LECTURE-1

An Overview of Lakes and Their Management: The Indian Scenario

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INTRODUCTION

There is no specific definition for Lakes in India. The word "Lake" is used loosely to describe many types of water bodies – natural, manmade and ephemeral including wetlands. Many of them are euphemistically called Lakes more by convention and a desire to be grandiose rather than by application of an accepted definition. Vice versa, many lakes are categorized as wetlands while reporting under Ramsar Convention.

India abounds in water bodies, a preponderance of them manmade, typical of the tropics. The manmade (artificial) water bodies are generally called Reservoirs, Ponds and Tanks though it is not unusual for some of them to be referred to as lakes. Ponds and tanks are small in size compared to lakes and reservoirs.

While it is difficult to date the natural lakes, most of the manmade water bodies like Ponds and Tanks are historical. The large reservoirs are all of recent origin. All of them, without exception, have suffered environmental degradation. Only the degree of degradation differs. The degradation itself is a result of lack of public awareness and governmental indifference. The situation is changing but slowly. Environmental activism and legal interventions have put sustainability of lakes in the vanguard of environmental issues.

A lake is a reflection of its watershed. Precipitation on the land that does not infiltrate the soil or collect in pools flows downhill, collecting in streams and rivers, which may in turn flow into lakes or reservoirs farther downstream. In this way, the nature of the landscape—topography, soils, geology, and vegetation covering—influences the kinds of materials carried by surface-water runoff. When humans disturb the natural, protective vegetative cover of the landscape with homes, roads, farms, or other features, the types and amounts of materials dissolved or carried by runoff change significantly. For example, water draining urban areas typically contains metals such as lead and zinc, lawn fertilizers and pesticides, bacteria from pets, and automotive pollutants from parking lots and roads. Likewise, runoff from agricultural fields often contains nutrients, pesticides, and, if livestock are present, bacteria. Contaminants originating from such diffuse sources are called nonpoint-source pollutants. Some wastes enter water from a pipe or other defined location called a point source; hence, the waste is called a point-source pollutant.

Factories and wastewater treatment facilities, for example, produce wastes containing nutrients, metals, pesticides, and other chemicals that, when discharged into water, can pollute downstream lakes. Human wastes are the primary contributor to eutrophication, the most pervasive of water quality problems in lakes. Humans also are directly responsible for two additional stresses on lakes: overuse and exotic (or invasive) species.

This paper is an attempt at presenting a comprehensive view of the typical problems experienced in the better known lakes, their present environmental status and efforts being made to make them environmentally sustainable.

Data

India is well known for the huge variance in its lakes, but the data is nebulous. There is no orderly or scientific census of lakes. Though there is a distinction between fresh water lakes and brackish water lakes, just as the lakes of southern peninsular India are distinct from those of the Himalayan region and natural lakes from manmade reservoirs, there is no scientific evaluation. Most of the large reservoirs (formed by construction of dams) have been constructed during the last 50 years. It is, therefore, possible to access their data, though not always easily. Reservoirs include tanks which are, however, not properly accounted though estimated at over half a million in number spread all over the country, predominantly in southern India.

The water spread areas of rivers; lakes, reservoirs, and brackish water have not been comprehensively surveyed. The Table at Annexure-1 gives an overview of the same.

Classification of Indian Lakes

There is no unique or rigid classification. It depends on the context and the classifier. The commonly perceived classifications are the following:

- Geographical classification like Himalayan, Peninsular, Coastal etc.
- Liminological Classification like Fresh Water, Brackish Water etc
- Functional classification like Irrigation, Water Supply, Hydropower etc.
- Water quality classification
- Management classification

For the present review, the last classification under the following broad categories is relevant:

- Urban Lakes
- Non-Urban Lakes:
  - Inland Fresh water
  - Inland Brackish water
- Sacred Lakes/Tanks
- Coastal Estuarine lakes
- Ephemeral Lakes

Urban Lakes are however, only a subset of all fresh water bodies, i.e., Reservoirs, Lakes, Ponds, Tanks, etc. Annexure-2 gives a list of lakes restored, under restoration and in need of restoration.

ENVIRONMENTAL STATUS OF LAKES IN INDIA

The lakes and reservoirs, all over the country without exception, are in varying degrees of environmental degradation. The degradation is due to encroachments eutrophication (from domestic and industrial effluents) and silt. There has been a quantum jump in population during the last century without corresponding expansion of civic facilities resulting in lakes and reservoirs, especially the urban ones, becoming sinks for contaminants. The main causes for the impaired conditions of the lakes could be summarized as under.

