Lecture 4

Case of INDIA

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WATER RESOURCES AND RIVER MANAGEMENT FOR SUSTAINABLE DEVELOPMENT IN INDIA

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INTRODUCTION

All development projects have environmental, economic and social consequences, some beneficial and other adverse. Water resources projects are no exception to this. With the increase in economic activities and the consequent potential for stress on ecosystems and natural resource stocks, the study and recognition of linkages between freshwater issues and other sectoral and cross sectoral issues are becoming increasingly important.

The main challenge facing the management of water resources is how to maximize all the positive impacts and minimize the adverse impacts; how to ensure reliable water supply and efficient use in the agricultural sector, mitigate flood damages, control water pollution and at the same time reduce environmental and social impacts, such as rehabilitation and resettlement of displaced people, mitigate the problems of water logging and salinity and reduce the spread of waterborne diseases and the problems associated with pollution. The idea of environmentally sound water management or sustainable development and management of water resources is to convey the concept that development is to be accomplished with minimum damage to the environment. However, translating the concept into a reality is a difficult task.

India has 15% of the world population but only 4% of the world's water supply. Preserving the quality and the availability of the freshwater resources is the most pressing of the many environmental challenges being faced by the nation. It is imperative that conservation, recycle, reuse of precious water and treatment of wastewater are given serious attention for sustainability of built environment for our populous country.

This report attempts to bring out the Indian scenario of various related issues concerning water resources including those of Flood Disasters, Sediment Disasters, Water shortages, Water contamination and damage to ecosystems.

1. FLOOD DISASTERS

Floods are natural phenomena, which particularly occur in plains, where inadequate riverbed slopes result in inundation of a large width of the valley. The flat gradients of the plains also cause silting of rivers that in turn results in higher flood levels. With the spillover of human activities on such flood plains, the floods become a cause of disaster. Over 40 million hectares, which is about 12% of the total geographical area of India, experiences periodic floods. The average area affected by floods annually in India is about 7.5 m. ha of which crop area is about 3.5 m. ha. Floods have claimed on an average about 1500 human lives and 94000 cattle ever year. The floods are also a cause of large-scale damages to forests & crops besides causing deaths of aquatic and wildlife, in various National Parks, delta region, low altitude hilly areas and alluvial flood plains of several Indian states like Assam, Arunachal, Uttrarakhand, U.P., Bihar, Orissa and West Bengal.

1.1 Flood Prone Area

The *flood prone area* may be a single index that may be useful in preliminary assessment of problem of flood in a region or country as a whole.

Rashtriya Barh Ayog (RBA – the Indian National Commission on floods) attempted in 1980 to project the picture of area liable to floods, using the data for the period 1953 to 1978. While assessing the area liable to floods as about 34 m. ha., the RBA recognized that annual flooding is not coextensive and that different areas are often flooded in different years by different streams. It further recognized that some protected areas in India till then could have been affected in some of the years on record. The 'protected area' till then was indicated by RBA as 10 m. ha. The area liable to floods was taken by it to be about 40 m. ha (instead of 44 got by adding 10 and 34 m. ha). Thus the figures of area prone to floods have not so far related the maximum area affected in a year with the probable return period of such flood and is more an estimate based on some judgement rather than a reliable basic data to prepare a Perspective Plan. Further, the assessment would change if the unit were changed to taluka/district.

1.2 Water Logging

Another important problem concurrently with flooding is water logging of flat land, such as the vast Indo-Gangetic plain and the deltaic area of main rivers such as Mahanadi, Godavari, Krishna and Cauvery and smaller rivers in the East Coast. The water logging is a consequence of -

1.2.1 Stagnation of rainwater during monsoon storms over flat areas primarily from lack of adequate capacity of outlet channels or adverse topography of the terrain. The extreme flat slopes even up to 1 in 10,000 to 20,000 in Punjab, Haryana, Uttar Pradesh, Bihar & West Bengal and deltaic area in the East Coast with slopes of 1 in 10,000 contribute to such condition.

1.2.2 Over bank spill of floodwater, which enters the unprotected area and stagnates over low lands and saucers in the basin and can not return back to the main river even after the flood recedes.

1.3 Flood Control Measures

The structural measures of flood management apart from constructing embankments include reservoirs, channel improvements, anti-erosion spurs etc. The non-structural measures include flood plain zoning, flood proofing, disaster preparedness, flood forecasting and warning etc.

1.3.1 Structural Measures

Major embankment projects taken up are on rivers Kosi and Gandak (Bihar), Godavari and Krishna (Andhra), Mahanadi, Subernaekha (Orissa) and Brahmaputra (Assam). These embankments played an important role in providing reasonable protection to affected areas, even with occasional breaches and other problem like drainage congestion, and enabled economic development.

There are few cases of reservoirs built only for flood control purpose. Multi-purpose reservoirs would involve a balancing of different interests like irrigation, power generation and flood control, which are often at variance with one another. The aim is to realize optimal benefits from the project as a whole. A reservoir is more effective for flood control if a designated space is reserved and a reservoir regulation arrangement is laid down. As far as possible, co-operation of existing reservoirs be planned in such a manner that flood moderation is achieved to the maximum extent even where no specific storage has been provided for flood cushion. There is opposition to water storage projects by environmental activists by exaggerating minor adverse environmental impacts while suppressing their tremendous beneficial socio-environmental impacts.

1.3.2 Non-Structural Measures

a) Flood Plain Zoning (FPZ)

The basic concept of FPZ is to regulate land use in flood plains to restrict flood damage by determining flood risk locations and their extent. It envisages limiting if not preventing, indiscriminate development in such areas so as to minimize the losses in the event of major floods, beyond what the protection measures are designed for or in case of their failure. Central Water Commission (CWC) of India has circulated essential features of flood plain management, to the State Governments apart from giving wide publicity in various fora.

The Working Group on flood control program for the 10th Five Year Plan of Government of India recommended that it would be best to seek flood management as an integral part of the package of measures that may include multipurpose storage dams, embankments, detention basin etc, as may be appropriate in specific cases. The emphasis is to work out a comprehensive strategy for the entire basin, including non-structural measures like flood plain zoning, flood forecasting and warning etc.

