Environmental Implications of the Hydropower Projects in District Kinnaur, Himachal Pradesh, India: A Review

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Abstract: Appraisal of impact of changed flow regime on the river bed ecosystem and supply of environmental flows has become indispensable in the increasing construction of hydropower projects (HEPs). The environmental effects of HEPs can be sorted according to diverse criteria like long term and short term impacts, impacts on the dam operation sites and on the nearby areas areas, social and unsocial effects, positive and negative effects. These impacts possibly be prepared in an concentrated and complex way like climatic, hydraulic, biologic, social, cultural, archaeological etc. Construction and operation of HEPs have constantly been related with changes in the social, physical and natural condition.

A portion of the harmful effects of HEPs comprise loss of vegetations, land aggravations, changes in river flow pattern, unplanned resettlement, medical issues, loss of social esteems and minimization of local communities.Therefore, present study is an affort to review the environmental implications of the hydroelectric projects in Kinnaur District of Himachal Pradesh. The investigation proposes that there is a need to evaluate the advantages and adverse social effects of the HEPs in the region. Appropriate environmental evaluation should be done to ensure that rare species are not being lost and individuals dislodged ought to be suitably restored.

Keywords: Mountain, Hydropower, Environmental Effects, Resettlement and Rare Species, Kinnaur

I. INTRODUCTION

Power is measured as a principal agent in the era of riches and furthermore a huge factor in monetary improvement. The significance of power in financial advancement has been perceived all around the world. The recorded information verify a solid connection between the accessibility of power and monetary actions. Throughout the previous two decades, hazard and reality of natural and ecological degradation have turned out to be more evident. Increasing proof of ecological issues is because of a blend of a few components, since the environmental effects of human actions has augmented drastically due to contineous increment of total populace, consumption and industrialization (Yuksel, 2010). Accomplishing answers for the environmental issues we confront today requires lasting potential activities for sustainable advancement. In such manner, sustainable power sources by all accounts appears to be a standout amongst the most proficient and successful plannings. That is the reason there is a intimate association between renewable energy and sustainable development (Kaygusuz and Sarı 2003, Yuksel, 2009, Dincer, 2000).

In the twentieth century large dams and other developmental projects were often connected with advance and prosperous financial improvement for some nations, including India (Khagram, 2005). Dam construction projects lures government with the guarantee of hydroelectricity, water system, and drinking water for their developing populace. They represents a copious resources to creating nations (Khagram, 2005).

India, in the same as other nations around the globe, has a huge requirement for energy, and has recognized hydropower production as a key segment in addressing that need (Sharp, 2000; Alternative Hydro Energy Center, 2011). While HEPs produces monetary and social advantages, major dams in India cause huge numbers of a similar social and ecological concerns recorded around the world (Khagram, 2004). One important criticism of the dam construction process in India is an absence of significant people's involvement, which is particularly a vital issue for local communities directly affected by the HEPs (Sinclair and Diduck, 2000; Paliwal, 2006; Rajaram and Das, 2006; Diduck et al., 2007). The sharp elevations and various rapid flowing perennial rivers of the Himalayan states of India supply the regions with a huge potential for HEPs (Government of India, 2008). This potential, combined with India's significant requirement for energy, make the Himalayan states an essential resource of hydroelectric production (Rangachari et al., 2000).

As of late, the number of HEPs in the Himalayan regions has expanded drastically. In 2003, India's central government declared a 50,000 MW proposals planned to expand the involvement of hydropower from 25% to 40% of the entire energy production in the nation (Central Electricity Authority, 2004). Under this proposal, out of proposed 162 HEPs, 133 projects are in the Himalayan regions (Agrawal et al., 2010).

II. HYDROPOWER DEVELOPMENT IN HIMACHAL PRADESH

The rivers of the Indian Himalaya have a tremendous potential for hydropower production. Plenty of stream flow diversion type HEPs in Himalayan regions are in various phases of implementation. Himachal Pradesh has five river basin i.e., Satluj, Yamuna, Beas, Ravi and Chenab and the distinguished capability of hydropower is 20463.5 MW out of this 6066.00 MW has been exploited till now. When compared to other states in India, Himachal Pradesh is maintaining an above-average economic outlook. As one of the fastest growing states in India, Himachal Pradesh relies mainly on four sources for its economic growth: agriculture, tourism, cement and hydropower. Specifically, the plenty of perennial rivers and streams empowers Himachal Pradesh to sell electricity to neighboring states like Delhi, Punjab and Rajasthan. Himachal Pradesh has an expected 23,000 MW of hydel potential (DoE, 2014), which represents 25% of India's aggregate hydel potential. Of this amount, 8,368 MW are already being utilized by hydropower projects in Himachal Pradesh, with an additional 3,805 MW in the process of being exploited (Himachal Pradesh: the abode of the gods, 2013).

