for mammals, birds, amphibians, and some groups of reptiles. The following table shows the number of globally threatened species in Myanmar estimated in 2005 (BirdLife International, 2005).

Table 1. Summary of globally threatened species in Myanmar

Taxonomic Group	Global Threat Status			
	Critically Endangered	Endangered	Vulnerable	Total
Mammals	**4**	**9**	**26**	**39**
Birds	**4**	**8**	**33**	**45**
Reptiles	**4**	**10**	**7**	**21**
Invertebrates	**0**	**0**	**1**	**1**
Plants	**13**	**12**	**13**	**38**
Total	**25**	**39**	**80**	**144**

Source: Myanmar: Investment Opportunities in Biodiversity Conservation, 2005

2. Institutional and Legal Framework

2.1. CITES

Concerned by the impacts of commercial trade on wildlife populations, governments of 80 countries together in 1973 to draw up the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). The treaty which came into force in 1975, aims to regulate and monitor the trade in species whose survival is or could soon be jeopardized by international trade. CITES has established a world-wide system of controls on international trade in threatened wildlife and wildlife products by stipulating that government permits are required for such trade.

CITES provides protection in two main categories:

2.1.1. Most Endangered Species

Appendix I: Includes all species threatened with extinction which are or may be affected by trade. It prohibits commercial trade in wild-collected species in danger of extinction.

2.1.2. Other Species at Serious Risk

Appendix II: a) Includes all species which although not necessarily currently threatened with extinction may become so unless trade is subject to strict regulation; and b) Other species which must be subject to regulation in order that trade in certain specimens of species referred to in sub-paragraph a) above may be brought under effective control, i.e. species similar in appearance.

Appendix III: All species which any Party identifies as being subject to regulation within its jurisdiction for the purpose of preventing or restricting exploitation. The cooperation of other Parties, is therefore, needed.

The Convention currently covers some 30,000 plant and animal species and has 144 member countries, few of which achieve high standards of implementation and enforcement. Myanmar became a member country in 1997.

2.2. IUCN

IUCN – is a union of sovereign states, government agencies, and non government agencies. IUCN has three basic conservation objectives: (i) to secure the conservation of nature, and especially of biological diversity, as an essential foundation of the future; (ii) to ensure that where the earth's natural resources are used this is done in a wise, equitable and sustainable way; and (iii) to guide the development of human communities towards ways of life that are both of good quality and in enduring harmony with other components of the biosphere IUCN has its South East Asia regional headquarters in Bangkok, Thailand. No national IUCN office has been established in Myanmar.

The 1996 IUCN Red List of Threatened Animals comprises a total number of 5,205 threatened species (mammals: 1,096; birds: 253; amphibians: 124; fishes: 734; and invertebrates: 1,891). The Red List identifies eight categories that enable the classification of almost every species or subspecies in the world as follows:

2.2.1. Extinct (EX)

A taxon is Extinct when here is no reasonable doubt that the last individual has died.

2.2.2. Extinct in the Wild (EW)

A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as naturalized population (or populations) well outside the past range. A taxon is presumed extinct in the wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), and throughout its historical range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

2.2.3. Critically Endangered (CR)

A taxon is Critically Endangered when it is facing an extremely high risk of extinction in the wild in the immediate future, as defined by any of the criteria.

2.2.4. Endangered (EN)

A taxon id Endangered when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future, as defined by any of the criteria.

2.2.5. Vulnerable (VU)

A taxon id Vulnerable when it is not Critically Endangered or Endangered but is facing high risk of extinction in the wild in the medium-term future, as defined by any of the criteria.

2.2.6. Lower Risk (LR)

A taxon is Lower Risk when it has been evaluated, does not satisfy the criteria for any of the categories Critically Endangered, Endangered or Vulnerable. Taxa included in the Lower Risk category can be separated into three subcategories:

(a) Conservation dependent (CD). Taxa which are the focus of a continuing taxon-specific or habitat-specific program targeted towards the taxon in question, the cessation of which would result in the taxon qualifying for one of the threatened categories above within a period of five years.

(b) Near threatened (NT). Taxa which do not qualify for conservation dependent, but which are close to qualifying for Vulnerable.

(c) Least concern (LC). Taxa which do not qualify for conservation dependent or near threatened.

2.2.7. Data Deficient (DD)

A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may well be studied, and its biology well known, but appropriate data on abundance, and/or distribution is lacking. Data Deficient is therefore not a category of threat or Lower Risk. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and threatened status. If the range of a taxon is suspected to be relatively circumscribed, if a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.

2.2.8. Not Evaluated (NE)

A taxon is Not Evaluated when it has not been assessed against the criteria

2.3. WWF

WWF- World Wide Fund For Nature (known as World Wildlife Fund in Canada and the USA) is an international NGO which pledges to conserve nature by preserving the variety of life on earth, ensuring sustainable use of natural resources, and reducing wasteful exploitation and consumption of those resources. WWF has an office in Bangkok; no WWF office in Myanmar has been opened.

2.4. TRAFFIC

TRAFFIC is a joint program of WWF and IUCN. TRAFFIC was founded in the 1970s largely to assist in the implementation of the then newly adopted CITES, TRAFFIC's work on CITES-related issues remains at the core of the Network's activities at national, regional and international levels. However, TRAFFIC's program now aims to address wildlife trade issues in a wider context, including attention to major commercial sectors such as fisheries and timber trade and a wide range of key regional and local issues, such as the trade in songbirds in Southeast Asia. TRAFFIC East Asia monitors implementation of new regulations in wildlife trade to determine their effectiveness, particularly with regard to ivory, tiger bone, turtle shell, and reptile skins and rhinoceros horn.

2.5. Myanmar

The new Myanmar Forestry Policy was formulated in 1995 to update the Old Colonial Indian Forest Policy formulated in 1894. The new Forest Policy aims at, inter alia; a balanced and complimentary land use, gazette 30% of the total land area as reserved forest and 5% as protected area system. A new Forest Law was enacted in 1992. The law includes regulations and procedures relating to conservation, wildlife, sustained yield of forest products, and protection of forest land.

The Protection of Wildlife and Wild Plants and Conservation of Natural Areas Law of 1994 is more specific than the Forest Law on wildlife, wild plants and protected areas. Seven categories of protected areas have been defined under Myanmar legislation. The new wildlife legislation includes protection of threatened and endangered species and has issued guidelines for the control and regulation of local and international trade activities (SEATEC INTERNATIONAL, 1999).

2.5. Myanmar threat categories

These categories relate specially to the threat to survival of the species in Myanmar, in accordance with the Protection of Wild Animals, Wild Plants, and Conservation of Natural Areas Act 15(A), 1994. Species are afforded varying degrees of protection according to their designation.

2.5.1. Completely Protected (CP)

Completely Protected species may not be hunted except for scientific purposes under a special license.

2.5.2. Protected (P)

Protected species may be hunted but only with special permission.

2.5.3. Seasonally Protected (SP)

Seasonally Protected species are subject to traditional subsistence hunting by rural communities only during the (i.e. non-breeding) season. Mammalian species are protected during the period from 15 June to 30 September. Avian species are protected during the period from 15 March to 30 September (FD, 2003).

2.6. Survey of wildlife management organization in Kachin State

Wildlife Conservation Society (WCS) is one of the active wildlife conservation organizations in Myanmar. WCS carried out a lot of conservation activities in Kachin State and their activities are described in Table 2.

Table 2. List of Survey Projects initiated by Wildlife Conservation Society (WCS)

No.	Project Title	Location	Duration	Team members	Remarks
1.	Study of Putao area	Putao District, Kachin State	March, 1996.	Dr. Alan Rabinowitz, WCS U Saw Tun Khaing, WCS U Thet Tun, FD.	1. Feasibility of Hkakabo-razi Expedition was studied. 2. Existence of blue sheep in Myanmar side was discovered.
2.	Khakaborazi Biological Expedition	Khakaborazi National Park, Kachin State	2 March – 12 April 1997.	Dr. Alan Rabinowitz, WCS U Saw Tun Khaing, WCS U Khin Mg Zaw, FD U Mg Mg Kyaw, FD. U Saw Lwin, MFA member. U Zin Oo, FD U Hla Tun, FD U Nyo Tun, Yangon University U Aung Win, Yangon University U Myo Khin, Yangon University U San Aye, Survey Dept: U Than Kyaw, Survey Dept: Major Kai Khan Moong, Ministry of Defence U Myat Soe, FD. U Win Kyi, Outsider.	1. Existence of blue sheep in Myanmar side was confirmed. Black barking deer and new species leaf deer (Phet-gyi) were discovered. 2. Flora and Fauna were recorded along the expedition route. 3. Khakaborazi National Park was established on 10.11.98 as a result of this expedition.

No.	Project Title	Location	Duration	Team members	Remarks
3.	Naung Mung Biological Expedition	Naung Mung area, Kachin State	24 April – 17 May, 1998	Dr. Alan Rabinowitz, WCS Ms. Salisa, WCS U Saw Tun Khaing, WCS U Saw Lwin, MFA member U Kyaw Nyunt, MFA member U Thein Aung, FD U Than Myint, WCS U Min Thein, FD U Myat Soe, FD U Tha Nyo, WCS U Win Kyi, Outsider	1. The existence of leaf deer (***Muntiacus putaoensis***) was confirmed and study on its distribution was made. 2. Study on mammals, avifauna, orchids, hunting and wildlife trade, butterfly collection and shifting cultivation was made. 3. The trip report with the recommendations was put up to the Ministry of Forestry.
4.	Hkakaborazi National Park Expedition	Hkakaborazi National Park	14 Jan: - 2 Feb: 2000.	Dr. Alan Rabinowitz, WCS Mr. Steve Winter, WCS U Saw Tun Khaing, WCS U Thein Aung, FD. U Saw Lwin, MFA member U Than Myint, WCS U Myat Soe, FD U Myint Kyaw, FD U Tun Shaung, Photographer U Win Kyi, Outsider U Kyi Shwin, WCS	The trip was aborted due to bad weather.
5.	Hponkanrazi Wildlife Sanctuary Expedition	Hponkanrazi Wildlife Sanctuary	Dec 2000 – Jan 2001	Dr. Gorge Schaller WCS U Saw Tun Khaing WCS U Than Myint, WCS U Thein Aung, FD. U Than Zaw WCS	
6.	Wildlife Trade and Hunting Survey Project in Naung Mung area	Naung Mung area	July 2002 – June 2003	Dr. Madhu Rao WCS U Than Myint WCS U Than Zaw WCS U Saw Htun WCS U Myint Kyaw FD	Wildlife Trade and Hunting Survey Project in Naung Mung area
7.	Northern Forest Complex Survey Project in Hkakaborazi National Park	Hkakaborazi National Park	July 2003 – June 2004	Dr. Madhu Rao WCS U Than Myint WCS U Than Zaw WCS U Saw Htun WCS U San Nai Dee FD	
8.	Northern Forest Complex Survey Project in Hponkanrazi Wildlife Sanctuary	Hponkanrazi Wildlife Sanctuary	July 2004 – June 2005	Dr. Madhu Rao WCS U Than Myint WCS U Than Zaw WCS U Saw Htun WCS U Yon Nai Hti Na FD	

3. Background of the Study Area

3.1. Kachin State

Kachin State is the northern most state in Myanmar, made up of the former Bhamo and Myitkyina Districts. It has common boundaries with India, China, Shan State and Sagaing Division. It lies between 23° 45' north and 28° 31' north latitudes and 95° 55' east and 98° 45' east longitudes. It has an area of 34,379 square miles. There are eighteen townships and 691 village tracts. Myitkyina is the capital of the Kachin State which is 467 feet above sea level (Lasi Bawk Naw, 2007).