Pollutants entering from fixed point sources

- Nutrients from wastewater from municipal and domestic effluents
- Organic, inorganic and toxic pollution from industrial effluents
- Storm water runoff.

Pollutants entering from non- point sources

- Nutrients through fertilizers, toxic pesticides and other chemicals, mainly from agriculture runoff
- Organic pollution from human settlements spread over areas along the periphery of the lakes and reservoirs

Other basin-related causes of impairment

- Silting of lakes on account of increased erosion as a result of expansion of urban and agricultural areas, deforestation, road construction and such other land disturbances taking place in the drainage basin
- Diversion of rivers feeding the lakes reducing their sizes
- Competition for using lake water such as for drinking, irrigation, hydropower etc.,
- Untreated or inadequately treated domestic and industrial effluents from point sources located all over the basin
- The degree of the problems varies from lake to lake, but is more pronounced in urban lakes, as brought out in the following sections.

Status Review

The status of important lakes and reservoirs spread all over the country and the management measures undertaken to prevent their further degradation and to restore them are briefly explained in the following sections. These water bodies have received the attention of National and International organizations, NGOs and Courts.

IDENTIFIED PROBLEMS

The human settlements and public effluent sources are the chief factors for the degradation of lakes, particularly the urban lakes. A lake front property has societal prestige, which causes intense shoreline development in urban centres and thus adversely impacts on the lake water quality. The anthropogenic pressures in the catchment itself has resulted in degradation of the catchment area due to deforestation, extensive agricultural

use and consequent erosion and increased silt flows, which have vitiated the quality of water stored in the lakes. Infrastructure development, housing pressure and encroachments have resulted in converting all urban lakes into hyper eutrophic state. Most urban lakes and rural lakes have vanished under this pressure. In the lakes, which have survived, the drinking water supply has been substantially reduced or become totally non potable, flood absorption capacity impaired, bio- diversity threatened, and livelihood of fisher folks affected. Reduction in the Osmansagar and Himayatsagar Lakes which are sources of drinking water supply to Hyderabad in Andhra Pradesh, Udaipur lakes in Rajasthan, Nainital lakes in Uttaranchal, etc are a few examples.

The water quality of urban lakes has deteriorated so much as to cause serious disturbance to the bio-diversity of the lake environment. Bio-remedial measures alone as in the case of the Powai lakes in Mumbai, the Kodaikanal and Ooty lakes in Tamil Nadu, etc., have been unable to achieve lake equilibrium in full.

Growth of water hyacinth has been prolific in many lakes resulting in breeding of vectors and consequently causing endemic diseases; Loktak Lake, Bhopal lakes, Ropar Lake, Sukna lake, Kanjli lake, and Pong dam lake are classic examples.

Cultural siltation in the form of immersion of Idols during specific festivals, an annual feature in India, has been a source of serious metallic pollution of lakes. Examples of such actions are the Bhoj Wetlands, the city lakes of Bombay, Hyderabad, Bangalore etc.

In many lakes, the uncontrolled tourist pressure has resulted in disturbance to the bio-diversity of flora and fauna, which thrive on the lake. Examples are the high altitude lakes of Tsomori, Pongsho, Dal, etc.

The coastal lakes have been seriously affected due to an imbalance in salinity levels. This is attributed to lack of balance between fresh water from the inland catchment of the lake and entry of the seawater into the lake at the mouth of the estuary. Examples are the Chilika in Orissa, the Pulicat in Tamil Nadu, the Kuttanad Lake in Kerala, and Kolleru Lake in Andhra Pradesh. Location of satellite ports, chemical industries, thermal power plants have also contributed to siltation and pollution, as in the case of the Pulicat Lake.

Water shortages in the lakes, with sources of replenishment seriously impaired, have resulted in bird sanctuaries and fisheries getting affected seriously. Examples are the Keoladeo National Park (Bharatpur Lake), the Nalsarovar Bird Sanctuary Lake, Dal Lake etc.

In spite of taking several engineering measures, the ephemeral lakes in the flood plains of the Ganga and Brahmaputra river basins are not providing the desired economic benefits to the large population dependent on them for livelihood.

