Challenges in Water Management and its Adverse Impacts on Ecosystem

Gajendra Dixit
Assistant Professor
Thakur Institute of Management Studies,
Career Development & Research, Mumbai (MS) India
gajendra.dixit@thakureducation.org

Brijesh Pandey
Assistant Professor
Thakur Institute of Management Studies,
Career Development & Research, Mumbai (MS) India
Brijesh.pandey@thakureducation.org

***Abstract*—The urge for rapid economical growth and negligence towards the environment has resulted into various water issues such as floods, famine, water scarcity, siltation of river systems, contamination of drinking water, water salinization, water borne diseases, depletion of ground water levels etc. These problems are very severe and widespread in developing countries due to the exploitation by developed countries. It is very difficult to address these issues in context of developing countries as there is acute poverty, illiteracy, poor governance and greed for economical prosperity.**

Keywords--Gground water depletion, Siltation; Water scarcity; Water saliization; Floods; Pesticides; climate change; green house gases;

I. INTRODUCTION

The surface area of our planet earth is having 30% of land and 70% of water. Of this 30% of land most of the land is inhabitable and in remaining part we have a large chunk of population. The water demand for this population is also too large. Though our planet has 70% of water, most of it is saline and not potable. Only 3% of water is potable, which is in the form of Ground water, fresh water rivers, dams and glaciers. This 3% of water is also getting contaminated due to industrialization, excessive use of pesticides and fertilizers, deforestation, rapid urbanization etc.

Water quality in developing countries is often hampered by lack of or limited enforcement of:

- emission standards
- water quality standards
- chemical controls
- non-point source controls (e.g. agricultural runoff)
- market based incentives for pollution control/water treatment
- follow-up and legal enforcement
- integration with other related concerns (solid waste management)
- trans-boundary regulation on shared water bodies
- environmental agency capacity (due to resources or lack of political will)

II. WATER AVAILABILITY AND SCARCITY

Approximately 71% of all illnesses in developing countries are caused by poor water and sanitation conditions. Also the women's in the families have to walk several kilometers to fetch the water. Once filled, water jugs can weigh as much as 20 kg [2].

In the last century due to population explosion and increasing consumption of water per capita people are using more water than ever before. By 2025, up to 1.8 billion people could face water scarcity [3]. Scarcity of water can is classified in to three categories, Physical water scarcity (low quantity of water availability), Economical water scarcity (low quality of water) and Institutional Water scarcity.

A. *Physical water scarcity:*

These are the dry, arid areas where the natural water is present in very low quantities. These areas are further facing acute shortage of water due to excess ground water usage than the rate of replenishing. It is estimated that on average a withdrawal rate above 20 percent of renewable water resources represents substantial pressure on water resources – and more than 40 percent is 'critical'. The global areas which are withdrawing more than the critical threshold levels are Middle East, Northern Africa and Central Asia. According to Food and Agriculture Organization of United Nations, it is now estimated that more than 40 percent of the world's rural population lives in river basins that are physically water scarce.

B. *Economical water scarcity:*

Economical water scarcity occurs in the areas where there is acute shortage of financial aid or human resource. In such areas water is available for those few people who can pay for it. This type of scarcity is mainly visible in the
Central and South America, Central Africa, India, and South East Asia.

C. *Institutional water scarcity:*

When institutions and legislations fail to ensure reliable, secure and equitable supply of water to users.
In the developed countries the demand from municipal corporations and industry, is growing faster than agricultural

demand this is leading to Institutional water scarcity. Whereas in less-developed countries agricultural use remains dominant, in Europe 55 percent of water is withdrawn by industry. Water stresses occur locally across the globe, but some entire regions are highly stressed, particularly the Middle East, the Indian subcontinent and northeastern China. Sub-Saharan Africa and the Americas generally experience lower levels of water stress.

III. CHALLENGES IN WATER MANAGEMENT

The land and water resources are the most essential elements for the rural and agricultural development; also, they are highly correlated to food insecurity, poverty, climate change adaptation and mitigation, migration etc.

Current projections indicate that world population will increase from 6.9 billion people today to 9.1 billion in 2050[4]. Also, economic progress of emerging countries (BRICS) has lead to higher standard of living of mass population; it translates into higher demand for nutritional food. World food demand will surge as a result, and it is projected that food production will increase by 70 percent in the world and by 100 percent in the developing countries. This food demand will create a heavy stress on finite water resources.

Major challenges in Water management are as follows:

A. Depletion in ground water level due to excessive Irrigation:

Irrigation extracts water from rivers, lakes and aquifers. In the world on an average188 million ha (62 percent of total irrigated area), is supplied from surface water, and 113 Mha (38 percent) from groundwater. With the use of tube well technology, and drastic reduction in technology costs, groundwater use has grown exponentially in recent years. This is visible particularly in Asia, Northern Africa and the Middle East. From agricultural census data for India, the irrigated areas equipped with groundwater structures rose from approximately 10 Mha in 1960 to almost 40 Mha by 2010[5]. In South Asia, groundwater now accounts for 57 percent of the total irrigated area, and in the Arabian Peninsula for 88 percent.