Kachin State occupies the northern mountain zone and is therefore mountainous throughout, with the exception of river valleys. The general height of mountains range is from 3000 feet to over 9000 feet, with peaks usually rising above 11,000 feet. Dense forests are remarkably recognizable in the environs of the Kachin State and are home for many biological hotspots. The mountains are covered with various types of forests ranging from evergreen forest through temperate coniferous forests and temperate scrub to alpine meadows. The southern lowland regions are covered with tropical deciduous forests containing important stands of teak and other hardwoods (Olson and Dinerstein, 1998)

The native indigenous people are: Rawang, Jingpaw, Lisu, Lachid, Lawngwaw, Zaiwa, Tai Lay, Tai Mongsa, Tai Hkamti, Tai Lung and Tai Laing. There are also other nationalities such as Myanmar, Kayin, Kadu, Kanan, Chinese and Indians living in the state (Lasi Bawk Naw, 2007).

Among them, Lisus are very famous as skillful hunters. They are skilled in searching rare and very valuable natural resources. They are very brave. They are not afraid to rush into harsh-weathered regions. They are ready to confront any ferocious animals.

Compared to other states and divisions of our country, Kachin State has long been known as a country of extensive forests and biologically richest regions and also famous for the wealth of abundant valuable natural resources. Moreover, Kachin State has five protected areas: **Hkakaborazi National Park, Hponkanrazi Wildlife Sanctuary, Hukaung Tiger Reserve, Bumphabum Wildlife Sanctuary and Pidaung Wildlife Sanctuary.** Within these protected areas, there are globally threatened wildlife species such as Tiger, Asian Elephant, Gaur, Red Panda, Musk Deer and Takin etc (FD and WCS (Myanmar Program), 2004)).

This area faces a number of significant threats to biodiversity including dredging for gold, pollution from gold mining, disturbance to sandbars, degradation of forests due to excessive extraction of timber, rattan and bamboo, hunting for wildlife trade, mining, agricultural conversion, human settlement, large-scale conversion of forests to commercial plantations, and over-exploitation of non-timber forest products (NTFPs).

Wildlife and its product play a very important role for the livelihood of local people. These resources have been utilized by local people as early as the beginning of human history to meet their needs for food and fur, medicines, transportation, sports and pets. Both traditional Kachin medicines and traditional Chinese medicine (TCM) have a long history and are very popular. Variation in culture has promoted use of these natural resources in different ways. In the previous times, local people have exploited natural resources in traditional mode sustainably. In all these years, wildlife species were never under such severe threat.

But over the past few years, trade in wildlife and its products in this region have dramatically increased and as a result there is serious decline in wildlife populations due to human over-utilization, increasing rate of population growth and unsustainable nature of development of economy.

Traditionally, hunting was a valued occupation for Kachin, with animal trophies garnering respect for male hunters among their local communities. This traditional practice has become a conservation problem, as killing wildlife has been made easier due to readily available arms supplied by armed ethnic groups, and because there are highly attractive market prices for such products at the Myanmar-China border. After the degradation of habitat, trade and commerce in wildlife is the major factor responsible for the decline of wildlife species all over the world (Thaung, 2007).

3.2. Illegal logging and wildlife trade in Kachin State

Globally, wildlife trade is the serious conservation problem and is the second largest illegal trade in volume, and comes only next to narcotics and is followed by arms and ammunition (Wildlife Enforcement Network, 2009). The scale of the illegal wildlife trade is alarming. Due to the nature of illicit trade, it is hard to obtain exact figures, but some experts estimate the value of the illegal wildlife trade at 10-20 billion US dollars annually (Wildlife Enforcement Network, 2009). While arrests and interceptions are on the rise, in actual situation, it comprises only a small fraction of these underground criminal enterprises. It's the most serious threat to a number of endangered and vulnerable species.

The illegal wildlife trade affects all Southeast Asian nations. The rich biodiversities of Indonesia, Malaysia and Myanmar are particularly targeted. A significant proportion of wildlife trafficked through Southeast Asia is purchased by wealthy consumers outside the region, particularly in China, Europe and United States (Wildlife Enforcement Network, 2009).

Kachin state is one of the global hotspots for the poaching, trafficking and consumption of illegal wildlife parts and products. The region's high biodiversity, increasing affluence and accessible transport links lead to illegal trade in protected species and attractive option for the criminals. The scale of illegal trade in wildlife and its products is expanding and threatening sustainable use of natural resources to fulfill the demands of the increased human population and the demand for economic development in and outside the region. Illegal trade in natural and harvested timber and endangered species has devastating impacts.

Increasingly known as the "World's Factory", China's demand for wood products is growing each year. Unable to meet this demand from domestic wood resources since its 1998 logging ban, China has witness a rapid growth in wood imports and is now the second largest wood importer in the world. China mainly imports raw materials or crude products such as logs, timber and wood pulp and exports finished products like paper, laminated board, wooden furniture and other processed wood products. This allows China to derive most of the benefits through added values of wood products. The continuous growth of world demand for timber, including growth in China is stimulating the illegal timber trade in neighboring countries (TRAFFIC China, 2007).

Global Witness (2005) recently reported considerable unease about the scale of illegal forest activities in Kachin State. Kahrl et al. (2004) analyzed the China-Myanmar timber trade and its implications for forests and livelihoods in Myanmar's Kachin State and Yunnan Province of China. They found that China's demand for timber was underlying cause for the unsustainable harvest of valuable forests in Kachin State.

Therefore, illegal logging is one of the big issues in Kachin State. There were no opportunities to estimate the magnitude of logging in there.

A considerable amount of wildlife and its products are entering China from across the borders. The masses of demand come from the Chinese traditional culture of using wildlife for food and medicine. A rising appetite for wildlife and increasing use in TCM are fueling an increase in the illegal exports of endangered animals to China's Markets. Increased volume of illegal trade in several species found in the region has placed them on the list of endangered, threatened and vulnerable species. Formerly, no systematic surveys of wildlife trade have been conducted in this area. This paper reviews the general status of illegal wildlife trade and suggested points for future actions.

4. Project Design and Methodology

4.1. Goal

This research project is aimed to provide information on current status of wildlife trade in Kachin State for the **Environmental Impact Assessment: Special Investigation for Hydropower Development of Ayeyawady River Basin above Myitkyina.**

4.2. Objectives of the current study

The main objectives of the current study are:

- To study the status of wildlife species, wildlife trade and trade routes in the Kachin State and other trade flows
- To evaluate the impacts of wildlife trade on endangered wildlife populations
- To examine the biological and economic importance of wildlife to local communities
- To recommend appropriate conservation measures

4.3. Participants

Wildlife trade survey team is comprised of 2 members only, Daw Saw Mon Theint (EC member and Research Scientist of BANCA) and Daw Sabai Min (Member, BANCA).

4.4. Study sites

The study sites for this research cover the following areas where wildlife trade was commonly practiced with a connection of trade routes: (1) Myitkyina, (2) Putao, (3) Pannandin, (4) Wynmaw, (5) Laiza, (6) Bamaw, (7) Lweje, (8) Pangwa, (9) Kangfang, (10) Hpimaw, (11) Chipwi, (12) Kambaiti (13) Myitson area and (14) Muse. Among them, Laiza, Lweje, Pangwa, Kangfang, Hpimaw, Kambaiti and Muse are situated in China-Myanmar border. The map of the study sites is shown in Figure 1.