Montraux Record

The problems in Chilika, Loktak, and Keoladeo lakes were so severe that they were put on the "Montraux Record of lakes" based on their high degree of pollution and environmental /ecological deterioration. The purpose was to undertake urgent remedial measures for their conservation, supplemented with adequate monitoring. Chilika has been recently taken out of the Montraux Record, in the light of improved conditions in the lake.

STATUS OF WATER QUALITY ASSESSMENT IN SURFACE WATER

Water pollution in India has now reached a crisis point. Almost every river system in India is now polluted to a considerable extent. According to the National Environmental Engineering Research Institute (NEERI), Nagpur, nearly 70% of water in India is polluted. Water is polluted by four kinds of substances: traditional organic waste, waste generated from industrial processes, chemical agents of fertilizers and pesticides used for crop protection and silt from degraded catchment. The chief source of pollution is identified to be sewage (constituting 84 to 92% of the wastewater) and industrial wastewater (comprises 8 to 16%). In India, about 306 million cubic m of sewage is produced per day. About 80% of this sewage is directly poured into water, while 20% is processed in the treatment plants.

Most sewage systems open into water courses and release a large amount of organic materials into it. Microbial decomposition of dead organic matter, present in the sewage, causes depletion of oxygen or even anoxic conditions. This severe oxygen depletion may result in mass mortality of aerobic aquatic organisms, including fish. During decomposition of organic matter, gases like free carbon dioxide, hydrogen sulphide etc. are produced. These gases, besides being toxic, react with water to form acids, which alter the pH of water. This shift in pH may produce an adverse effect on aquatic biota. Presence of abnormal concentration of suspended matter, heavy metals and dissolved salts is also peculiar to sewage effluents. Decomposition of large quantities of organic matter in the sewage adds to inorganic nutrients loads such as nitrate, phosphate, sulphate etc. This nutrients enrichment may cause eutrophication.

A majority of rural population is yet dependant on various unprotected sources of water (viz., wells, rivers, ponds, lakes etc.) for meeting daily domestic water requirements in our country. Consequently, as emphasized that a majority of such population has to be on the risk of different water borne diseases. Pollution of water bodies, also adversely affecting the growth of aquatic fauna and flora. The rate of toxic chemical production has been increasing many folds after 1960 (Table 1). Consequently, water quality deterioration has been witnessed in the form of fish mortality in various rivers and lakes in India (Table 2).

Therefore, water quality assessment of various sources is very essential to know the status of water quality and to create awareness in the public regarding safety measures. According to National Water Policy, "both surface water and ground water should be regularly monitored, and a phased program should be undertaken for improvements in water quality".

Table 1. Toxic Chemical Production in India

Industries	Toxic Chemical Production (thousand tonnes)			
	1960	1970	1980	1986-87
Pesticides	1.46	3.00	40.68	56.2
Dyes & Pigments	1.15	13.55	30.85	-
Organic Chemicals, Petrochemicals	580	17100	24100	42500
Fertilizers	153	1059	3005	7000
Steel	1500	3400	8000	9000

Non-ferrous metals	8.5	34.6	82.9	123.4
Caustic Soda	101	304	457	764
Pharmaceuticals	1.23	1.79	5.07	-

Table 2. Fish mortality in Indian waters due to water quality deterioration

Place	Year	Pollutant
Kankaria lake, Ahmedabad	1982	Domestic waste
Naini lake, Nainital	1980, 81	Domestic waste
River Gomti, Lucknow	1983, 84,86	Distillery waste
River Chaliyar, Alwaye	1974	Pesticide
River Tungabhadra, Harihar	1984	Rayon Polyfibre
River Ganga, Allahabad	1981	Fertilizer effluent
River Ganga, Monghyr	1968	Oil Refinery
River Adyar, Madras	1981, 82	Tannery
Rihand Reservoir	1970, 78, 80	Chemical & Thermal effluent

MANAGEMENT MEASURES

Special Purpose Vehicles (SPVs):

SPVs for Lake Management and conservation with a unified mandate have been set up. These are - the Bhoj Wetland Authority in Bhopal (Madhya Pradesh), the Chilika Development Authority (CDA) in Orissa, the Loktak Development Authority (LDA) in Manipur, Lake Development Authority in Bangalore (Karnataka), J&K Lakes and Waterways Development Authority in Jammu and Kashmir, Hyderabad Urban Development Authority in Andhra Pradesh, and Jal Vikas Samiti in Udaipur, Rajasthan. More such organizations are being planned.