The Working Group also suggested enacting legislation to effectively ensure flood plain zoning. The areas, which are prone to floods of different return periods, can be first delineated and identified. It recommended that a Standing committee of experts should be set up to lay down detailed norms and prepare pilot flood risk and zoning maps for typical river basins /sub basins and generally monitor and guide the states in FPZ activities. It should comprise Central and State Officials as also outside experts and NGOs in addition to representatives of people living in flood-vulnerable areas.

The people and authorities concerned should be made aware of the risk of living in these flood plains and the consequences thereof. Instruments such as differential insurance rates, additional surcharge on the premium of properties in risk areas, etc. can be used for encouraging desirable measures and discouraging harmful ones.

b) Flood Forecasting

Flood forecasting is an important part of disaster preparedness under the non-structural measures of flood mitigation, which can reduce the potential flood damages considerably. Technical advancement can help in predicting the flood and giving a longer lead-time for action. Flood forecasting can be used as an important tool in taking up integrated development of the basin and meeting multiple demands. CWC has established a flood forecasting system covering 62 major rivers covering almost all the flood prone states of India that however needs to be modernized and strengthened.

1.4 Rashtriya Barh Ayog's Recommendations

The aspects emphasized by RBA- the National Commission on Floods, include the need to assess flood damage rationally; review the performance of embankment system and incorporating the same in the flood control plan of the State; coordination among concerned organizations to ensure reduction of flood problems; adoption of suitable flood control measures as a part of comprehensive planning for water resources. Preparation of contour maps for flood prone basins, studies of erosion patterns and project maintenance works etc. are also needed.

1.5 Disaster Preparedness

Developing nations, which can ill afford such disasters, are also the least prepared and as a result suffer the devastating impacts. The developments, if haphazard and on piecemeal basis, increase the vulnerability against natural disasters such as floods. The expenditure incurred in disaster preparedness is repaid several times over in savings of unbudgeted disaster relief and recovery expenses. Disaster Preparedness would minimize the impact of natural hazards like floods.

2. SEDIMENTATION DISASTERS

Sediment flow in rivers is a natural process caused by erosion, transportation and deposition of sediments. Civilization owes itself to this process as it came into being in the valleys of the Nile, Tigris, Euphrates, Indus and the Yellow rivers, brought about by the fertile deposits of these rivers. However what was a boon in that time & space has now acquired the dimensions of a disaster. This is especially true in the context of water storage projects. Loss of topsoil with the runoff from precipitation, loss of generated biomass by way of grazing, pilferage of firewood and brushwood for fuel etc. has been taking place at an alarming rate due mainly to various human factors. Reduction in vegetative cover by felling of trees and grazing makes the topsoil more vulnerable to the action of wind and rain. With the loss of topsoil, chances of survival of grass, herbs, shrubs, bushes and trees on the uncultivated land appreciably reduce, thereby exposing the soil to further degradation. This process continues in most of the watersheds, in the process of struggle for survival by the rural landless laborers in the vicinity. In the absence of such harmful intervention of human beings, natural degradation is a slow process and often restorative by nature. There is an obvious need to take steps to prevent such degradation of the catchment area.

Uncontrolled deforestation, forest-fires, over-grazing, improper methods of tillage, improper agricultural practices and various human activities are responsible for accelerated soil erosion. Due to impact of rain and water flowing over land surfaces, in gullies and stream channels, large quantities of top soil is eroded from the catchment and carried by the rivers, not all of which reaches the sea. Earthquakes, large-scale landslides and other activities such as cutting of forests, mining, road building and other construction activities accelerate this process.

Out of India's total land area of 329 million hectares, about 175 million hectares is prone to sediment erosion. It is estimated that about 6000 million tonnes of soil is eroded every year in India as a result of sheet erosion. Besides, gully and ravine erosion ravages 8000 ha annually. The sediment erosion and transportation causes serious problems such as loss of fertility of soil, reservoir sedimentation, channel aggradations, increase in peak flood flows, depletion of ground water flow etc. The 1950 earthquake of magnitude 8.6 on Richter Scale that occurred in the Indian state of Assam, brought so much sediment down the Brahmaputra river that some of the tributaries silted up and caused major changes in the morphology of the river. It also caused flooding in large portions of the Brahmaputra Valley in the next several years.

Sedimentation causes serious problems in engineering projects for irrigation, navigation, and hydropower development and flood control. Costly maintenance, loss of efficiency and in some cases, damage of important engineering works have been experienced due to deposition of sediments in reservoirs, navigation and irrigation channels. Depletion of storage in a reservoir on account of sediment deposition causes many problems. Besides, storage loss which is of much economic significance, there are planning and operational problems due to silting of reservoirs. The entry of sediments in the canals or in the turbines may cause serious operational problems as well as sometimes jamming of hydraulic gates.

Various measures for watershed development and catchment area treatment are undertaken in India for soil and water conservation which help in prolonging life of storage reservoirs, reduction in watershed degradation, improving fertility of soil, augmenting supply food, fodder and fuel, moderating floods and enhancing total production, employment and income.

3. WATER RESOURCES OF INDIA AND WATER SHORTAGES

India experiences extremes of climate. Normal annual rainfall varies from 100mm in Western Rajasthan to over 11,000mm at Cherapunji, in the northeastern part of the country. The annual average rainfall is of the order of 1,170mm, which together with snow melt yields nearly 4,000km^3 of water. After deducting for infiltration and evaporation, the average surface flow in the river systems of the country is estimated at 1,869 km^3. The constraint in exploiting the available water is that the major part of the flows occurs as floods during short periods and there are obvious limitations in storing all the quantity. The utilizable surface flow is estimated at 690km^3. The utilizable groundwater potential is estimated at 432 km^3. Thus, the total utilizable water resources of the country are about 1,122km^3.