Since Himachal is abundant with hydel potential and few other economic resources, hydropower has been seen as key to continued economic development. Although the Indian government has identified hydropower as a key source for renewable energy, the administration is not properly equipped to achieve efficient and timely construction of said facilities. developers from the private sector. These incentive packages make hydropower even more profitable to investors, as they can mitigate expenses (Singh and Vaidya, 2012).

The expansion of hydropower capacities fosters the economic development of the state, it also leads to environmental damage and to conflicts about the re-allocation of land and water resources (Chhatre and Saberwal, 2006; Erlewein, 2012; Him Dhara, 2011; Sinclair and Diduck, 2000). Mountain streams are changed into cascades of HEPs, thereby changing natural conditions and leaving little space for original habitats.Most notably, the repeated diversion of rivers into head race tunnels dries up large parts of the riverbed and virtually results in the 'disappearance' of long river stretches (Figs. 2). In view of such substantial ecological and socio-economic transformations the question arises as to what extent India's current system for Environmental Impact Assessment (EIA) is in a position to appraise and reduce environmental impacts and how this position might be strengthened. Most research focuses on evaluating the compliance with existing EIA procedures. For example Goel (2000), Nandimath (2009), Paliwal (2006) and Panigrahi and Amirapu (2012) have studied the effectiveness of the Indian EIA system in different sectors including dam-building, all concluding that there are considerable discrepancies between legislation and implementation. In contrast, there is little research investigating the legislation's inherent limitations and the potential of other assessment instruments to improve environmental decision-making for hydropower development in India (Agrawal et al., 2010).

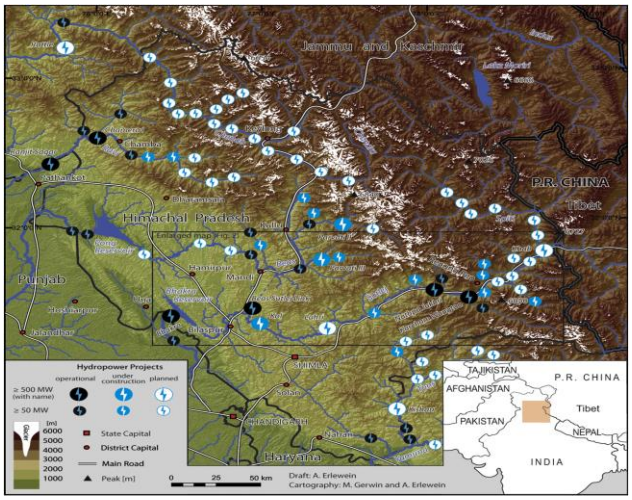

Fig.1. Hydropower Development in Himachal Pradesh

Various HEPs have developed in the province of Himachal Pradesh. Of these, major hydroprojects are situated on the river Satluj and its tributaries in district Kinnaur. Kinnaur is located in the North Eastern part of Himachal Pradesh, India bordering The Republic of China. It has an area of 6041 sq. km about 11.5 % of

The elevation of the district ranges from 1500 meter to 7025 meter above mean ocean level. The significant part of district is drained by river Satluj. There are numerous HEPs developed in Kinnaur district, some of them are listed in table-1.

TABLE 1. MAJOR HYDROPOWER PROJECTS IN KINNAUR

Hydropower Projects	Status	Capacity MW
Nathpa-Jakhri	Commissioned	1500
Karcham- Wangtu	Commissioned	1000
Bhaba	Commissioned	120
Baspa-2	Commissioned	300
Sorang	Commissioned	100
Tidong-1	Under Construction	60
Kashang	Under Construction	66
Total		3146

III. HAZARDS & RISK ANALYSIS OF DISTRICT KINNAUR

Kinnaur is located in the Trans Himalayan zone of Himalayas, a hilly region having elevated mountain ranges thought to be a sedimentary wedge between impacting plate edges encasing profound narrow valleys of Satluj and its various tributaries.

The area has a distinctive climatic state. Winters are severe with heavy snowfall causing Glaciers and Avalanches. Summers are gentle with rainy season in the majority of the Kapla and Nichar sub-divisions of the area. Pooh sub-division of this region forms a portion of 'Indian Cold Desert' and gets meager precipitation as it falls in rain-shadow region of Himalayas.