Restoration Plans/Actions

The lake restoration undertaken in the country could be categorized broadly as elaborated in the following management actions.

a) Source control: Treatment of watershed or catchment of lakes which not only brings in substantial improvements in the lake environment (reduction of silt, control of chemicals, and nutrients) but also results in the overall development of the community living in the catchment. Soil conservation measures, bank/slope erosion control measures, afforestation, drainage improvements, diversion of silt carrying channels away from the lake, control of sewage wastes, sewage interceptions and diversions and participation of people in watershed management measures have been widely adopted as effective management tools in all the lake restoration projects.

b) In lake treatment: The following are several palliative measures under taken to remove eutrophication and improve quality of lake water:

- Dredging and de-silting – as in the Bhoj wetlands, Dal and Nagina Lakes, the Sukna Lake, the Ropar lake, and the Renuka Lake.
- De-weeding/hyacinth control or removal (biological, chemical, mechanical and manual measures, bio-composting) – as in the Loktak, Bhoj Wetlands, Harike and Kanjli lakes.
- Bio-remediation (Clean up with bio-products - natural bacteria breakdown, and aerators to churn the lakes) as in the Powai Lake in Mumbai, Ooty and Kodaikanal lakes in Tamil Nadu, and Mirik Lake in West Bengal.
- Introduction of composite fish culture/larvivorous fish species to control mosquitoes (Sasthamkotta lake, Ashtamudi lake, etc).
- Engineering measures (hydraulic) to improve flow of seawater into the lake to maintain salinity levels in coastal lakes e.g opening of lake's outer channel into the sea ensured better exchange of salinity level in Chilika lake;
- Revival of traditional drainage system to replenish lake storage and drain out flood waters to improve rabi cultivation of Tals, Chaurs, and Oxbow lakes.
- Lake water supplementation through irrigation canal systems in the area as in the case of Nalsarovar bird sanctuary and the Keoladeo National Park
- Some portions of Chilika, Loktak, Wular and Harike lakes have been designated as protected areas. Some lakes have also been declared as sanctuaries or national parks, like the Keoladeo National Park for exotic and migratory birds, Nalsoravar bird sanctuary, and Kolleru lake. The Pulicat lagoon and the Pong dam lake are protected as wild life sanctuaries. Part of the Deepor beel has been declared a sanctuary.
- Harvesting of aquatic weeds as in Dal lake of Kashmir for growing vegetables which also provided benefits to the local communities. Management of 'phumdis' in Loktak lake through community efforts during monsoon by pushing them out of the lake into Manipur River has been found useful.

c) Shoreline management: Shoreline management has been achieved in many urban lakes by banning construction activity to specific heights above the periphery of the lake (Hyderabad City lakes, Udaipur lakes, etc). In many cases, the lake periphery has been declared as protected area or wild life sanctuary (Pong Dam Lake, Deeper beel, etc). To prevent pollution from human wastes, community toilet facilities are provided around periphery of the lake (Udaipur lakes, Sasthamkotta, and Ashtamudi lake). Solid waste management measures have been introduced (Bhoj Wetlands, Mirik Lake, etc). Demarcation of lake boundaries has been done with fencing around the lake periphery, in many lakes (Mysore city lakes, Bangalore city lakes, Kanjli lake). Peripheral roads and green belts have been created (Bhoj wetlands). Eco tourism facilities have been undertaken which has converted many lakes into tourist centres (Jalmahal and Jaisamand lakes in Rajasthan, Mirik Lake in West Bengal). In some cases, tourism has been controlled to prevent adverse effect on the bio diversity of the lake areas (Tsomoriri lake). Restrictions and guidelines have been imposed on Idol immersions (Bhoj Wetlands, Bangalore, Mumbai and Hyderabad Lakes).

d) Peoples' participation: This very effective management method is becoming increasingly popular in conserving Lake Environments in Urban areas. Non-