3.1 Water resources assessment

(a) Surface water

Out of the average annual flow of 1,869 km^3 a live storage of only 171 km^3 of water has been developed through about 3,000 large dams. An additional live storage of 3 km^3 is estimated to have been created through medium projects, each having a capacity less than 10 million m^3. Thus, the total live storage is about 174 km^3 at completed projects. Dams to create additional live storage of 72 km^3 are now under construction and for 132 km^3 are being planned. With the live storage of 25 km^3 of minor tanks, the ultimate live storage would be 403 km^3, which would be around 22 per cent of the average annual flow of the rivers.

The Central Water Commission, Government of India has a network of 877 key stations through the country in collect and compile hydrological data, as well as to take measurements of river flows on a regular basis. In addition, silt observations and water quality observations are made at a few selected sites. Most of the hydrological data collection activity is manual, though automation has been introduced at some of the stations. Snowmelt and glacial ice melt provide a major part of the run off in the mountainous areas of the Himalayas. The snow melt forecasts provide an important input to the river management. Remove sensing techniques have been found useful in predicting the snowmelt run off.

To improve India's institutional and technical capability to measure, collate, analyze, disseminate and use data concerned with quantities and qualities of surface and ground water, including the use of data for hydrological design a project entitled "Hydrology Project" is being implemented in peninsular river basins of India under the World Bank Assistance.

(b) Groundwater

With the increased emphasis on groundwater in the last few years, a scientific assessment of the groundwater potential of the country was undertaken and extensive exploration work was carried out in the country. In the reassessment based on guidelines laid down by a Ground Water Estimation Committee of 1984 and the additional available data, the annual replenish able ground-water is estimated as 432 km^3. The present annual utilization is 115 km^3 through 15.3 million groundwater structures. A hydrographic network of about 15,000 stations monitors the levels and the quality of groundwater. Monitoring shows that some areas as exhibiting signs of over-exploitation. There is a proposal to extend the network to 17,000 stations.

(c) Need of Storage Dams

It must be noted that future demands of water can be met only by exploiting almost all the 1122 bcm of utilizable water by conventional means. It would thus be essential to utilize the entire 690 bcm of the utilizable flows for which storages of the order of 400 b.cu.m will have to be created. Water demands forecasts show that Rajasthan, Maharashtra, Gujarat, Haryana, Karnataka and Tamilnadu could face heavy water supply shortfalls. The water shortages would be far more serious in the water short basins like the Cauvery, Pennar, Sabarmati, Mahi, and Krishna etc. To meet the bulging water requirements, it would be necessary to ensure substantial augmentation of water supplies; requiring sufficient raising of water storage capacities, thus necessitating completion of new large water storage projects.

The recent Supreme Court Judgement for Narmada Projects has also highlighted that against the utilisable storage 690 cu. km. of surface water resources out of 1869 cu. km.; so far storage capacity of all dams in India is only 174 cu. km., which is incidentally less than the capacity of Kariba Dam in Zambia/Zimbabwe with a capacity of 180.6 cu. km. and only 12 cu. km. more than the Aswan High Dam of Egypt. The impact on environment should be seen in relation to the project as a whole. Water of poor quality leads to ill health, whereas water in insufficient quantity claims large chunks of time spent in augmenting the supply; otherwise, the significant time could be spent on more remunerative tasks.

3.2 National Water Policy - 2002

National Water Policy was first adopted in 1987. Since then a number of issues and challenges have emerged in the development and management of the water resources. Therefore, The National Water Policy has been reviewed and updated in April 2002.

National Water Policy - 2002 sets out the following water allocation priorities: (1) drinking water; (2) irrigation; (3) hydropower; (4) ecology, (5) Agro-industries and non-agriculture industries (6) navigation and other uses. Its highlights are given below:

- Water is a scarce and precious natural resource, to be planned, developed conserved and managed as such, and in an integrated and environmentally sound basis, keeping in view the socio-economic aspects and needs of the states. Efforts to develop, conserve, utilize and manage this crucial resource in a sustainable manner have to be guided by the national perspective.
- Water resources development and management is to be planned for a hydrology unit, such as a drainage basin as a whole or for a sub-basin, multi sectorally, taking into account surface and ground water for sustainable use incorporating quantity and quality aspects as well as environmental considerations. Individual development projects and proposals should be formulated within the frame work of over all plan keeping in view the existing agreements/ awards for a basin/sub-basin for optimal results.
- Water resources projects involve a number of socio-economic issues such as sustainability, appropriate resettlement and rehabilitation of project-affected people, public health concerns of water impoundment, dam safety etc. Problems of water logging and soil salinity have emerged in some irrigation commands, leading to the degradation of agricultural land. Complex issues of equity and social justice in regard to water distribution are required to be addressed. The development and over-exploitation of groundwater resources in certain parts of the country have raised the concern and need for

judicious and scientific resource management and conservation. All these concerns need to be addressed on the basis of common policies and strategies.

- Improvements in existing strategies, innovation of new techniques resting on a strong science and technology base are needed to eliminate the pollution of surface and ground water resources, to improve water quality. Science and technology and training have to play important roles in water resources development and management in general.
- Water resource development projects should as far as possible be planned and developed as multipurpose projects. Provision for drinking water should be a primary consideration. The study of the likely impact of a project during construction and later on human lives, settlements, occupations, socio-economic, environment and other aspects shall form an essential component of project planning. In the planning, implementation and operation of a project, the preservation of the quality of environment and the ecological balance should be a primary consideration.
- The adverse impact on the environment, if any, should be minimized and should be offset by adequate compensatory measures. The project should, nevertheless, be sustainable.
- The planning of projects in hilly areas should take into account the need to provide assured drinking water, possibilities of hydro-power development and the proper approach to irrigation in such areas, in the context of physical features and constraints of the basin such as steep slopes, rapid run-off and the incidence of soil erosion. The economic evaluation of projects in such areas should also take these factors into account.
- Special efforts should be made to investigate and formulate projects either in, or for the benefit of, areas inhabited by tribal or other specially disadvantaged groups such as socially weak, scheduled castes and scheduled tribes. In other areas also, project planning should pay special attention to the needs of scheduled castes and scheduled tribes and other weaker sections of the society. The economic evaluation of projects benefiting such disadvantaged sections should also take these factors into account.
- The drainage system should form an integral part of any irrigation project right from the planning stage.
- For construction of storage and the consequent resettlement and rehabilitation of population a skeletal national policy needs to be formulated so that the project-affected persons share the benefits. States should accordingly evolve their own detailed resettlement and rehabilitation policies, taking into account the local conditions. It is to be ensured that the construction and rehabilitation proceed simultaneously and smoothly.
- Both surface water and ground water should be regularly monitored for quality. A phased programme should be undertaken for improvements in water quality. Effluents should be treated to acceptable levels and standards before discharging them into natural streams. Minimum flow should be ensured in the perennial streams for maintaining ecology and social considerations. Principle of 'polluter pays' should be followed in management of polluted water. Preservation of existing water bodies by preventing encroachment and deterioration of water quality.
- Efficiency of utilization in all the diverse uses of water should be optimized and an awareness of water as a scarce resource should be fostered. Conservation consciousness should be promoted through education, regulation, incentives and disincentives. The resources should be conserved and the availability augmented by maximizing retention, eliminating pollution and minimizing losses. For this, measures like selective linings in the conveyance system, modernization and rehabilitation of existing systems including