The special geo-structural, topographical, geomorphologic and climatic state of the region makes it susceptible to different types of natural calamities which have been aggravated by growing human involvements with the environment. There is a need to distinguish and outline the Hazard Risk zones of the region, which will supply the essential data to work on micro-level and to delineate active and inactive procedures of the hazards. The catastrophes, which normally takes place in the study area and its different regions inclined against different sorts of debacles, are shown in table 2.

TABLE 2. DIASTER HAZARDS VULNERABILITY IN THE STUDY AREA

Hazard Type	Name of Sub-Division & Hazard Susceptibility		
	Pooh	Kalpa	Nichar
Earthquakes	Very High	Moderate	Moderate
Landslides	High	High	High
Avalanches	High	Moderate	Low
Cloud Bursts	Low	Low	Moderate
Floods	Very High	High	High
Glacial Lake Outburst Flood (GLOFs)	Very High	Moderate	Very High
Wind Storm	High	Moderate	Moderate
Road Accidents	Moderate	Moderate	Moderate
Forest Fires	Low	High	High
Domestic Fires	Moderate	Moderate	Moderate
Drought	High	Moderate	Moderate

(Source: after, DDMA, 2012)

The fragile Himalayan region being a storehouse of natural resources has also thrown challenges in the form of natural fury like floods, earthquakes and now its most abundant resource i.e. water is being tapped to generate power by building hydroelectric projects.

The current climatic incidence in July 2013 reflected upon the unmatched hazards that pose a potential threat over the NW Himalayan regions, practically the highway alignments were lost to intense precipitation and many parts of roads were washed away from Nathpa to Recong peo and the area was inaccessible till Kalpa. The Sangla valley was additionally difficult to reach for over a month.

Fires in the region are relatively common in the summer seasons because of the utilization of combustible material for home building and wood for fuel. Because of the dryness and nonappearance of dampness forests effortlessly burst into flames as well. Floods are normal during the precipitations. Cloud bursts are short and disturbing while intense constant precipitations flood low lying houses and immerse the strata prompting landslide and subsidence. Flooded natural discharge channels cause intense erosion. Throughout the dry season drought circumstances arises. Because of the hilly terrain natural sources become scarce as groundwater level falls down. Study area is situated on the folds of the Himalayas lies in the quake Zone IV and is very inclined to seismic tremors.

IV. IMPACT OF HYDROPOWER PROJECTS

The HEPs in Himachal Pradesh are generally run of the river type. The stream water is redirected through an underground headrace tunnel which gives the start for water to fall through. The fall is utilized to generate electricity by using turbines situated in power house deep inside the hills. The blasting of the slopes needs to lay the steeply falling head race

tunnel and the development of underground power houses and the reservoir at the start, severely disturbs the delicate environmental equilibrium in the hilly terrain of Himachal Pradesh. There is frequent landslides in the region due to blasting and other developmental activities which damages the forests, roads, houses, water sources and farmland in the villages.

Each large HEP is expected to carry out the Environment Impact Assessment (EIA) of that project alone, which is known to be an deceitful, cut, copy and paste attempt in majority of the cases. In most of the cases, EIA is done in isolation and no attempts has been made to evaluate the cumulative impact assessment and carrying capacity to know the number of projects that can be built on the river Satluj and its tributaries. Specifically, the Sutlej river in Kinnaur has turned into a case of how bumper-to-bumper HEPs can spell disaster. HEPs that has commissioned have already blocking the flow of river Sutlej in Kinnaur district. The nonappearance of fish above Rampur till Karcham and Tapri is demonstrative of the negative impacts of the structures which have blocked the network of rivers and streams in the region. People in the region fear that when the rest of the HEPs would commissioned, no water would flow downstream influencing the marine life and occupation of individuals living along the river. Therefore, there is a an urgent need to have basin wise research on HEPs.

Many researchers have suggested that the number of HEPs in every river basin must be chosen on the basis of the carrying capacity of that particulat basin and overlapping of HEPs should be prohibited by maintaining the distance of no less than 7 km between each HEP.

Dams in Kinnaur are acting as a physical barrier to fish movement and reducing patterns in the catches of game fish like Mahaseer and Trout. The impacts of HEPs on river ecosystem is shown in figure 2 and table 3 demonstrates the positive and negative impacts of HEPs in general.