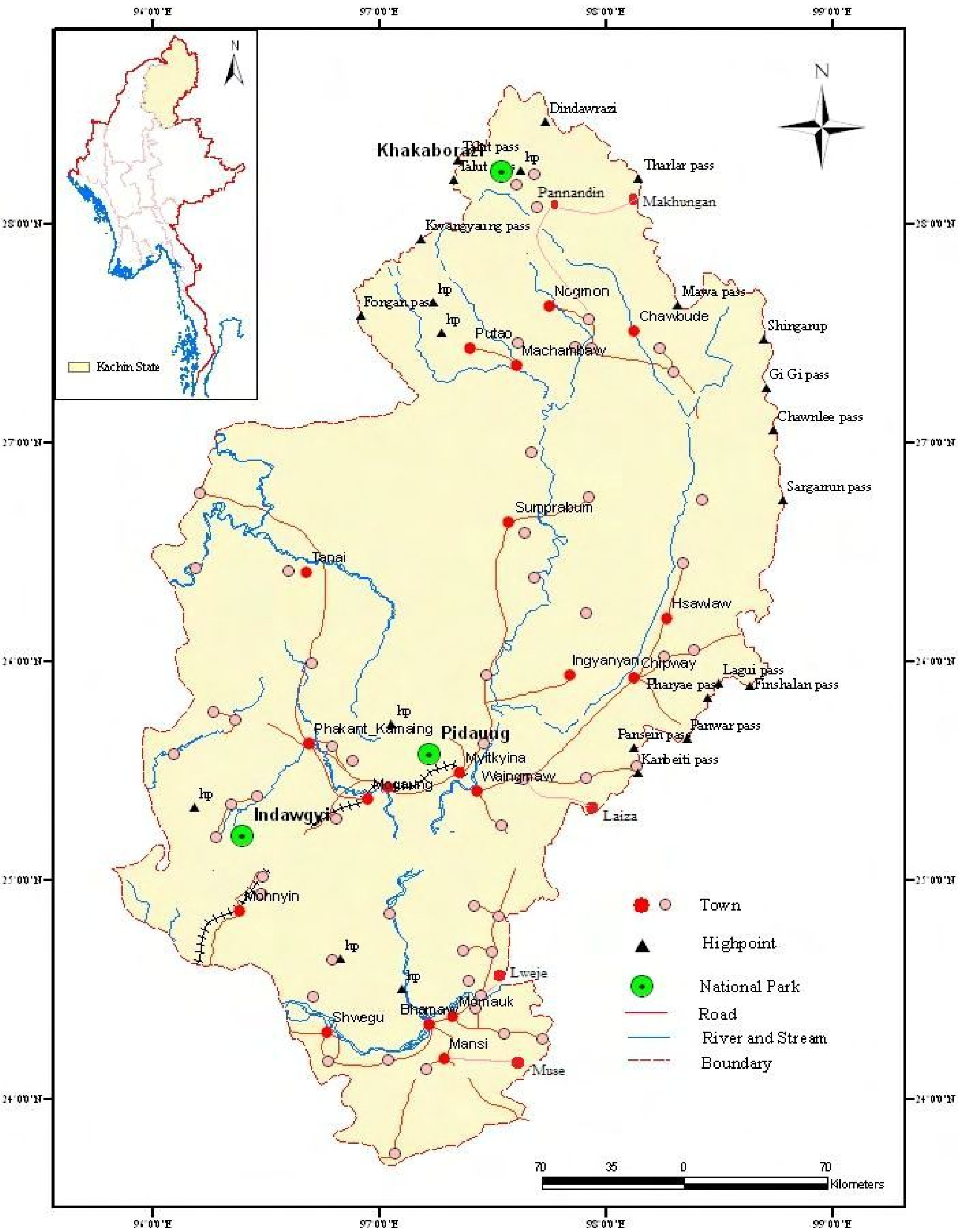


Figure 1. Map of the study sites

4.5. Itinerary

From	To	Study site	Remarks
20.1.09	5.2.09	Myitkyina	Market surveys, interview surveys with local people, small scale sellers and middleman traders and old data collection
6.2.09	4.3.09	Putao and Pannandin	Market surveys, villages surveys, interviewed with local dwellers, hunters and middleman traders in and around the Putao District and Pannandin area and old recorded data collection
6.3.09	8.3.09	Laiza	Market survey in major wildlife trade market on the border with China
11.3.09	18.3.09	Bamaw and Lweje	One of the source and trade routes on the border with China
23.3.09	8.4.09	Kangfang, Hpimaw, Pangwa, Chipwi	Investigation of trade routes on the border with China
18.4.09	19.4.09	Wynmaw	Market survey
20.4.09	22.4.09	Kambaiti	Investigation of trade route on the border with China
23.4.09	20.5.09	Myitkyina, Myitson area and Laiza	Market survey and villages surveys
13.7.09	20.7.09	Muse	Market survey in major wildlife trade market on the border with China

4.6. Methodology

The project design was based mainly on field studies using questionnaire surveys with local people and direct observations. To assess hunting and wildlife trade patterns, four sets of questionnaires were used (Appendix 1 to 4). Information such as average time taken for hunting efforts, favourite season for hunting, types and number of weapons used, distance to hunting sites, prey species captured, prices of wildlife parts sold, destination of wildlife trade routes, main occupation and alternative sources of income are collected.

Field investigations and collection of data were carried out in the study area during the months of January to May in 2009 and July, 2009, respectively.

Data concerning the wildlife trade were collected both from respondents and market places. In the field work stage, the focus was made on trade through direct observation and meetings with the respondents and middleman traders who were available to be interviewed and directly discussed with.

Structured interviews with villagers, hunters, small-scale dealers, middleman-traders and traders were made during the field study. As part of these interviews, groups of villagers were shown drawings and photographs (sometimes photocopies) of wildlife species. These pictures included species likely to be of importance in village subsistence economies (such as wild pigs, muntjacs, sambar and pangolins) and all international Red Data Book species. Villagers were also asked what species were (a) most frequently eaten (b) preferred for food (c) crop pests and livestock predators and also being discussed on the recent trends in wildlife population levels in their hunting and gathering areas.

In addition, inquired information about wildlife trade in each study area, identified trade routes and sources, data collection and data analysis, collection and compilation of old data and compilation of observations on wildlife trade in Kachin State were also conducted. Moreover, market survey and village survey for each study site were also carried out.

5. Results

Based on the field observation, it is found that a number of species in the study area has been severely threatened, mainly because of commercial trade pressures. A total of 28 wildlife species were recorded during the survey period. Out of the total recorded species, 25 species were listed as globally threatened according to IUCN and MWPL. Traded wildlife species and their traded parts observed during this study are described in Table 3 and summary of traded wildlife species, estimated retail values of their traded parts and their conservation status are presented in Table 4.

Table 3. Traded wildlife species and their traded parts

No.	Species	Traded as
1	Guar	Horns and skulls, meat
2	Takin	Horns and skulls, meat
3	Sambar	Whole antlers, other ingredients for traditional medicines, meat
4	Chinese Serow	Body parts (horns, head, forelegs, etc) for traditional medicine, meat
5	Red Goral	Body parts (horns, head, forelegs, oil, etc.) for traditional medicine, meat
6	Asiatic Black Bear	Live animals, claws, paws, teeth, skin, oil, gall bladder, bile, meat
7	Clouded- leopard	Skin, bones, teeth, claws, ingredients for traditional medicines & as living animals
8	Small Indian Civet	Skin, bones, parts and derivatives & as living animals
9	Asian Golden Cat	Skin, bones, teeth, claws, ingredients for traditional medicines & as living animals
10	Leopard Cat	Skin, bones, teeth, claws, ingredients for traditional medicines & as living animals
11	Porcupine	Stomach, quills
12	Chinese Pangolin	Live animals, frozen whole animals, scales, leather, foetus, meat
13	Eurasian Wild Pig	Fangs, meat
14	Macaque Spp.	Parts and derivatives for traditional medicine, meat
15	Hoolock Gibbon	Live animal, meat, skulls, parts for medicine
16	Asian Elephant	Live animals, tusks or worked ivory, skin, skull and other bones, teeth, hair, trophies
17	Tiger	As whole body parts
18	Great Hornbill	Casques and live birds

Table 4. Traded wildlife species, prices of their traded parts and their conservation status observed in the current study

No.	Common Name	Scientific Name	Location of Observation	Price(Kyat)	IUCN Status	CITES Status	MWPL Status
1	Guar	*Bos gaurus*	PTO, MKN, LZ, PW	30,000 (Decorated Horns), 7,000/viss(Meat)	VU	Appendix II	CP
2	Takin	*Budorcas taxicolor*	PTO, MKN, LZ	30,000 (Decorated Horns)	VU	Appendix II	CP
3	Sambar	*Cervus unicolor*	PTO, MKN, LZ	60,000-100,000 (Decorated antlers),	NT	-	P

				4,500/viss(Meat)			
4	Chinese Serow	*Capricornis milneedwardsi*	PTO, MKN, LZ, LJ	5,000(Big horns), 3,000 (Small horns)	NT	-	-
5	Red Goral	*Nemorhaedus baileyi*	PTO, MKN, LZ	10,000 (A pair of horns),	VU	Appendix I	CP
6	Asiatic Black Bear	*Ursus thibetanus*	PTO, MKN, LZ	100,000/part in counting hundredths of a viss (Gallbladder-yellow), 80,000-black	VU	Appendix I	P
7	Clouded- leopard	*Neofelis nebulosa*	PTO, MKN, LZ	30,000(Skin)	VU	Appendix I	CP
8	Small Indian Civet	*Viverricula indica*	PTO, MKN, LZ	15,000(Skin)	LC	Appendix III	CP
9	Asian Golden Cat	*Catopuma temminckii*	PTO, MKN, LZ	20,000(Skin)	VU	Appendix I	CP
10	Leopard Cat	*Prionailurus bengalensis*	PTO, MKN, LZ	20,000(Skin)	LC	Appendix II	P
11	Yellow-throated Marten	*Martes flavigula*	PTO, MKN, LZ	10,000(Skin)	LC	Appendix III	P
12	East Asian Porcupine	*Hystrix brachyura*	PTO, MKN, LZ	3,000-6,000/stomach, 200/each quill	LC	-	-
13	Chinese Pangolin	*Manis Pentadactyla*	PTO, MKN, LZ	100,000/viss (Skin)	EN	Appendix II	CP
14	Eurasian Wild Pig	*Sus scrofa*	PTO, MKN, LZ	15,000 (a pair of tusk)	-	-	-
No.	**Common Name**	**Scientific Name**	**Location of Observati on**	**Price(Kyat)**	**IUCN Status**	**CITES Status**	**MWPL Status**
15	Stump-Tailed Macaque	*Macaca arctoides*	PTO, MKN, LZ	10,000 (Skull with brain)	VU	-	P
16	Rhesus macaque	*Macaca mulatta*	PTO, MKN, LZ	10,000 (Skull with brain)	VU	Appendix II	P
17	Assamese macaque	*Macaca assamensis*	PTO, MKN, LZ	10,000 (Skull with brain)	VU	Appendix II	P
18	Hoolock Gibbon	*Hoolock hoolock*	PTO, MKN, LZ, HM	15,000 (Skull with brain)	EN	Appendix I	CP
19	Asian Elephant	*Elephas maximus*	MKN, LZ, KF, HM	30,000(Molar), 2,000/1squ inches(Skin)	EN	Appendix I	CP
20	Tiger	*Panthera tigris*	MKN, LZ	400,000 (canine), 50,000-80,000(penis)	EN	Appendix I	CP
21	Black Musk-deer	*Moschus fuscus*	PTO	50,000/g(Musk sac)	EN	Appendix I	CP
22	Red Panda	*Ailurus fulgens*	PTO, MKN,	10,000 (Skin)	VU	Appendix I	CP
23	Red Giant Flying Squirrel	*Petaurista petaurista*	PTO	3,000/stomach	-	-	-
24	Leaf Muntjac	*Muntiacus putaoensis*	PTO	4,000/viss (Meat)	-	-	-
25	Red Muntjac	*Muntiacus muntjak*	PTO, MKN, LZ	3,500/viss (Meat), 2,000 (Skin)	LC	-	SP
26	Great Hornbill	*Buceros bicornis*	PTO, LZ	10,000-15,000 (Decorated Bill)	NT	Appendix I	CP
27	Rufous-necked Hornbill	*Aceros nipalensis*	PTO	10,000-15,000 (Decorated Bill)	VU	Appendix I	CP

28	Wreathed Hornbill	*Rhyticeros undulatus*	PTO	10,000-15,000 (Decorated Bill)	-	-	CP

NOTE : PTO-Putao, MKN-Myitkyina, LZ-Laiza, LJ-Lweje, PW-Panwar, KF-Kangfang, HM-Hpimaw
Conversion: 1 Viss = 1.6 kg

5.1. Myitkyina and Environs

5.1.1. Market Surveys

According to the market survey, it was observed that body parts of wildlife are used for medicinal purposes. Around and within the Myoma Market in Myitkyina, five shops were recorded as traditional medicine shops, where parts of wild animal species were especially sold as traditional medicine. It was found that there were nine traded species. Photographic records of wildlife parts from market survey are given in **Photo 1 to Photo 12**.

Out of the total recorded species, 8 species were listed under threat categories. Among the total recorded species, 3 were completely protected, 2 were normally protected, 1 seasonally protected and 3 were unprotected by Myanmar Wildlife Protective Law (MWPL) (1994). In addition, 4 species were listed on CITES appendices I (CITES, 2009) respectively, and 3 endangered species, 2 vulnerable species and 1 lower risk near threatened species were recorded with IUCN Red List (2008) (**Table 5**).