tanks, recycling and re-use of treated effluents and adoption of traditional techniques like mulching or pitcher irrigation and new techniques like drip and sprinkler may be promoted, wherever feasible.

- There should be a master plan for flood control and management for each flood prone basin. Adequate flood-cushion should be provided in water storage projects, wherever feasible, to facilitate better flood management. In highly flood prone areas, flood control should be given overriding consideration in reservoir regulation policy even at the cost of sacrificing some irrigation or power benefits.
- From the present emphasis on the creation and expansion of water resources infrastructures for diverse uses, there is now a need to give greater emphasis on the improvement of the performance of the existing water resources facilities. Therefore, allocation of funds under the water resources sector should be re-prioritized to ensure that the needs for development as well as operation and maintenance of the facilities are met.
- For effective and economical management, the frontiers of knowledge need to be pushed forward in several directions by intensifying research efforts in various areas, such as - hydrometeorology; snow and lake hydrology; surface and ground water hydrology; river morphology and hydraulics; assessment of water resources; water harvesting and ground water recharge; water quality; water conservation; evaporation and seepage losses; recycling and re-use; better water management practices and improvements in operational technology; crops and cropping systems; soils and material research; new construction materials and technology (with particular reference to roller compacted concrete, fiber reinforced concrete, new methodologies in tunneling technologies, instrumentation, advanced numerical analysis in structures and back analysis); seismic design of structures; the safety and durability of water-related structures; economical designs for water resource projects; risk analysis and disaster management; use of remote sensing techniques in development and management; use of static ground water resource as a crisis management measure; sedimentation of reservoirs; use of sea water resources; prevention of salinity ingress; prevention of water logging and soil salinity; reclamation of water logged and saline lands; environmental impact; regional equity.

In summing up the National Water Policy emphasizes the vital importance of water for human and animal life, for maintaining ecological balance and for economic and developmental activities of all kinds. Considering its increasing scarcity, the planning and management of this resource and its optimal, economical and equitable use has become a matter of the utmost urgency. Concerns of the community need to be taken into account for water resources development and management. The success of the National Water Policy will depend entirely on evolving and maintaining a national consensus and commitment to its underlying principles and objectives. State Water Policy backed with an operational action plan shall be formulated in a time bound manner say in two years.

4. WATER CONTAMINATION AND DAMAGE TO ECO SYSTEMS:

4.1 Water Pollution

The growth of urban megalopolis, increased industrial activity and dependence of the agricultural sector on chemicals and fertilizers has led to the over loading of the carrying capacity of our water bodies to assimilate and decompose wastes. The increasing discharge of domestic and industrial wastes has also led to the contamination of ground water, making it unfit for human consumption at many places. It is estimated that 80% of all diseases and over $1/3^{rd}$ of deaths are caused by consumption of contaminated water and on an average as much as $1/10^{th}$ of each person's productive time is sacrificed to water related diseases.

4.2 Protection of Natural Water Resources

Responsibility should be assigned to various civic and industrial authorities to treat the wastewater before disposing it in conveyance drains or natural streams. Water quality should be monitored regularly at every outfall drain. State wise river basin conservation plan should be formulated for different basins. The pathogenic, toxic and biological, physical and chemical effects of various types of water pollution in different scenario and regions should be scientifically analyzed, collated, understood and suitable action plans should be framed.

4.3 Water Quality Improvement

Strict environmental laws (command and control measures) or market – based instruments for controlling water pollution must be scrupulously applied and implemented to large and medium scale enterprises. Common effluent treatment plants (CETPs) can provide a viable solution to the problem of water pollution by small scale industries, which are not able to bear the cost of treatment of their effluents on an individual basis. We should strive hard for strengthening of monitoring capabilities of various organizations regular monitoring of discharges by firms and public access to information on discharge by polluters and ambient air & water quality.

4.3.1 Water quality criteria

Any stretch of river or coastal water may be subjected to more than one organized use. The list contains irrigation, drinking, industry, power generation, fisheries and wild life propagation, navigation, recreation and aesthetics, and even receptacle for treated wastes. In any stretch there would be one use which would be demanding the highest quality of water and that stretch is designated by that best water quality use (designated best use). The recognized designated best uses along with nomenclature (class of water) are listed in table 1. Based on critical analysis of water quality carried out by them the Central Pollution Control Board (CPCB) has classified four rivers as in table 2.