Governmental organizations have acted as catalysts. In major urban centres, people have organized themselves e.g 'Peoples Group' (Hyderabad), 'Jheel Sanrakshan Samithi (JSS)' (Udaipur), 'Society of Appeal for Vanishing Environments' (SAVE) (Nainital), Howrah Ganatantrik Nagarik Samiti (HGNS) (Howrah), 'Green Kashmir' (J&K), 'Ecological Task Force' (Harike), 'User's Committee' (Pushkar), and similar other groups. They have also moved the Judiciary (the Supreme Court and the High Courts) through Public Interest Litigations (PILs) seeking directives of the courts to restore lakes. Information Centres - cum - watch towers for Mass awareness and promoting public participation in the lake conservation programme have been established in many lakes. In the high altitude lakes of Leh in J&K, the local community of Korzok village has established a conservation trust with help from WWF-India to undertake conservation measures of the lake. The Ministry of Environment and Forests (MOEF) has recognized that the elaborate process of assessment of social, economic and ecological aspects of wetland (including Lakes) resources through community participation can help to formulate a comprehensive management plan, which is ecologically viable and socially acceptable. A project has been in operation for last more than four years through the involvement of Loktak Development Authority, Wetlands International and MOEF.

Private organizations such as 'Godrej' are interacting with WWF-India to carry out conservation activities relating to lakes (wetlands). Similarly, other private organizations like the Project Development Company limited (PDCOR), Jaipur, India Canada Environment Facility, etc., are taking interest for conservation and management of lakes in regard to eco-tourism development, sustainable fisheries development, and wildlife development. The Jalmahal lake restoration project in Jaipur, when implemented, could set example for private participation.

e) Environmental education and awareness: Material for generating awareness on the importance of biodiversity and dependence of the local community on natural resources have been developed by the Chilika Development Authority in collaboration with Wetlands International South Asia, Centre for Environment Education, Ahmedabad and Ramsar Centre. In the case of Chilika lake awareness generation is focused on highlighting its highly threatened population of Dolphins and as a unique habitat for rich avifauna. Environmental education and awareness kits have also been developed for school children and uneducated youth living in and around the Chilika lake. Centres of Excellence have been set up to develop resource material and generate awareness about environment including lakes/wetlands. WWF-India and Centre for Environmental Education, Ahmedabad have set up interpretation centres at Keoladeo National Park, Bharatpur. Chilika Development Authority has established two awareness centres at Satpuda and Balogaon.

Education and Awareness division of the MOEF is involved in developing specific projects for Environment Education and Awareness including Wetlands. Environmental education awareness in general, which includes wetlands (Lakes also) as well, is included in curricula at different levels of education. Special modules relating to wetlands have been developed at Wildlife Institute of India to generate awareness about the values and functions of wetlands (lakes included) and the need for their conservation to wider group of participants representing government, non-government and private

entrepreneurs. Such modules have also been developed specifically for participants from South Asian Countries.

Guide lines for Integrated Management Action Plans

In the guide lines issued by MOEF for management of wetlands (including lakes), mangroves and corals, the main components of the management action plan are a) description of the site, b) problem/ threats, c) Management objectives (short term and long term), d) strategies for achieving the objectives - the tentative list of actions identified are under the headings i) protection measures, ii) watershed management, iii) restoration measures, iv) hydrological measures, v) pollution control measures, vi) Socio-economic development through community participation, vii) monitoring and evaluation, viii) public awareness and education, and ix) legislative and administrative measures. Research priority areas for conservation of wetlands have also been identified.

INSTITUTIONAL MECHANISM

Several organizations, both Government, Non-Government and at Community levels, have been participants in lake restoration. However, the coordination between these agencies is only marginal. At present, the National Lake Conservation Plan (NLCP) of the MOEF is playing an important role in restoration of lakes.

National Lake Conservation Plan (NLCP)

The objective of NLCP is development of national level policies and actions with focus on urban lakes. It envisages a comprehensive and holistic approach for lake conservation. The socio-economic development of the people dependent on the lake ecology shall also be fully integrated. The programme includes the following:

- Prevention of pollution from point and non-point sources.
- Catchment area treatment.
- Desilting and weed control.
- Research & Development studies on flora and fauna.
- Other lake specific activities such as integrated development approach, including interface with human populations.

Under the NLCP, the Central and State governments share the costs in the ratio of 70:30. 21 urban lakes have been identified for conservation programmes. The scope of NLCP has been enlarged during the X Plan by including the rural lakes in the programme, with corresponding increase in plan outlay.

ROLE OF INTERNATIONAL INSTITUTIONS

International institutions such as the WWF, UNDP, UNEP, ADB, World Bank and many other funding agencies are involved in providing technical and financial assistance to the MOEF and the State organizations responsible for the upkeep of the

lakes and reservoirs. In this effort, the wetland restoration policy is also a key factor as it encompasses lakes and reservoirs as well.