5.1.2. Utilization of wild animals in the markets

Wild animal species are sold as traditional medicine, food and souvenir in the markets. Mammal species were traded as the most common species in the use of traditional medicine, souvenir and food.

5.1.3. Usage in traditional medicine

Wildlife products are sold mainly at the traditional medicine shops. Skulls of macaque, bear, palm civet, Asiatic jackal and pythons were sold for the preparation of ointment for treatment of skin inflammation. Skulls with brain of Gibbon were sold for curing of headaches. Skins and sole of Asiatic elephant and skins of pythons were sold to prepare ointment treating skin disease (example; scabies). Scales of pangolin were sold for the preparation of smallpox ointment, prevention and treatment of breast cancer and for curing convulsions in children. Skeletons of elephant and python were sold to be used in the preparation of ointment for treating rheumatism. Antlers of barking deer and sambar were sold to be used in the medicine curing piles and breast cancer. Horns of goral were sold for heart and liver ailment. Tusks of wild pig were sold to be used in treating tooth ache. Quills of Malaysian porcupine were sold for personal charms to protect from ghosts and evil spirit. Stomachs of porcupine were sold to be used in the medicine curing gastric disease. Penises and bones of tiger were used for wildlife based aphrodisiacs and carapace of yellow tortoise and Asian leaf turtle were sold for treating urinary disease. Gall bladders of bears were used in traditional Asian medicines and bear's paws were sold to supply a demand for exotic cuisine.

Table 5. Parts of traded animal used for medicinal purposes in Myintkyina and Environs

No.	Common Name	Scientific Name	Parts used	Conservation status

				IUCN	CITES	MWPL
1	Chinese Serow	*Capricornis milneedwardsi*	Hooves, Horns, Tongue, Oil	LR/NT	-	-
2	Asian Elephant	*Elephas maximus*	Skin, Molar teeth	EN	Appendix I	CP
3	Red Muntjac	*Muntiacus muntjak*	Antlers	-	-	SP
4	Tiger	*Panthera tigris*	Genital organ, Bones, Canine	EN	Appendix I	CP
5	Hoolock Gibbon	*Hoolock hoolock*	Head with brain, Skull, Bones	EN	Appendix I	CP
6	Asiatic Black Bear	*Ursus thibetanus*	Paws, Oil, Skull, Canine, Gallbladder	VU	Appendix I	P
7	Sambar	*Cervus unicolor*	Legs, Antlers	-	-	P
8	Porcupine	*Hystrix brachyura*	Stomach, Intestine, Quills	VU	-	-
9	Eurasian Wild Pig	*Sus scrofa*	Tusks	-	-	-

Photo 1: Canines teeth of Tiger (Myitkyina)

Photo 2: Tiger's bones on sale (Myitkyina)

Photo 3: A pair of bear's paws (Myitkyina)

Photo 4: Canines teeth of bear (Myitkyina)

Photo 5: Gall bladders of bear (Myitkyina)

Photo 6: Head of gibbon on sale (Myitkyina)

Photo 7: Radius and ulna of gibbon on sale

Photo 8: Skins of elephant (Myitkyina)

Photo 9: Tusks of wild pig used in hatbands

Photo 10: Horns of serow (Myitkyina)

Photo 11: Assorted wildlife parts on sale

Photo 12: Interviewing with seller

5.2. Putao, Pannandin and Environs

5.2.1. Market Surveys

There are two distinct markets in Putao Township.

(a) Myoma Market

(b) Airport Market

Myoma Market lies in the center of Putao and Airport market lies near the Putao Airport. Interview was carried out during field survey in the study areas by using questionnaires with the concerned persons such as traders or any wildlife enterprises.

According to the market surveys, it was observed that there was difference between Myoma market and Airport market in Putao. In the last four years, Myoma market was a very popular market for wildlife trade. But now it is not popular for wildlife trade due to the intervention of Nature and Wildlife Conservation Division, Forestry Department, Ministry of Forestry with the active participation of Wildlife Conservation Society (Myanmar Program). Therefore, at the moment Myoma market is just selling bushmeat only. Although wildlife products are being sold at the airport market, they are not openly displayed. Moreover, in the secretive trade, traders only deal with regular customers and they do not believe in strangers.

Photo 13: Market survey in Putao

Photo 14: Interviewing with shopkeeper in Putao

5.2.2. Village Surveys

To meet the objectives of the surveys, 20 villages within or around Putao, Machanbaw and Pannandim townships were designated as survey sites. All scientific data collections were mainly focused in those villages. Data collection activities included questionnaire-based interview surveys on wildlife trade, hunting patterns, economic importance of wildlife and socioeconomic condition of local communities. According to the field observation, wildlife trade activities in these areas were gradually decreased compared to the last decade due to the conservation activities of NWCD and WCS. In these areas, illegal hunting of rare and endangered species of wild animals were strictly prohibited and confiscated. However, very few villagers claimed they had old stocks of wildlife products available for sale upon inquiry. Hence, illegal hunting and illegal wildlife trade are still dynamic in these areas, with enforcement directly affecting the volume of illegal trade.

Photo 15: Questionnaires-based interview surveys in Htangar village

Photo 16: Hunter and hunted skins of leopard cat and small indian civet

5.2.3. Questionnaires-based interview surveys on hunting and wildlife trade patterns

A total of 120 households in the survey areas were selected to conduct questionnaire-based interviews during the study period. According to the village surveys, it was found that the majority of hunters are Lisu tribe. They always used sharp swords, crossbows, poisonous arrows and sometimes they used guns to hunt their prey.

Hunting occurred throughout the year, but the majority was from June to January. From the month of February to May, most of them were engaged in *Taungya* (slash and burn) activities, and hence their main occupation has to be regarded as hunting. Winter season is the best season for hunting. According to the results obtained from general hunting interviews, it was found that a number of hunted species have decreased compared to five years ago. Other large mammals such as bear, takin, guar, sambar, and some cat species were already rare species because of over hunting activities during the previous times. The above mentioned species are already at critically lower numbers in this region. Therefore, a number of species may be acutely threatened mainly by hunting and commercial trade pressures. It may be assumed that this finding shows the future population number of aforementioned species could be affected.

The hunters kept the valuable wildlife skins and body parts during the hunting periods and traded their goods at border markets via middleman or themselves. Apart from that it was also observed that some of the local residents sold out the wildlife parts, particularly of bones and canines teeth of tigers that they received from their ancestors as heritage long time ago due to the high prices they could fetch today. Most of the hunted wildlife parts were sold during the Christmastime and particularly during Chinese New Year's eve as they fetch soaring profits in exchange for their household needs. Skins and bones of cat species; skins, hooves, horns, tongue and oil of serow; antlers and skins of muntjac; the whole body parts of bears; skull of gibbon and scales of pangolin are the mainly traded goods in this region. Traders bring the hunted animals into town markets to sell the meat and any other body parts that will fetch a good price.

Twenty six hunted species were recorded in the study areas. Out of the total recorded species, 23 species were listed under threat categories. Among the total recorded species, 13 were completely protected, 7 were normally protected, 1 seasonally protected and 4 were unprotected by MWPL (1994). In addition, 9, 6 and 2 species were listed on CITES appendices I, II and III (CITES, 2009) respectively, and 2 endangered species, 12 vulnerable species and 3 lower risk near threatened species were recorded with IUCN Red List (2008) (**Table 6**). Thus, hunting and wildlife trade are critical threats to biodiversity in tropical forests throughout the study area. Photographic records of wildlife parts observed during the market survey and village survey are shown in **Photo 17 to Photo 30.**

Photo 17: With Lisu hunters in Putao

Photo 18: Lisu hunter with red panda (alive)

Table 6. Hunted Species in Putao District

No.	Common name	Scientific name	Conservation status		
			IUCN	CITES	MWPL
1	Chinese Serow	*Capricornis milneedwardsi*	LR/NT	-	-
2	Red Muntjac	*Muntiacus muntjak*	-	-	SP
3	Red Goral	*Nemorhaedus cranbrooki*	VU	Appendix I	CP
4	Black Musk-deer	*Moschus fuscus*	EN	Appendix I	CP
5	Red Panda	*Ailurus fulgens*	VU	Appendix I	CP
6	Eurasian Wild Pig	*Sus scrofa*	-	-	-
7	Stump-Tailed Macaque	*Macaca arctoides*	VU	-	P
8	Rhesus macaque	*Macaca mulatta*	VU	Appendix II	P
9	Assamese macaque	*Macaca assamensis*	VU	Appendix II	P
10	Hoolock Gibbon	*Hoolock hoolock*	EN	Appendix I	CP
11	Sambar	*Cervus unicolor*	-	-	P
12	Guar	*Bos gaurus*	VU	Appendix	CP

				II	
13	Takin	*Budorcas taxicolor*	VU	Appendix II	CP
14	Asiatic Black Bear	*Ursus thibetanus*	VU	Appendix I	P
15	Yellow-throated Marten	*Martes strigidorsa*	-	Appendix III	P
16	Red Giant Flying Squirrel	*Petaurista petaurista*	-	-	-
17	Leaf Muntjac	*Muntiacus putaoensis*	-	-	-
18	Asian Golden Cat	*Catopuma temminckii*	VU	Appendix I	CP
19	Small Indian Civet	*Viverricula indica*	-	Appendix III	CP
20	Leopard Cat	*Felis bengalensis*	-	Appendix II	P
21	Clouded- leopard	*Neofelis nebulosa*	VU	Appendix I	CP
22	Porcupine	*Hystrix brachyura*	VU	-	-
23	Chinese Pangolin	*Manis Pentadactyla*	LR/NT	Appendix II	CP
24	Great Hornbill	*Buceros bicornis*	LR/NT	Appendix I	CP
25	Rufous-necked Hornbill	*Aceros nipalensis*	VU	Appendix I	CP
26	Wreathed Hornbill	*Rhyticeros undulatus*	-	-	CP

Photo 19: Fresh and dry meet of sambar on sale (Putao Myoma Market)

Photo 20: Skin of black musk deer (Pannandim)

Photo 21: Skin of Asiantic black bear

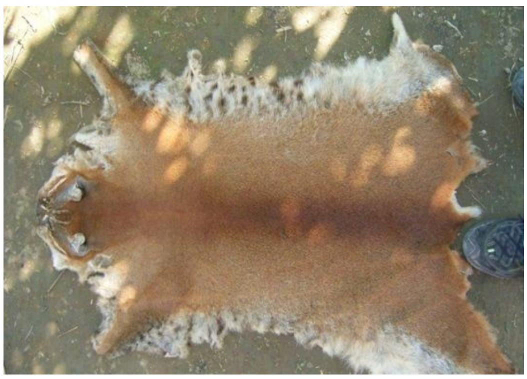


Photo 22: Asian Golden Cat Skin

(Yaekyawdee)

Photo 23: Fresh skin of red muntjac

Photo 24: Chinese serow skin (Putao)

Photo 25: Leopard Cat Skin (Phetmar)

Photo 26: Small Indian Civet Skin (Upper-Shangaung)

Photo 27: Head of gibbon on sale (Putao)

Photo 28: Stomach of porcupine (Putao)

Photo 29: Gall bladder of boa (Putao)

Photo 30: Head of rufous-necked hornbill

5.3. Bushmeat consumption in study area

Hunting is a typical livelihood practice in Kachin State. With the population increasing, such practices have a serious impact on the future prospects for many threatened species. Eating wild animals has long been a tradition in Kachin State. Bushmeat (wildlife species used for meat), provides an affordable source of animal protein as well as income generating opportunities, especially among the rural poor. Normally bushmeat is preferred over domestic sources of meat by local people. Nevertheless, the demand of Chinese workers from various development projects involved in the study area transformed the consumption stage from local to commercial scale rendering more threat for the existing wildlife. However, bushmeet is only consumed near its place of origin and not traded elsewhere. The customers believed that wildlife was nourishing and had curative value. According to the field study, gaur, serow, goral, sambar, red muntjac, leaf muntjac, wild pig, porcupine, pangolin and gibbon species were mainly consumed as wild meat in all the study sites. All of these species were sold in local markets and traded with other villages. The prices of wild meat were varied depending on location and availability (Table 4) (Photo 31 to Photo 34).