Table 1. The recognized designated best uses along with nomenclature (class of water)

Designated best use	Nomenclature (class of water)
Drinking water source without conventional treatment but after disinfection	A
Outdoor bathing	B
Drinking water source with conventional treatment followed by disinfection	C
Fish culture and wild life propagation	D
Irrigation, industrial cooling or controlled waste disposal	E

Table 2. Classification of critical rivers in India

River	Total length (km)	% of length in various categories				
		A	B	C	D	E
Ganga	2,525	--	11	56	33	--
Yamuna	1,376	--	36	64	--	--
Brahmi	799	--	23	77	--	--
Subarnarekha	395	--	--	90	--	10

4.3.2 Ganga Action Plan Phase-I

The Ganga Action Plan Phase-I was initiated in February, 1985 to combat the problem of pollution of the Ganga. The Action Plan envisaged diversion and treatment of domestic wastes in 27 important towns situated along the river. In all, 261 schemes were undertaken for sewage interception and diversion, sewage treatment, low cost sanitation measures, electric crematoria and river front development. The various schemes have been aimed to reduce the pollution in the Ganga by atleast 75 per cent. Of the 261 schemes, 211 have been completed by now and the remaining are expected to be completed in the next two years.

4.7.3 Ganga Action Plan Phase-II

The second phase of Ganga Action Plan (GAP) for pollution abatement of Yamuna and Gomti rivers at an estimated cost of Rs. 4,210 million has been approved. The second phase of GAP has also envisaged formulation of Action Plan for Pollution Abatement of River Damodar. The works that were required but were not included in the first phase of GAP are proposed to be covered under this phase.

4.7.4 National River Action Plan

An approach paper on the National River Action Plan (NRAP) has been approved by government at an estimated cost of Rs.10,000 million spread over a period of 100 years. NRAP will include grossly polluted stretches of all those rivers of the country not covered in the GAP Phase I and II.

4.8 Environmental Aspects

India is a land of rivers having predominantly agriculture based economy. Development of a river valley projects has become a lifeline of progress and prosperity of the country. Water Resources Development (WRD) Projects are indispensable as they are inextricably linked to the country's economy besides their need for the welfare of the people. However, in the last two decades, a very strong opposition has been voiced to the construction of large dams arguing that irreparable damage to the environment may result due to such projects. On the one hand a fear syndrome has been created in recent years against WRD projects by exaggerating the likely or assumed adverse environmental impacts and by ignoring or suppressing their tremendous benefits. On the other hand, controversial debates are generated on the grounds that the possible environmental impacts are not properly evaluated in many projects. As a result, many potential economic development activities, which could generate wealth and employment to people have been blocked in several large cities, towns and villages due to acute shortage of water especially during the dry season. At the same time, progress floods routinely continue to affect the economic causing large scale loss of lives and properties.

4.8.1 Rehabilitation & Resettlement

The problem relating to resettlement and rehabilitation (R&R) are far more complex than are generally perceived by the public policy makers or the project implementing authorities. The objective of any R&R package should be to provide the same quality of life, if not better to the affected persons than what they have been enjoying before displacement. Generally suitable compensatory measures such as providing alternative land to the affected persons should be made. Unfortunately some projects had to be shelved on this account alone. An argument is made that the tribal population should not be displaced at all, as they cannot adapt in a different environment. This approach may result in perpetuation of their backwardness. Experience in the northeastern region indicates that the tribal people definitely want water storage projects for bringing in overall economic prosperity to them. Awareness and persuasive approach are needed to tackle this problem. At the same time the rehabilitation packages should provide for more than one option and be made attractive enough at a fractional cost of the project benefits, so that affected people are induced to accept them.

Meanwhile, the construction of multi-purpose projects like Sardar Sarover and Tehri Dam attracted the attention of a large number of Non Governmental Organizations (NGOs) both in India and abroad, mainly on the issue of R&R. There has been an adverse publicity regarding these projects, particularly relating to the problems in proper implementation of the resettlement and rehabilitation of PAPs.

Government of India has recently evolved a draft National Policy for R&R of displaced people to help the State/Project authorities in expediting construction activities. The policy is under consideration for adoption.

4.8.2 Safety of Water Resources Projects:

There are about 3,600 dams in India of which more than 2,300 are of 15m and more in height. 45 of them have been classified as dams of national importance that have heights of 100m and above and/or having storage capacities of 1 cubic km or more. The Dam Safety Organization in India was created in Central Water Commission in the year 1979 to assist the state governments to locate the causes and potential distress areas that could affect the safety of dams and allied structures.

Reservoir induced seismicity is generally considered as a source of the man made disaster associated with the creation of a reservoir. Koyna dam in Maharashtra is often cited as an example. Though it has not been conclusively proved that the creation of reservoir induces seismicity, yet as a precautionary measure a number of seismological stations are set up at the dam sites for observations and analyzing the results for planning necessary preventive measures. Dams are also designed to withstand the seismic forces considering the maximum design flood. Dam break analysis is also carried out as an integral part of the design activity of large storage structures so as to plan and take necessary mitigation measures in the event of occurrence of unlikely disaster.

4.8.3 Flora and Fauna

In case some unique or endangered species of flora and fauna are threatened by the project, suitable measures are to be taken for their rehabilitation. Similarly, if the project interferes with wild life migration, suitable arrangements ought to be made for their habitat. An extremely rare step for environmental protection would be to abandon a project, if it endangers rare species of plants or animals, in order to preserve the natural heritage. However, as the project submerges only a small fraction of forestland, it should be feasible that the endangered species of plants or animals are provided for in the vicinity of the project in the same watershed. Gene banks to preserve Species and to regenerate them in favorable conditions, elsewhere, are also possible.

Silent Valley project in Kerala, though a promising project planned to develop hydropower, was shelved, as it was affecting prime virgin forest with rare species of plants. On a positive side Heran reservoir in Gujrat which provided assured water enough for wild life has actually helped in population growth of wild life and crocodiles which were on verge of extinction. Pong reservoir is now acting as a resting place for migratory birds and number of rare species of birds have now been sighted in these areas. Water reservoir projects have in general enhanced the natural environment for development of flora & fauna in its vicinity.

Significant increase in the numbers of tigers, panthers, elephants and Cheetals have been observed in the famous Jim Corbett National Park with the availability of green fodder, clean water throughout the year and improved climatic conditions after construction of the Ramganga Multipurpose Dam Project. Rare species of birds also flock there. Similar phenomenon of an increase in birds and wildlife has also been observed around the Rihand and Matatila reservoirs, which were previously barren lands. Some of the best tourist places of India like Ukai tourist resort, Periyar wild life sanctuary, Shalimar garden, Brindavan garden, Pinjore garden, Kalindi-Kunj, Matatila Garden, Dhyaneshwar Udyan and the Ramganga Udhyan are the bye-products of river valley projects.