Some non-conventional means of water sources used for irrigation are water from wastewater plants and desalinated water; but this contributes only 1 percent. Both of these methods are mainly use in highly developed countries or in urban areas as it is very much cost sensitive.

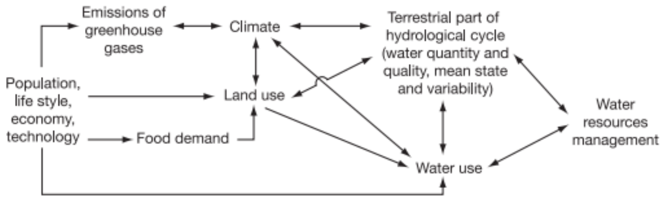
B. Greenhouse Gases and Climate change:

Agriculture, rapid urbanization, deforestation, industrialization has lead to drastic increase in levels of greenhouse gases in atmosphere, agriculture alone accounts for 13.5 percent of global greenhouse gas emissions (IPCC, 2007). At the same time, climate change brings an increase in risk and unpredictability for farmers – from warming and related aridity, from shifts in rainfall patterns, and from the growing incidence of extreme weather events. Poor farmers in low income countries are the most vulnerable and the least able to adapt to these changes.

Due to shift in rainfall patterns and its varied unpredictable intensity farmers are facing uncertainty and they are becoming more dependent upon ground water sources and other sources of water. Further rapid increase in population will lead to growing demand of water which will create great stress on water management [6].

The findings of Working Group II Third Assessment Report (TAR; IPCC, 2001) climate change highlights the impacts on hydrology and water resources, such as:

- Glacier retreat is likely to continue, and many small glaciers may disappear.
- Water quality is likely to be degraded by higher water temperatures.
- Unmanaged systems are likely to be most vulnerable to climate change.
- There are apparent trends in streamflow volume, both increases and decreases, in many regions.
- The effect of climate change on streamflow and groundwater recharge varies regionally and between scenarios, largely following projected changes in precipitation.
- With higher temperatures, the water-holding capacity of the atmosphere and evaporation into the atmosphere increase, and this favor increased climate variability, with more intense precipitation and more droughts [7].



Impact of human activities on freshwater resources and their management, with climate change being only one of multiple pressures (modified after Oki, 2005).

Climate-related observed trends of various components of the global freshwater system are as follows:

- Precipitation:
  Increasing over land north of 30°N over the period 1901–2005. Decreasing over land between 10°S and 30°N after the 1970s. Also, the intensity of precipitation will increase.
- Snow Cover:
  Decreasing in most regions, especially in spring.
- Glaciers:
  Decreasing almost everywhere
- Stream flow:
  Increasing in Eurasian Arctic, significant increases or decreases in some river basins. Earlier spring peak flows and increased winter base flows in Northern America and Eurasia.
- Evapotranspiration:
  Increased actual evapotranspiration in some areas mainly arid areas with high day temperature.
- Lakes:

Warming, significant increases or decreases of some lake levels, and reduction in ice cover.

- Droughts:
  Intensified droughts in some drier regions since the 1970s.

C. Quality of Water:

Water is an essential ingredient in all human activities including domestic and industrial activity. Industries and municipal corporations consume a large amount of water and when this used water is discharged into environment its quality is changed drastically.

In general population explosion and urge for rapid economical growth combined with industrialization, urbanization and no water treatment policy have lead to more adverse impacts on water quality. In most of the developing countries of Asia and Africa as they lack financial and infrastructural resources this issue is more visible.

To increase the water quality more number of waste water treatment plants are needed; but actual scenario is very disappointing. As per CPHEEO estimates about 70-80% of total water supplied for domestic use gets generated as wastewater [11].

The per capita wastewater generation by the class-I cities and class-II towns, representing 72% of urban population in India, has been estimated to be around 98 lpcd while that from the National Capital Territory-Delhi alone (discharging 3,663 mld of wastewaters, 61% of which is treated) is over 220 lpcd (CPCB, 1999). As per CPCB estimates, the total wastewater generation from Class I cities (498) and Class II (410) towns in the country is around 35,558 and 2,696 MLD respectively. As compared to above scenario the installed sewage treatment capacity is just 11,553 and 233 MLD, respectively.

As per the UNESCO and WWAP (2006) estimates (Van-Rooijen et al., 2008), the industrial water use productivity of India (IWP, in billion constant 1995 US$ per m 3) is the lowest (i.e. just 3.42) and about 1/30th of that for Japan and Republic of Korea.

Thus, overall analysis of water resources indicates that in coming years India has to deal with reduced fresh water availability and increased wastewater generation due to increased population and industrialization.

D. Nutrients and pesticides derived from crop and livestock management:

The nutrients and pesticides/ Herbicides used in livestock or crops when get mixed in water, it results in contamination of water. This can have an adverse effect on the aquatic lifecycle and also the fishes [8] and the whole food chain associated with it.