Photo 31: Fresh meat of serow

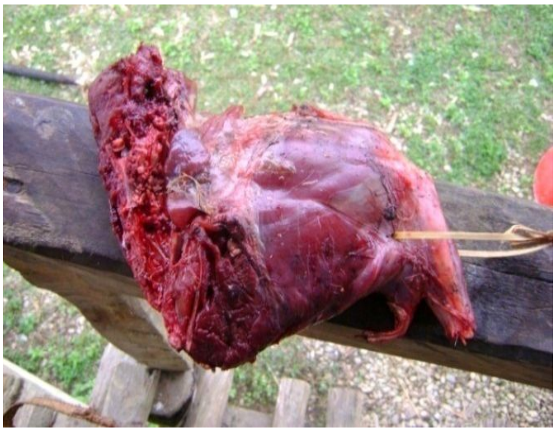


Photo 32: Fresh meat of red muntjac sale in Ratbot village (On the way of Pannandim)

Photo 33: Dried meat of guar selling in Panwar **Photo 34: Cooking the meat of wild pig (near Chibwe)**

5.4. Illegal logging and wildlife trade activity in border area of Kachin State

5.4.1. Laiza (Myanmar-China border market)

Laiza is a major wildlife trade market on the border with China but the wildlife trade here has never been monitored. According to the open discussions with local people and hunters and middleman, there is high demand for live animals, carcasses, canines, skulls, claws, horns, trophies, pieces of skin and various types of wildlife parts. According to salespeople, the majority of these wildlife goods come from the areas governed by the armed ethnic groups of Kachin State and also from Putao District.

During the survey time, large numbers of wildlife parts such as heads of gibbon, bills of hornbill, skins and molar teeth of elephant, bones of cat species, oil, skull, canine and gallbladder of bear, horns and antlers of various types of wildlife species were openly displayed for sale but difficult to obtain relevant data and volume involved in trade. This situation is due to the fact that traders only want to deal with intimate customers and were highly cautious of strangers. In addition, they are quite reluctant to allow taking of any photographs concerned with their business.

The most dominant species found in Laiza market was pangolin carcasses and scales. Pangolins are poached for their meat, consumed as food and their scales were used in traditional Chinese medicine across the region. Pangolins are completely protected animals in Myanmar and they are currently protected by Appendix II of CITES.

Over the course of the investigation, the survey team found that, traders or even small stall-holders in Laiza market are in direct contact with the Chinese buyers. Moreover, they are totally supported and covered by ethnic armed groups. Though, they were constrained to give any information to the survey team, there is a lot of evidence to indicate that the trade in wildlife products occurs at a very large scale in this border market.

5.4.1.1. Market Surveys

According to the market survey, it was observed that 6 shops were recorded for trading, especially parts of 21 traded wild animal species. Out of the total recorded species, 20 species were listed under threat categories. Among total recorded species, 11 were completely protected, seven were normally protected and two were unprotected by MWPL (1994). In addition, 18, 6 and 2 species were listed on CITES appendices I, II and III (CITES, 2009) respectively, and 3 endangered species, 10 vulnerable species and 3 lower risk near threatened species were recorded with IUCN Red List (2008). The detail recorded species list, their conservation status and estimated retail value of traded wildlife parts are presented in Table 4 and 7, respectively. Photographic records of these wildlife parts from market survey are described in **Photo 35 to Photo 46.**

Table.7. List of traded species and their status observed in Laiza border trade market

No.	Common Name	Scientific Name	Conservation status

			IUCN	CITES	MWPL
1	Guar	*Bos gaurus*	VU	Appendix II	CP
2	Takin	*Budorcas taxicolor*	VU	Appendix II	CP
3	Sambar	*Cervus unicolor*	-	-	P
4	Chinese Serow	*Capricornis milneedwardsi*	LR/NT	-	-
5	Red Goral	*Nemorhaedus baileyi*	VU	Appendix I	CP
6	Asiatic Black Bear	*Ursus thibetanus*	VU	Appendix I	P
7	Clouded- leopard	*Neofelis nebulosa*	VU	Appendix I	CP
8	Small Indian Civet	*Viverricula indica*		Appendix III	CP
9	Asian Golden Cat	*Catopuma temminckii*	VU	Appendix I	CP
10	Leopard Cat	*Prionailurus bengalensis*	-	Appendix II	P
11	Yellow-throated Marten	*Martes flavigula*	-	Appendix III	P
12	Porcupine	*Hystrix brachyura*	VU	-	-
13	Chinese Pangolin	*Manis Pentadactyla*	LR/NT	Appendix II	CP
No.	Common Name	Scientific Name	Conservation status		
			IUCN	CITES	MWPL
14	Eurasian Wild Pig	*Sus scrofa*	-	-	-
15	Stump-Tailed Macaque	*Macaca arctoides*	VU	-	P
16	Rhesus macaque	*Macaca mulatta*	VU	Appendix II	P
17	Assamese macaque	*Macaca assamensis*	VU	Appendix II	P
18	Hoolock Gibbon	*Hoolock hoolock*	EN	Appendix I	CP
19	Asian Elephant	*Elephas maximus*	EN	Appendix I	CP
20	Tiger	*Panthera tigris*	EN	Appendix I	CP
21	Great Hornbill	*Buceros bicornis*	LR/NT	Appendix I	CP

Photo 35: A snap shot describing trade in Laiza

Photo 36: Horns and antlers of wildlife

Photo 37: Various types of wildlife parts

Photo 38: Bills of Hornbill on sale in Laiza

Photo 39: Heads of gibbons on sale in Laiza

Photo 40: Dried skins of pangolin displayed at a stall in Laiza

Photo 41: Very fresh skin of pangolin drying in Laiza market

Photo 42: Wildlife products such as antlers, tiger's bones, bear's canines, claws and

elephant's skins were displayed on sale

Photo 43: Penis of tiger on sale in Laiza

Photo 44: Gall bladders of guar and quills

Photo 45: Skins of Clouded leopard on sale

Photo 46: Collection of available information

5.4.2. Makonkhen

Makhonkhen is one of the border trade markets. Villages around Panandim and upper parts of Kachin State are very convenient to reach this border market to trade their wildlife products rather than trading at nearest market in Putao, due to the transportation barriers of the hilly region.

5.4.3. Lweje

Lweje is one of the border areas. According to the information from local people and middle men, Lweje sometimes stood up a trade route depending on the seizure situation. During the survey, some wildlife parts such as skins, horns and hoofs of serow; horns and oil of goral and stomach of porcupine were displayed for sale in Sinlum reserved forest area.

5.4.4. Kangfang, Hpimaw and Panwar

According to the current study, illegal logging / timber and non-timber forest products (NTFPs) like bamboo, rattan and charcoal export to China were very significant in the border areas of Kangfang, Hpimaw and Panwar, compared to wildlife trading. Upper part of the Kangfang area, illegal logging camps and unsustainable extraction of logs were clearly seen in this study. It appeared that the rate of deforestation caused by uncontrolled logging is a very significant problem in Kachin State. The transportation of illegal logs and NTFPs across the border at Kangfang and Hpimaw was recorded during the survey (Photo 47. to Photo 55).

5.4.5. Muse

Muse is one of the popular wildlife markets and mainly traded in freshwater turtles and snakes coming from all over Myanmar. Freshwater turtles and snakes are sold not only for meat, but also for medicinal purposes and tonic products, for which they are made into jellies, soups and pills. It is believed that turtles and snakes can cure a range of illnesses including rheumatism, heart ailments and cancer, while increasing lifespan. According to informants in Muse, wildlife trades are still active. The sources of products traded in Muse mainly come via Mandalay region. It was heard that there is also rare bird and live animals trade and market for zoo exhibits. The most exported birds in this area were Pheasant, parrots and hill mynas but no evidences were available. However, the number of species found during survey conducted for this study was significantly lower. There is a large discrepancy between quantities quoted on questionnaire interviewed and quantities inferred from direct observations. This may have been due to traders who were often reluctant to disclose precise information to the survey team.

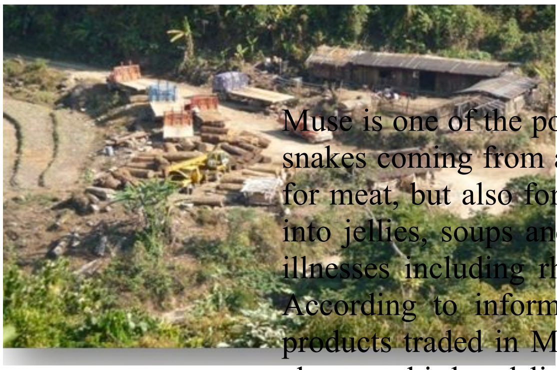


Photo 47: A logging camp in the study area (Kangfang)

Photo 48: The logging camp and Chinese workers

Photo 49: Using cable logging

Photo 50: A pile of logs(Kangfang)

Photo 51: Ready for transportation

Photo 52: Passing Border Bridge (Kangfang to China)

Photo 53: Illegal plywood for transportation to China

Photo 54: Wooden slabs to make parquet (Kangfang-China)

Photo 55: Carrying of Charcoal bags (Hpimaw to China)

5.5. Source and demand network for the wildlife trade

Wildlife parts observed from the village-level brokers were bought from the hunters living in villages and nearby. According to the field investigation, some Chinese traders from the border area send their resident collectors to the villages to buy wildlife products. Some of these species were sold to the local markets and other villages. Some species were bought by brokers or middle men from other divisions and states. They traded these animals to the international markets (border markets) through urban markets centers in Myintkyina and Mandalay. At international level trade, some wild animals were traded to the border markets such as Makonkhen, Kangfang, Hpimaw, Pangwa, Laiza, Kambaiti, Lweje and Muse which passed through urban centers (Figure 2).