4.9 Water Conservation & Improving Water Use Efficiency

In almost all major urban centres there is an acute problem of adequate water supply while the sources of augmentation are very few. It is roughly estimated that in urban water supply, 30 to 40 % of the municipal water is wasted through the distribution system. In Industrial sector too, there is a scope of economy in use of water. It is estimated by Bureau of Industrial Costs and Prices that 10 to 30% saving in water consumption in industries is possible by recycling, modifications in processing, evaporation control etc. Apart from ensuring leakage control, water conservation strategy in industries should include introduction of appropriate technology to ensure efficient use of cooling and process water and necessary pollution control mechanisms and maximum recycling and reuse.

In irrigation, the efficiency of water use can be increased by improved methods of irrigation such as drip and sprinkler irrigation and by careful planning of conjunctive use of ground water with surface water. Linking of canal distributaries are also tools for controlling water losses. In the industrial sector there is a vast scope of water saving by recycling and reuse of the wastewater.

5. OTHER WATER RELATED PROBLEMS

5.1 Reuse and Recycling of Water

The water intake by the industries is affected by the extent to which water is reused. Reuse is common in large-scale industries using substantial quantities of water. Pollution of water by the effluents discharged by the industries is a serious hazard increasingly being faced by the country. Although fresh water is a renewable source, generation of new and complex wastes by industries is adding to the complexity of water pollution. Both surface water and ground water are affected by such pollution.

Recycling and reuse of wastewater is, therefore, being increasingly resorted to wherever fresh water supplies are inadequate. Wastewater discharged by an urban center or an industry at a particular point in a river gets diluted by the river and another city or industry on the downstream draws the river water and uses it after the necessary treatment. This is generally referred to as indirect reuse. Apart from this, even within an industry a certain amount of water is normally recycled after necessary treatment for specific purposes. A high percentage of demand for industrial water is for cooling purposes. Recycle of industrial processed water should be introduced for cooling purposes wherever economically feasible, since cooling can tolerate low quality of water. Reuse of processed water reduces fresh water consumption as well as the quantity of wastewaters.

Treating municipal wastewater and reusing it for industrial purposes has been successfully accomplished by certain industries in the city of Mumbai. Other cities are now being encouraged adopting the same as far as feasible.

5.1.1 Options and Initiatives

There are various options for recycling and reuse of grey water (bathroom and kitchen wash) and black water (sewage). However, the grey water and black water from large residential complexes like Cooperative Housing Societies, multistoried buildings and industrial effluents from large industries can be recycled and reused for various purposes other than drinking.

The grey water may be put into various types of treatment such as grease trap, anaerobic filter etc and the filtered water may be let into wet land, polishing ponds etc. and can be reused for gardening and horticulture etc. The black water may also be put into various types of treatment such as screen, grit removal primary, secondary and tertiary treatment etc. and the treated waste water can be let into wet land for irrigation or for ground water recharge.

The State Governments may create Urban Development Fund for Urban Infrastructure development and the same can also be used for setting up of pilot projects for waste reuse, recycling and resource recovery.

5.1.2 Incentives and Legal Aspects

Suitable fiscal concessions and subsidies may be considered by the Central and State Governments to the industries, commercial establishments and any other agencies which adopt/practice waste reuse, recycling and resource recovery. Similarly, in case the Urban Local Bodies on their own would like to take the initiative and set up waste reuse, recycling and resource recovery schemes in their respective areas, similar fiscal concessions and subsidies may also be made available to them by the Central and State Governments. In fact, it may be made mandatory in phases that large industry and commercial establishments must meet a sizeable percentage of their non-potable water requirements from the reclaimed water. Similarly, for irrigating crops, horticulture, watering public lawns/gardens, flushing of sewers, fire-fighting etc. reclaimed water should only be used and to this effect, there is a need for legislation or amendment in the municipal bylaws.

5.2 Questionable Use of Water as a Carrier of Wastes

Removing wastes from industries, and homes by using water as carrier over long distances, to extract most of the waste in the sludge, and then leaving polluted water as effluent, need to be closely examined. Better alternatives need to be found to treat the waste at its origin, without using so much water. Use of low flushing and dry toilets as well as use of 'grey water' drained from showers, kitchens and laundries to flush the toilets, should be targeted for adoption in at least in all new construction of commercial institutions and planned colonies in all class I and II cities We have to adopt water sensitive urban planning so that rainwater is used adequately and the runoff from impervious areas, such as car parks, roads and footpaths can be infiltrated into the aquifer after ascertaining its quality without endangering the aquifer.

5.3 Archeology and Heritage

At times mineral deposits, archaeological monuments or shrines are threatened by submergence due to reservoirs. Mineral wealth can be exploited to the possible extent before inundation. It is also possible to protect the mineral wealth and monuments falling in the shoreline zones by constructing ring bunds.

Sometimes historical and cultural monuments may fall in the submerged area of a reservoir. The temple of Abu sibel in Egypt and the Nagarjunkonda in India are living examples of how ancient monuments have been saved and given a greater lease of life. Many temples have been successfully shifted with religious fervour in the Bargi, Srisailam and Sardar Sarovar projects. The Jyotirling temple has been preserved in the planning of the Omkareshwar Dam and improvement in the approach roads and bridges would also be integrated with the project. Similarly, Dargah at Galiakot, which would have come under submergence of Kadana reservoir on the river Mahi in Gujarat, was protected from submergence by constructing a ring bund. Srisailam, Narayanpur and Almatti reservoirs are good examples; where historical monuments have been rehabilitated successfully.