In the process of development of agriculture, pesticides have become an integral part for plant protection and for boosting food production. Also, the pesticides are used to keep away many dreadful diseases. However, exposure to pesticides both occupationally and environmentally results in a range of human health problems. It has been observed that the pesticides exposures are increasingly linked to immune suppression, hormone disruption, diminished intelligence, reproductive abnormalities and cancer [9].

Despite the fact that the consumption of pesticides in India is still very low, about 0.5 kg/ha of pesticides against 6.60 and 12.0 kg/ha in Korea and Japan, respectively, there has been a widespread contamination of food commodities with pesticide residues, basically due to non-judicious use of pesticides [10].

The first report of poisoning due to pesticides in India came from Kerala in 1958 where, over 100 people died after consuming wheat flour contaminated with parathion. Subsequently several cases of pesticide-poisoning including the Bhopal disaster have been reported. The Bhopal disaster has lead to contamination of ground water near Union Carbide plant. Consumption of this contaminated water has resulted in various incurable diseases in the population living in the vicinity.

E. Salinization:

With the advances and rapid growth of technology accompanied with decreasing prices for irrigation machinery resulted in to increased agriculture land under cultivation. Initially this resulted in higher crop yield and income; but the excess use of water negligence towards the water management techniques has lead to higher salinity in the soil thus making it infertile.

There are large irrigation schemes in Pakistan, China, India, Argentina, Sudan and many countries in Central Asia, where more than 16 Mha of irrigated land are now salinized (FAO, 2010c) [3].

IV. TECHNICAL OPTIONS FOR SUSTAINABLE LAND AND WATER MANAGEMENT

For sustainable land and water management following measures can be adapted:

A. Improving rainfed productivity:

For this the Government can undertake various technology driven initiatives. For example, in China, combined soil and water management investments have delivered good returns with manageable levels of risk. The Loess Plateau watershed rehabilitation project demonstrated on an area of 1.5 Mha that soil and water management improvements could be profitable.

B. Managing soil health and fertility:

Low and depleting nutrients in the soil and poor soil structure are causes of diminishing yields. In such cases sustainable land and water management techniques, including conservation agriculture, may help to restore and improve soil fertility through integrated soil fertility management [12].

C. Sourcing water for irrigated agriculture:

As we are using water for irrigation we must replenish it back to the environment and maintain the hydrological cycle balanced. Here we have to identify and implement various water preservation techniques that will also lead to increased ground water level. This will lead to ease the excess pressure on irrigation.

D. Modernizing irrigation systems:

Modernization of irrigation systems is must because it will save the water which is wasted if the farmers stick to the conventional ways of agriculture.

Modern techniques such as drip irrigation can help to drastically reduce the water consumption level in agriculture. Using drip irrigation, we can control the flow of water; depending upon the soil moisture need we can control rate from 2 liter/ hour to 20 liter/ hour. This also helps to prevent salinization of farmland.

In the western parts of Maharashtra state of India, a large land is used for producing Sugar cane which requires a lot of water; conventional way of irrigation here leads to wastage of water due to evaporation, salinization of fertile land etc. Such type of problems can be tackled by using Sprinkler irrigation system.

Thus using modern irrigation systems will lead to better management of water resources as well as help to increase the farm yields.

E. Managing environmental risks associated with intensification:

Intensified land use in agriculture is one of the major reason for ecological imbalance and a threat to bio-diversity in the globe. Low intensity land-use systems are very useful for large scale conservation programmes.

The intensified agriculture has lead to various problems, for example: In the wheat producing belt of Punjab state of India intensified over dependence on a single crop has resulted into decreased soil quality, salinization of farm land. Also, excess use of ground water for irrigation has resulted into depleting ground water levels.

F. Land and water approaches in view of climate change:

It will be beneficial for the whole agrarian society to understand the causes of climate change and its mitigation methodology. To tackle with the problem of climate change the farmers need to change their conventional pattern of crop production. An integrated approach using polyculture, intercropping, co-cultivation methodologies which involves planting of two or more plants simultaneously in the same field will remove the dependency of the farmer on a single crop. Also this methodology has resulted in disease resistant plants thus minimizing the use of pesticides; If it is combine with modern irrigation systems, this will drastically improve the crop yields and farmer income.

V. CONCLUSION

The urge for rapid growth, urbanization, deforestation, economical prosperity, industrialization has lead to ever-growing adverse problems related to bio-diversity, environment, hydrological cycle. Few severe problems faced by the world community are depleting ground water levels, contamination of potable water with pesticides and industrial residues which have caused various diseases and loss of human life; prominently visible in developing countries, excess use of irrigation resulting into infertility and salinization of farm land. These problems need to be addressed using modern technologies of irrigation, avoiding intensified agricultural production, promoting bio-diversity, positive approach towards environment and water management by implementing supportive government policies projects and financial aid.

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