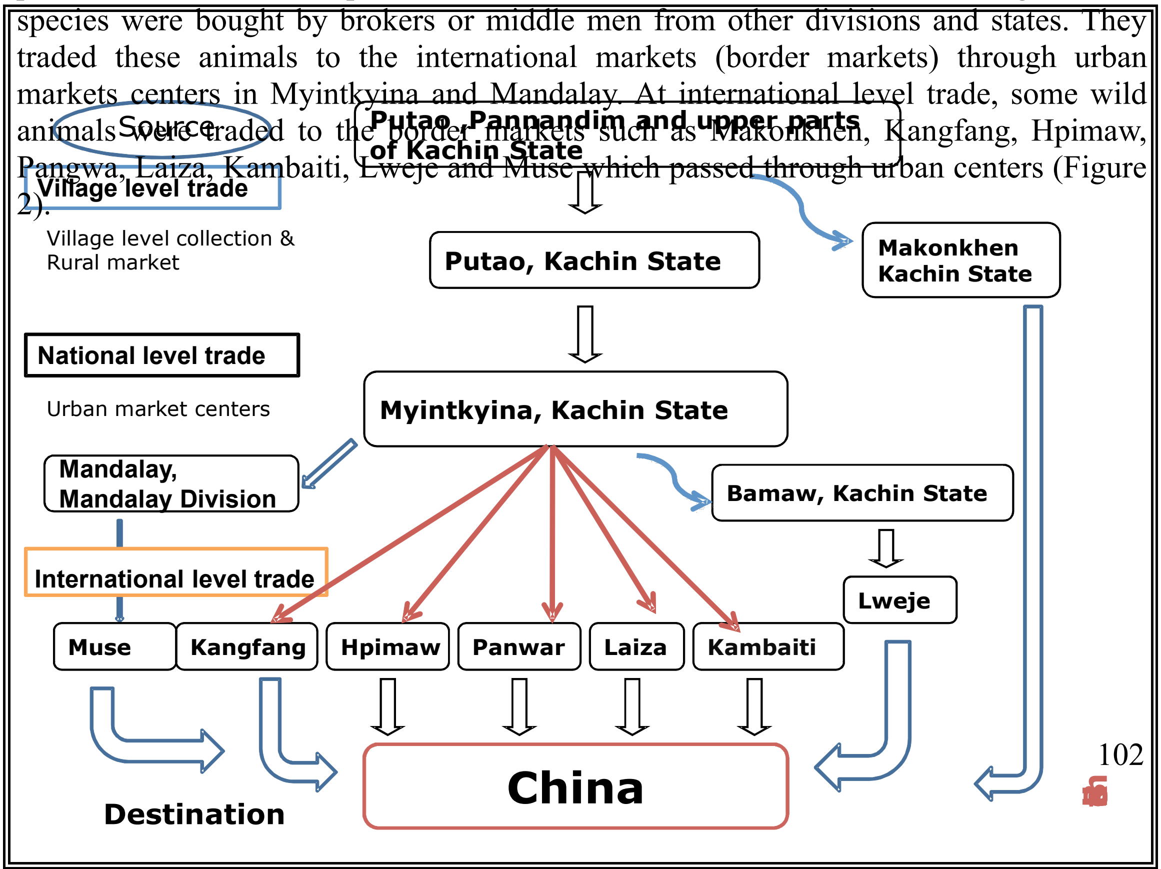


Figure 2. Diagrammatic representation of source and demand network for the wildlife trade in the Kachin State

5.6.Major trade routes of wildlife trade in Kachin State

Makonkhen, Kangfang, Hpimaw, Pangwa, Laiza, Kambaiti, Lweje and Muse were known as the final destination for wildlife traders. However, trade routes are occasionally changed so as to evade from wildlife checkpoints and also depending on the sale value of the wildlife products, such as tiger parts etc. Based on the current study, 8 trade routes are being in use for international trade from the source to China (Figure 3).

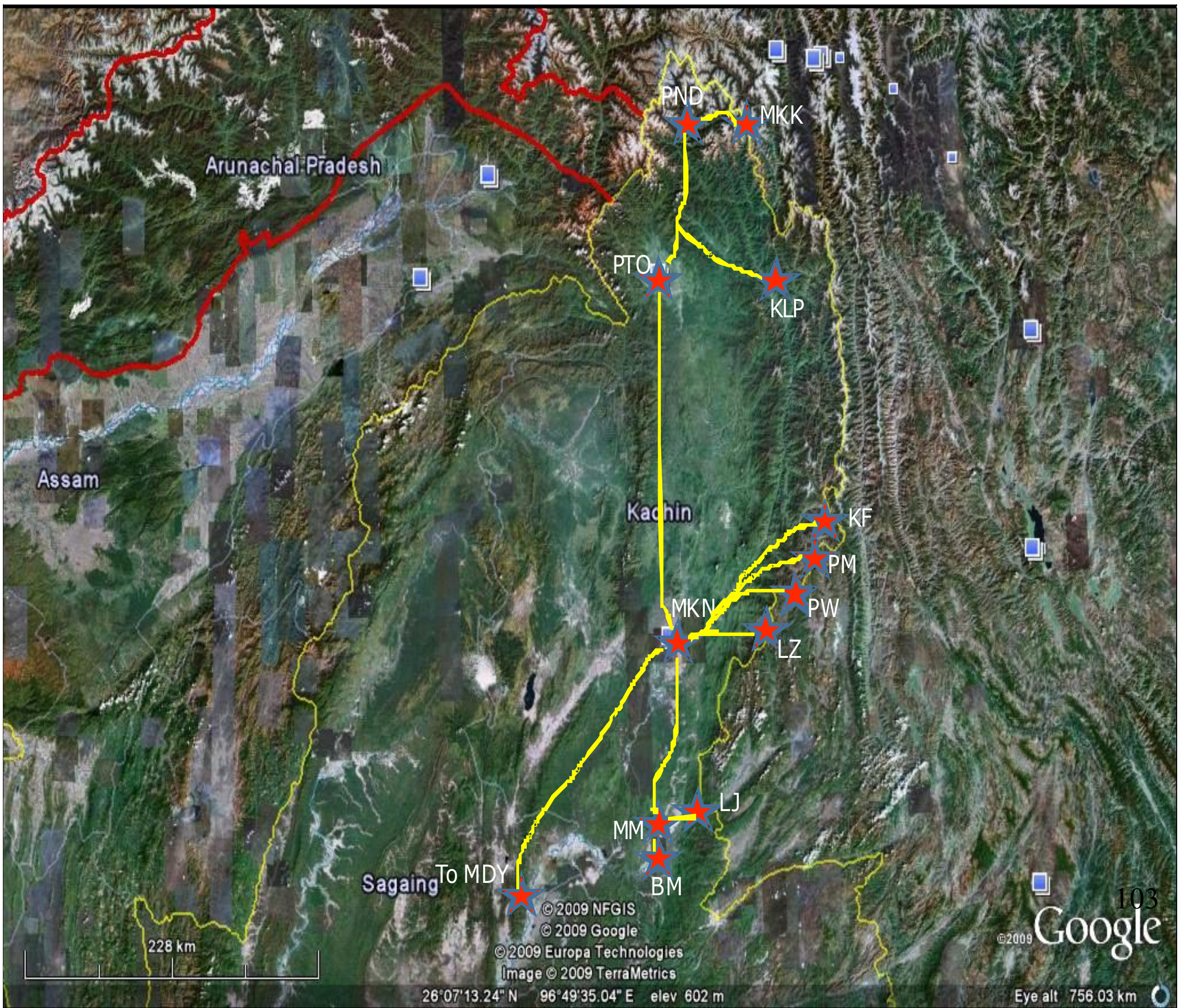


Figure 3. Map of trade route observed in the study area

6. Discussions

Illegal wildlife trade is the biggest ecological disaster in the Kachin State. Hunting is a very traditional occupation for local tribes. Hunting of wildlife for sale or trade is the overwhelming threat to the future survival of many wildlife species, particularly large mammals. Hunters were targeting particular species whose parts were valued by traders and helped maintain a thriving trade in wildlife parts to cities like Putao, Myintkyina and across the border markets of Myanmar- China.

The income derived from illegal wildlife poaching and trading is often vital for sustaining the livelihoods of impoverished hunters and traders. Some observers say small-scale hunters and traders have few alternatives for generating subsistence-level incomes. Additionally, some indigenous people may consider hunting certain animals, as a fundamental part of their culture, religion or tradition. These considerations may differentiate poor hunters and traders engaged in wildlife trade purely for profit only. Moreover, the nature of hill-tribes is very friendly with their wildlife environment. Without any other job opportunities, many hill dwellers exploit natural resources for their survival and are not quite concerned primarily about their livelihoods or sustainable development.

Another factor is the perceived low risk of capture or penalties associated with wildlife trafficking. Such a perception can be the consequence of limited enforcement capabilities or willingness to punish such illegal behavior. In addition, wildlife trade may be considered less risky than other high-valued black markets and the penalties associated with wildlife crimes tend to be substantially less severe than with other trafficking crimes.

Based on the findings of this study, the following factors should be considered in developing a management plan to achieve effective conservation in Kachin State. A total of 28 species were recorded during the field survey. Among them, the highest numbers of recorded species were observed from Putao District followed by Laiza (China border area) and Myintkyina environs respectively. Among the total recorded species, 15 were completely protected, 7 were normally protected, 1 seasonally protected and 5 were unprotected by MWPL (1994). In addition, 11, 6 and2 species were listed in CITES appendices I, II and III (CITES, 2009) respectively, and 4 endangered species, 12 vulnerable species and 3 lower risk near threatened species were recorded with IUCN Red List (2008). Therefore, out of the total recorded species, 25 species were listed under threat categories.

Based on the above finding, the overall percentage of traded wildlife species in Kachin State can be calculated for various categories as per world conservation status (Figure 6 to 8). For example, the recorded number of endangered species, consisting in the current trade activity, is only 4 species; whilst in terms of IUCN status it has been representing 14% of the study area. Based on trade across borders and domestic trades in the study areas, in terms of CITES categories., 41% of species can be listed as CITES Appendix I, 22% in Appendix II and 7% in Appendix III. In addition to that, 53% of the species under study were found to be in the category of completely protected wildlife species of MWPL. Detailed breakdown of the list of species and number of wildlife parts recorded in market surveys and village surveys are shown in Table 7 and Table 8, respectively. Based on the data expressed in these tables, the following histograms, Figure 9 and 10 can be drawn to carry out the current status of wildlife trade sources and hunted levels in the study areas. According to the current findings, it can be clearly seen that the largest quantities of wildlife products were mainly traded in Laiza border market via Myitkyina and Putao markets and hunting activities are highest in Khaunglanphu area than the others due to the lack of law enforcements, trade inspection and lax borders crossings.