CONCLUSION

A balance between the thrust areas of development (infrastructure and consumer goods), which are said to improve the quality of life, and the social aspects like bare necessities of life in the areas of water, food, fiber, power, education, health, housing and nutrition is needed. The media plays an important role in shaping the thoughts of the people, and it should set its focus right to set the agenda and making the society conscious through balanced & informed public debate. Due to the large temporal variations in river flows, storage of water becomes inevitable. Non-development of water storage projects is not a viable or available option. It is imperative that conservation, recycle, reuse of precious water and proper treatment of wastewater are given serious attention for sustainability of built environment for our highly populated country.

While water is a medium for the transmission of water borne diseases; water is also a primary contributor to the control of infectious diseases through its use for personal and domestic hygiene. Availability of water in India is under tremendous stress due to growing population, rapid urbanization, industrial growth and other demands for maintaining ecology. Integrated water management is of vital importance for poverty reduction, environmental sustenance and sustainable economic development in India because water has the potential for both disease causation and prevention.

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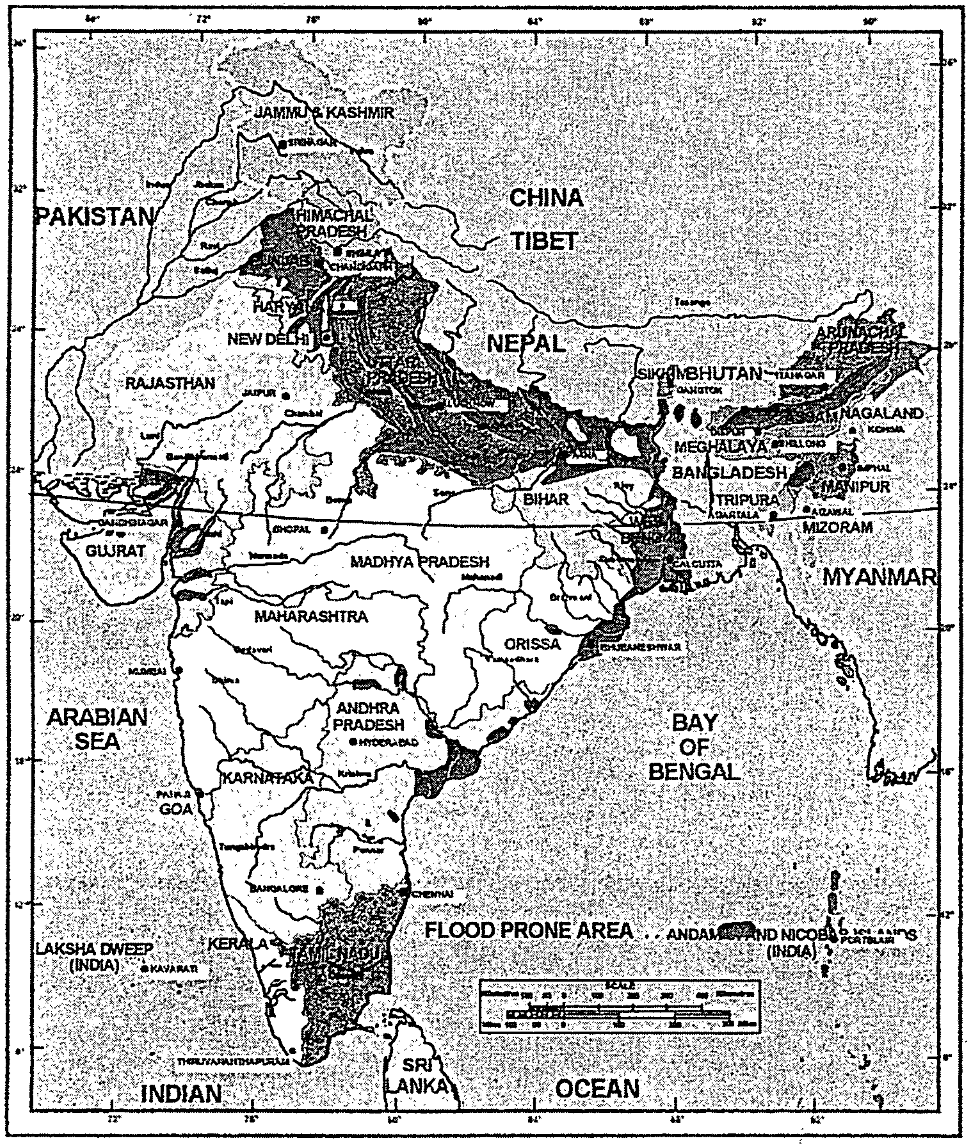
AREA LIABLE TO FLOODS