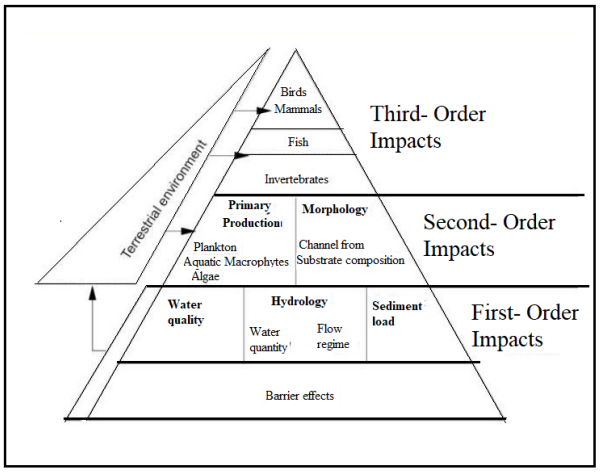

Fig 2. The pyramid of Impacts of Hydroelectric Projects on River Ecosystems

TABLE 3 POSITIVE AND ADVERSE IMPACTS OF THE HYDROPOWER PROJECTS

Positive Impacts	Adverse Impacts
Economic Impacts	
Provides long life expectancy (50–100 years and more)	Precipitation
Provides reliable service	Requires long-term planning
Provides low operational and maintenance costs	High upfront investment
Provides highest energy efficiency rates	Often requires foreign contractors and funding
Incorporates well proven technology	Requires long-term agreements
Encourages regional development	Requires multidisciplinary involvement
Social Impacts	
Leaves water available for other uses	May involve resettlement
Enhances accessibility of the territory and its resources	Requires management of competing water uses
May enhance navigation	land use patterns will be modified
Often enhances recreation	Waterborne disease vectors may need to be checked
Often provides flood protection	May restrict navigation
Environmental Impacts	
Produces no waste	Alteration in aquatic ecosystem
Produces no pollutants but only very few GHG emission	Inundation of terrestrial environment

Often creates new freshwater ecosystems with increased productivity	Temporary introduction of methylmercury into the food chain needs to be monitored
Avoids depleting non-renewable fuel resources	Water quality needs to be managed
Neither consumes nor pollutes the water it uses for electricity generation purposes	Sediment composition and transport may need to be monitored/managed
Enhances knowledge and improves management of valued species due to study results	Species activities and populations need to be monitored
Helps to slow down climate change	Barriers for fish migration, fish entrainment
(Source: After Dincer, 2000)	

Kinnaur district is famous for its scenic beauty and cool and pleasant weather. But, after the development of large dams, temperature of the area is rising each year.

The dynamite blastings during the construction of tunnels causes cracks in the houses. Approximately 80% of the local inhabitants in the region are affected by this problem. It has also caused drying up of agricultural fields, grazing lands and natural springs in the region. As per state Irrigation and Public Health Department, 43 out of 167 water sources had dried up in different villages affected by the Karchham Wangtoo HEP, and discharge in another 67 has gone down.

During the tunnel construction to give water a gradient, the excavation material is openly dumpted into the river Satluj or close to road side, which not only deteriorates the quality of air but also causes water pollution. The roads in Kinnaur are much near to the Satluj river, especially during the monsoon season, when the water increases in the dam, it touches the roads which leads to cause fragile base of mountains and roads.

Transmission tower lines are utilized to transmit power from Kinnaur to different states and regions. So far many forest lands has been diverted for the construction of these transmission tower lines. As per the state forest department, more than 70, 000 hectares of forest lands has so far been diverted to HEPs, out of which, about 1,000 hectares in Kinnaur region only. EIA reports of individual HEP signifies the felling of around 35,046 trees including exceptionally endangered species like Chilgoza trees (Pinus Gerardiana).

V. CONCLUSIONS

The rapid expansion of hydropower capacities is without a doubt one of the most significant processes shaping contemporary human environmental interactions in Himachal Pradesh and other so-called 'hill states' in Northern India. Environmental safety, Energy security and economic development is the national energy policy drivers of any nation of the world. In order to meet the constantly increasing demand for energy and soaring fossil fuel costs, construction of HEPs is a need of the hour especially in developing nations.

To overcome existing shortcomings the improvement of project EIAs needs to be supplemented with more comprehensive planning instruments. There is a dire need for environmental assessments which go beyond the level of individual projects and include decision-making processes. Although being itself constrained by the non-linearity of planning practices Strategic Environmental Assessment (SEA) can play an important role in closing knowledge gaps about cumulative and basin impacts and making the due consideration of ecological angles a integral part of decision-making.

Providing politicians, planners and the public with sound information about the environmental and socioeconomic implications of transforming the rivers into dam-cascades might lead to policy changes that allows for making better use of the so far only marginally tapped potential to avoid, reduce and mitigate the adverse impacts of extensive hydropower development in the area.

Participatory approaches must become a reality for people who are traditionally disadvantaged, to prevent developmental processes from destroying their livelihoods, appropriating the land that has supported their families for generations, and destroying the social status of their communities. Further, provisions must be made to remunerate local population in sustainable ways.

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