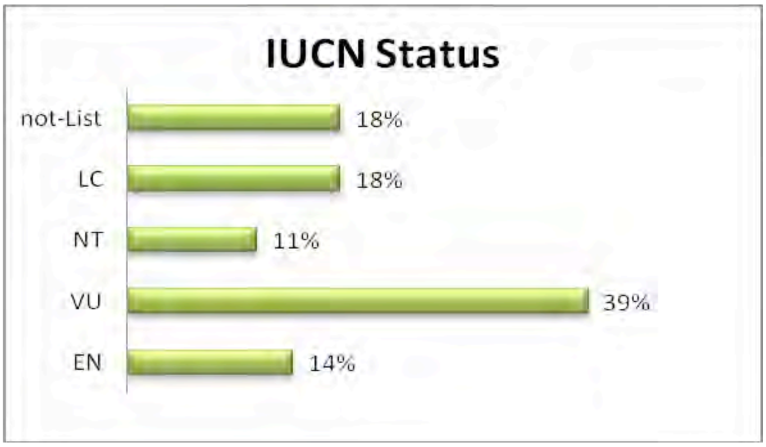


Figure 6. Percentage of traded species in IUCN status

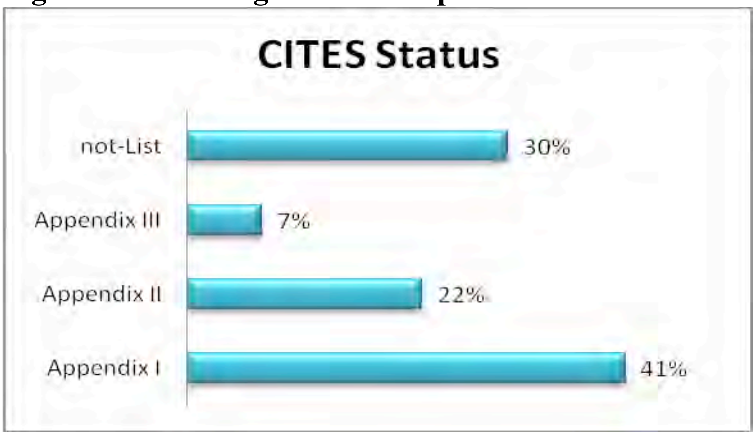


Figure 7. Percentage of traded species in CITES status

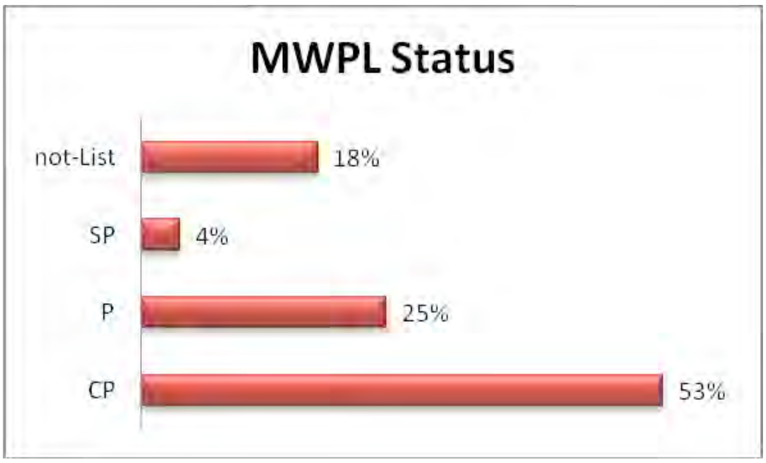


Figure 8. Percentage of traded species in MWPL status

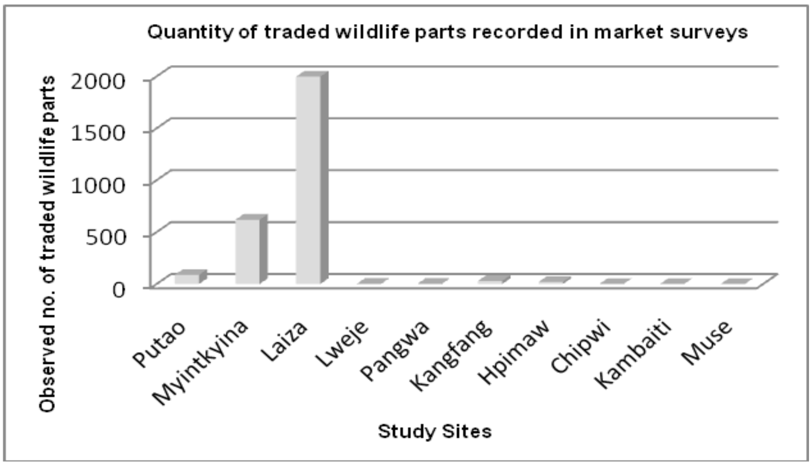


Figure 9. Quantity of traded wildlife parts recorded in market survey

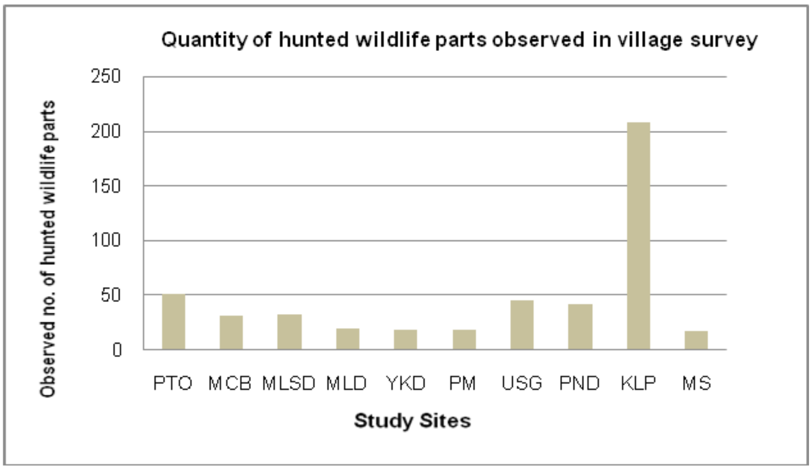


Figure 10. Quantity of hunted wildlife parts recorded in village survey

It will be difficult to assess the effects of illegal trade in wildlife and its products on the biodiversity of Kachin State as information available on wildlife trade is far from sufficient. But wildlife trade has become an important factor affecting survival of many wild species and their habitats. For example, the musk from the musk deer is used as an ingredient in more than 300 commercial TCMs. At the same time, the musk is much in demand in the international market for its use in cosmetics and perfumery. A considerable amount of this musk is taken from the wild. The illegal trade is threatening the survival of musk deer (*Moschus spp*.).This species was earlier found abundantly in most northern parts of the Kachin State, whereas its population has been dwindling currently because of excessive poaching. If this situation continues, the musk deer species could become extinct in Kachin and other Himalayan countries during the forthcoming decade. The Asiatic black bear is another example. Trade in bears and bear parts is the most immediate threat to the Asiatic black bear's survival. The species has been devastated by poachers, who sell its gall bladders for use in traditional Asian medicines and market its paws to supply a demand for exotic cuisine. In some regions of Southeast Asia, these bears are also captured for use as performing animals in zoos and circus. Without proper protection, the Asiatic black bear is at risk of extinction throughout its range due to these threats. It is currently protected by Appendix I of CITES. Furthermore, a considerable amount of pangolin spp. (EN species listed in IUCN and Myanmar Completely Protected Species) is already critical, and has become a focus of conservation. Thus, the decline of wildlife resources in recent decades is partially due to unsustainable extraction of natural ingredients for medicinal uses.

Table.6. Quantity of traded wildlife parts recorded in market surveys

No.	Common Name	Scientific Name	Observed Parts	Markets Surveyed									
				PTO	MKN	LZ	LJ	PW	KF	HM	CP	KBT	M
1	Chinese Serow	*Capricornis milneedwardsi*	Skins, horns, hoofs, toungs	7	36	8	4	-	-	-	-	-	-
2	Red Muntjac	*Muntiacus muntjak*	Skins, antlers, meat	10	213	-	-	-	-	-	-	-	-
3	Red Goral	*Nemorhaedus cranbrooki*	Skins, horns	2	-	-	2	-	-	-	-	-	-
4	Black Musk-deer	*Moschus fuscus*	Skins, musk	1	-	-	-	-	-	-	-	-	-
5	Red Panda	*Ailurus fulgens*	Skins	1	1	-	-	-	-	-	-	-	-
6	Eurasian Wild Pig	*Sus scrofa*	Tusks, meat	50	150	50	-	-	-	-	-	-	-
7	Macaque, Gibbon	*Macaque spp., Hoolock hoolock*	Skins, skulls, meat	-	12	64	-	-	-	2	-	-	-
8	Sambar	*Cervus unicolor*	Antlers	2	11	38	-	-	-	-	-	-	-
9	Guar	*Bos gaurus*	Horns, meat	1	-	19	-	1	-	-	-	-	-
10	Takin	*Budorcas taxicolor*	Horns		-	6	-	-	-	-	-	-	-

11	Asiatic Black Bear	*Ursus thibetanus*	Skins, gall bladder, canines, oil	1	14	48	-	-	-	-	-	-	-
12	Yellow-throated Marten	*Martes flavigula*	Skins	1	-	-	-	-	-	-	-	-	-
13	Asian Golden Cat	*Catopuma temminckii*	Skins	-	-	1	-	-	-	-	-	-	-
14	Small Indian Civet	*Viverricula indica*	Skins	-	-	2	-	-	-	-	-	-	-
14	Leopard Cat	*Prionailurus bengalensis*	Skins	-	-	5	-	-	-	-	-	-	-
16	Clouded-leopard	*Neofelis nebulosa*	Skins	-	-	3	-	-	-	-	-	-	-
17	Porcupine	*Hystrix brachyura*	Stomach, quill	7	27	151 2	-	-	-	-	-	-	-
18	Chinese Pangolin	*Manis Pentadactyla*	Skins, scales	-	-	23	-	-	-	-	-	-	-
19	Great Hornbill	*Buceros bicornis*	Bills, feather	4	-	16	-	-	-	-	-	-	-
20	Asian Elephant	*Elephas maximus*	Skin parts, molars teeth	-	150	203	-	-	30	20	-	-	-
21	Tiger	*Panthera tigris*	Canines, bones	1	5	-	-	-	-	-	-	-	-

NOTE : PTO-Putao, MKN-Myitkyina, LZ-Laiza, LJ-Lweje, PW-Panwar, KF-Kangfang, HM-Hpimaw,CP-Chibwe, KBT-Kambaiti, M-Muse