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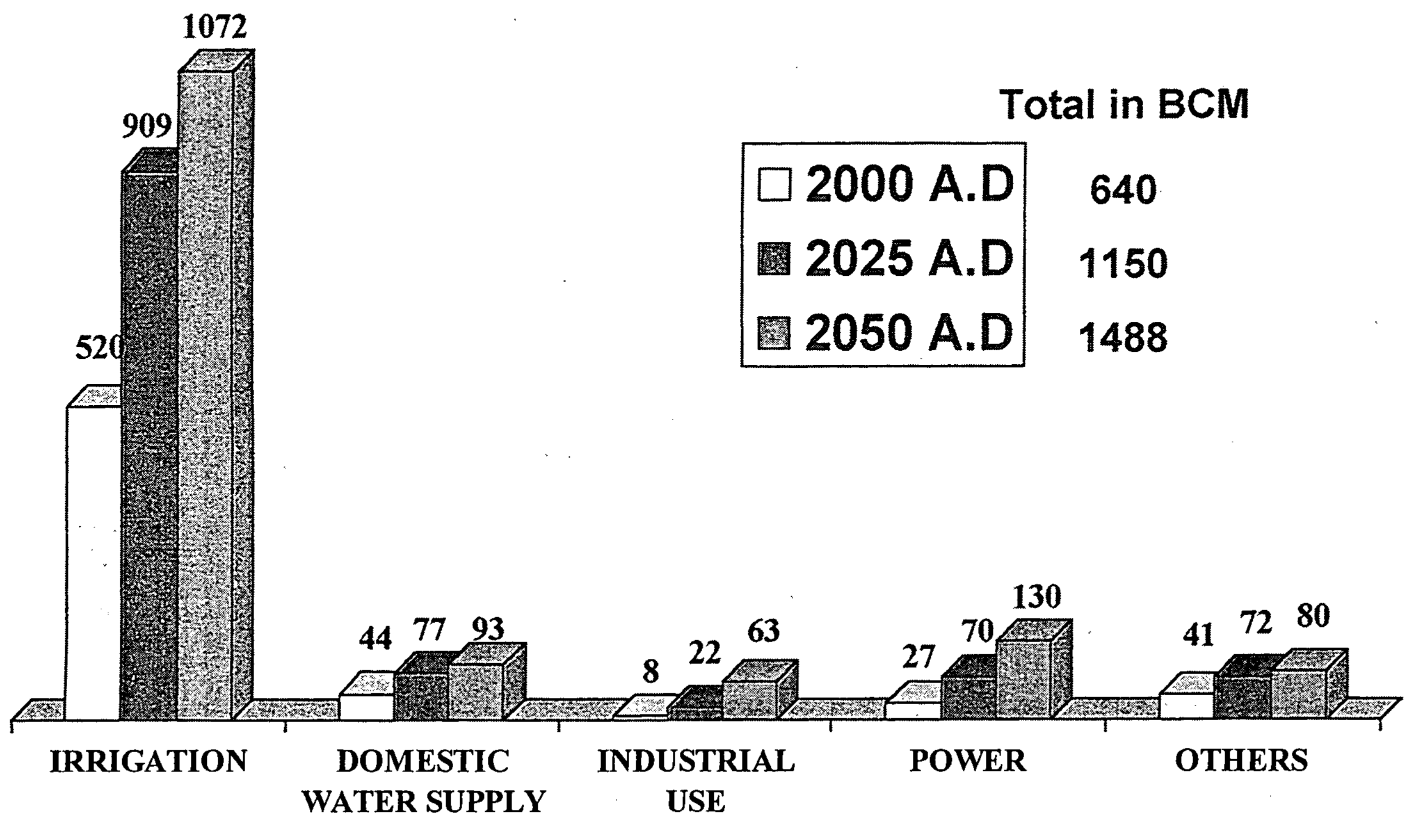

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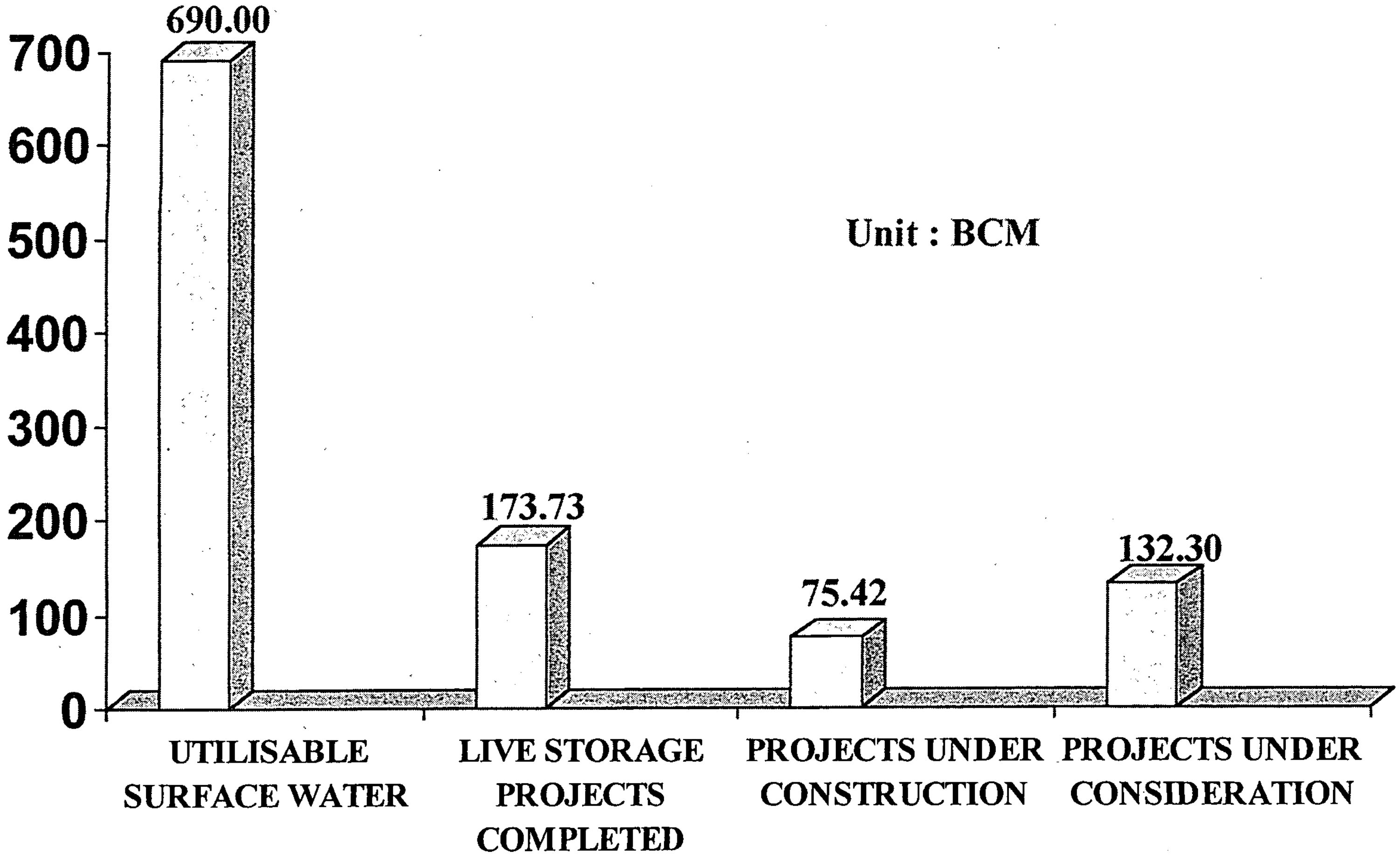

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