Table.7. Quantity of hunted wildlife parts recorded in village surveys

No	Common Name	Scientific Name	Observed Parts	Study sites									
				PTO	MCB	MLSD	MLD	YKD	PM	USG	PND	KLP	MS
1	Chinese Serow	*Capricornis milneedwardsi*	Skins, horns, hoofs,	-	-	-	-	-	-	-	3	52	-
2	Red Muntjac	*Muntiacus muntjak*	Skins, antlers, meat	5	10	6	10	10	6	10	1	52	3
3	Red Goral	*Nemorhaedus cranbrooki*	Skins, horns	-	-	-	-	-	-	-	1	-	-
4	Black Musk-deer	*Moschus fuscus*	Skins, musk	-	-	-	-	-	-	-	1	-	-
5	Red Panda	*Ailurus fulgens*	Skins	-	-	-	-	-	-	-	1	-	-
6	Eurasian Wild Pig	*Sus scrofa*	Tusks, meat	4	9	5	5	2	5	9	4	34	3
7	Macaque, Gibbon	*Macaque spp., Hoolock hoolock*	Skins, skulls, meat	5	10	15	5	5	5	22	21	61	5
8	Sambar	*Cervus unicolor*	Antlers	-	-	-	-	-	1	-	-	-	1
9	Guar	*Bos gaurus*	Horns, meat	-	-	1	-	-	-	-	-	-	-
10	Takin	*Budorcas taxicolor*	Horns	-	1	1	-	-	-	1	1	3	-
11	Asiatic Black Bear	*Ursus thibetanus*	Skins, gall bladder,	1	-	1	-	-	-	-	6	2	-

			canines, oil										
12	Yellow-throated Marten	*Martes flavigula*	Skins	1	-	-	-	-	-	-	-	1	-
13	Red Giant Flying Squirrel	*Petaurista petaurista*	Skins, stomach	-	-	-	-	-	1	-	-	-	-
14	Leaf Muntjac	*Muntiacus putaoensis*	Skulls	2	1	1	-	-	1	2	1	-	-
15	Tiger	*Panthera tigris*	Canines, bones	-	1	-	-	-	-	-	-	1	-
16	Asian Golden Cat	*Catopuma temminckii*	Skins	1	-	-	-	1	-	-	-	-	-
17	Small Indian Civet	*Viverricula indica*	Skins	-	-	-	-	-	-	1	1	-	1
18	Leopard Cat	*Prionailurus bengalensis*	Skins	-	-	-	-	1	-	-	-	1	-
19	Clouded-leopard	*Neofelis nebulosa*	Skins	1	-	3	-	-	-	-	1	-	-
20	Porcupine	*Hystrix brachyura*	Stomach, quill	30	-	-	-	-	-	-	-	1	2
21	Chinese Pangolin	*Manis Pentadactyla*	Skins, scales	1	-	-	-	-	-	-	-	-	3
TOTAL				51	32	33	20	19	19	45	42	208	18

NOTE: PTO-Putao, MCB-Machanbaw, MLSD-Mularshidee, MLD-Mulardee, YKD-Yawkyawdee, PM-Pyetmar, USG-UpperShangaung, PND-Panandim, KLP-Khaunglanphu, MS-Myitson

7. Conclusion

There are many relevant factors indicating the rapid depletion of natural resources in Kachin State. One was the low morale or disempowerment of much of the population, stemming from local and broader issues including corruption and abuse of power. A second issue concerns the complicated governance situation among the different ethnic armed groups. High unemployment rates and associated social welfare issues are expressed as a third important issue relevant to conservation. There are many underlying causes for high unemployment among the local people. Based on the field observations, many Chinese labors are gradually replacing the local workers in all of large scale development construction activities. Influential people with large-scale business activities are controlling not only the wildlife trade but also other booming trades in the study area, thereby leaving fewer opportunities for local people with small-scale ones.

China's high market demand is a fourth issue for the rapid deterioration of forest resources in Kachin State. Although there are strict regulations on their collection, effective law enforcement is too weak to stop illegal wildlife collection, transportation and market demand of these wildlife species.

According to the field surveys, it was observed that various parts of wildlife are mainly used for ingredients of traditional medicines, collectors' trophies, decorations and luxury items. Live animals are sold as pets or fresh food, while others are killed-often just for obtaining a single body part such as gall bladder of bears- and also traded for zoo exhibits.

Because the lax law enforcement, low penalties, limited awareness of the problem among the civil population, weak border controls and the perception of high profit and low risk contribute to large-scale commercial logging and illegal smuggling of wildlife and its products in this area, these practices are still very active. Investigations have found that illegal wildlife dealers utilize well-established and highly organized cross-border networks. Kachin State is rich in natural resources. Its location near resource hungry China and its rule by people in need of hard currency has resulted in the unsustainable exploitation of its natural resources.

Effective measures in controlling illegal wildlife trade cannot be undertaken in the absence of trade related information such as the number of species, names of species, their volume in trade, illegal routes in trade, countries involved in trade, demand and distribution of wildlife and its products in the markets, impact of illegal trade on species survival and sustainable use of wildlife and its habitats. Thus, lack of information on trade in wildlife and its impacts has hampered efforts of governments in the region to conserve their rich biodiversity.

8. Recommendations

The following recommendations are made following this study:

- Information gathered during monitoring activities should be passed on to the relevant authorities. Enforcement agencies in Myanmar as well as its neighboring countries should be encouraged to act upon information given to them and be encouraged to take further actions against the illegal trade.

- Implementation of national legislation needs to be reviewed and weaknesses addressed. TRAFFIC who is in a good position to begin dialogue with the CITES Management Authority in Myanmar, has to explore the needs of the country to improve its legislation, and enforcement thereof, relating to wildlife conservation and trade in wildlife and their products.

- Authorities in China should be made aware of the fact that wildlife trade continues to be smuggled into China for sale there. The China enforcement agencies should be encouraged to increase efforts to prevent wildlife from being smuggled into China from Myanmar through activities such as increased checks at border markets.

- Most importantly, national laws should be enforced, and markets openly selling protected wildlife should be closed down. Those found violating the national legislation should be prosecuted to the full extent of the law.

- In order to reduce illegal international trade of wildlife and other protected wildlife, Myanmar should be encouraged to work closely in partnership with China, Thailand and other relevant countries, as international co-operation is essential to enforce CITES effectively and to put an end to the illegal international trade.
- Authorities in airports and other points of international border crossings should be more vigilant to prevent parts and derivatives of protected wildlife from being carried across Myanmar's borders. Myanmar should ensure that staff based at these checkpoints is sufficiently trained in CITES implementation, enforcement and identification of species parts.
- Regular and systematic monitoring of the markets in Myanmar should continue to be carried out by government authorities assisted by NGOs for the enforcement efforts as well as to detect changing trends and dynamics in the trade.
- Myanmar, as a Party to CITES, should enforce effective enactment of existing wildlife laws or revise its legislation in compliance with new CITES legislation.

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Appendix 1

Investigation of hunting, catching and purchasing

Investigator: **Time:** **Sites:** **Units:**

Species name	Hunting number		Catching number		Purchasing						Remark
	Adult	Juv.	Adult	Juv.	Live	Price	Body	Price	Fur	Price	
Chinese Serow											
Red Muntjac											
Red Goral											
Black Musk-deer											
Red Panda											
Eurasian Wild Pig											
Macaque, Gibbon											

Sambar											
Guar											
Takin											
Asiatic Black Bear											
Sun Bear											
Yellow-throated Marten											
Red Giant Flying Squirrel											
Leaf Muntjac											
Tiger											
Asian Golden Cat											
Small Indian Civet											
Leopard Cat											
Clouded- leopard											
Porcupine											
Chinese Pangolin											

Appendix 2

Investigation of distributing center of wild animal and its production

Investigator: Time: Name:

Species name	Type	Quantity	Price	Source	Remark
Chinese Serow	Skins,Horns,Hoofs,Toungs				
Red Muntjac	Skins,Antlers,meat				
Red Goral	Skins,Horns				
Black Musk-deer	Skins,Musk				
Red Panda	Skins				
Eurasian Wild Pig	Tusks,Meat				
Macaque, Gibbon	Skins,Skulls,Meat				
Sambar	Antlers				

Guar	Horns,Meat				
Takin	Horns				
Asiatic Black Bear	Skins,gallbladder,Canines,fat				
Yellow-throated Marten	Skins				
Asian Golden Cat	Skins				
Small Indian Civet	Skins				
Leopard Cat	Skins				
Clouded- leopard	Skins				
Porcupine	Stomach,Quill				
Chinese Pangolin	Skins,Skills				
Great Hornbill	Bills,Feather				
Asian Elephant	Skin parts,Molars				
Tiger	Canines,bones				

Appendix 3

General Hunting Interview

Location (Town/village):............................	Interviewer:................................
Date:..	Interviewee:................................
Position: N:............................	Religion:....................................
E:............................	

1. How often do you hunt? (e.g., once a week, once a month, twice a year, once a fortnight, etc.) ____
2. Average time taken for hunting (days or hours)______________________________
3. What is your most favorite season for hunting? ______________________________
4. Number of people accompanied with you ____________________________
5. Do you hunt in daytime or nighttime, or both? ______________________________
6. What kinds of weapons do you use for hunting?

Spear [ ] dogs [ ] Blowpipe [ ] Flint gun [ ] Trap [ ]

Crossbow [ ] Jaw trap [ ] Snare [ ] Other: ________________________

7. What kinds of animals do you normally get now? _________________________
8. What kinds of animals have you hunted before? _____________________________
9. In each hunt, how many animals do you usually get? ________________________
10. What is your assessment on the abundance of wildlife in the forests compared to the last five years?

    ____

11. What are your purposes for hunting? (for sport, subsistence, trade, pest control, etc.):

    ____

12. Your main occupation:

    i) Hunting ( ) ii) Farming ( ) iii) Other ( )

13. Please rank the following occupations in terms of economic significance for household income (From the most significance to the least significance):

    i) Hunting ( ) ii) Shifting Cultivation ( ) iii) Forest products collection ( ) iv) Other ( )

14. Have you ever sold the meat or any part of the animal you hunt?

    No: [ ] Yes [ ]

Name of wildlife sold	Part of wildlife sold	Use of wildlife/ parts	Current Price (Kyats)	Barter/Exchange with what commodity?	To who sold? (neighbour, trader etc.)	Destination- trade route/ Origin of trader

15. Your usual hunting area:____
16. How far your usual hunting area is from the village?

    ____

17. Are the hunting areas divided on the basic of individual or community or ethnic groups or they have no boundary?

    ____

18. Is wild meat served for a meal in your house today? Yesterday? Yes…… No…….

If Yes, Species ____________; Cost/kg ____________;

How obtained? ____

19.

Comments:____

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Appendix 4

MARKET SURVEY DATA

Name of Town: ____

Name of Market: ____

Name of Surveyor: ____

Cut Weight of Meat sold	Species	Age	Sex	Price	Time of Sale	Date of Sale