The international conventions which cover all aspects of lakes, in the name of wetlands, and on which India has been a signatory, are detailed below.

Ramsar Convention

India has been a contracted party to the Ramsar Convention since 1st February 1982. Identified Ramsar sites are given in Annexure-2. These wetlands broadly represent Himalayan freshwater wetlands, Himalayan High altitude wetlands, coastal lagoons, floodplain systems and semi arid & arid zone wetlands. Their protection is envisaged through notification of the above (Lakes) under the provisions of Environment (Protection) Act, 1986, as ecologically fragile areas. Ramsar Convention also provides funds under Small Grants Fund (SGF) as emergency assistance to Ramsar sites, which have suffered damage or are in imminent danger of damage.

Convention on Biological Diversity

India signed the Convention on Biological Diversity on 5th June 1992, ratified it on 18th February 1994 and brought it into force on 19th May 1994. This convention provides a framework for the sustainable management and conservation of India's natural resources.

World Heritage Convention

India ratified the World Heritage Convention in 1977 and since the following five natural sites have been inscribed as areas of 'outstanding universal value'.

1. Kaziranga National Park
2. Manas Wildlife Sancturay
3. Keoladeo National Park
4. Sundarbans National Park
5. Nandadevi National Park

Convention on Conservation of Migratory Species of Wildlife Animal (CMS)

A Memorandum of Understanding concerning conservation measures for Siberian Cranes was signed in 1993 by India, Iran, Kazakhstan, Pakistan and Russian Federation under the Convention on Conservation of Migratory Species of Wildlife Animals (CMS). The agreement aims at coordinating efforts to save the central and western Asian population of this highly endangered species.

UNDP

Under UNDP's global programme for conservation and sustainable use of threatened wetlands, several Indian wetlands have been identified for survey and mapping using remote sensing.

World Wide Fund (WWF) for Nature-India

WWF International supports WWF-India's wetlands conservation programme (1991), through financial support and encouragement. It also supports the Government of India's national programme by providing technical, policy, advocacy (at national and international levels), and field action-oriented support. The WWF-India Programme, has the following objectives.

- Improve the information base on Indian wetlands
- Promote education and awareness about wetland values
- Facilitate better wetland management
- Contribute to the Government of India's National Programme on Wetlands, Mangroves and Coral Reefs
- Support the Ramsar Convention and other relevant environmental treaties
- Act to halt wetlands destruction and degradation
- Demonstrate the wise use of wetland resources

ILEC

ILEC recognizes that World Lake Vision should complement World Water Vision (GWP) in promoting IWRM as the guiding principle for the sustainability of lakes. Lake management has, therefore, to be a subset of IWRM at the basin level. In India, MOEF, the nodal ministry for restoration of lakes has confirmed to Ramsar convention that River basin approach has been envisaged for conservation and wise use of wetlands in the country, that Government of India provides technical and financial support to promote sustainable development of wetlands at the river basin level and that projects have been undertaken in the States of Manipur, Orissa, Gujarat and Punjab to integrate conservation and wise use of wetlands into river basin management. However, this has remained basically an exercise on paper.

GWP - SASTAC

GWP-SASTAC has taken the initiative to establish a thematic network on water quality of lakes in South Asia. Indian Association of Aquatic Biologists, Hyderabad has been entrusted with the work, as driver agency, for establishing the Network, which will provide a common platform for all those interested in ensuring sustainable environment of lakes.

FUNDING

Funding and other assistance for scientific study, preparation of management plans and restoration of lakes provided by the Govt. of India (MOEF under

NLCP, WWF & Ramsar convention) and International funding agencies (UNDP, ADB, Indo-Norwegian, India-Canada Environment Facility, etc) covers only a very small number of the problem lakes in the country. While World Bank, OECF Japan and Government of Netherlands did not evince interest in a proposal for conservation of Dal Lake, World Bank showed its interest in taking up the conservation of Harike, Kanjli and Ropar wetlands of Punjab and Udaipur lake and Sambhar wetland in Rajasthan but wanted the projects to be routed through the State's Water Sector projects, as part of water resources management at the state level. The Bank wanted to look at the problem of Lakes from an integrated development approach rather than an environmental issue alone and, therefore, made Integrated Management of Lake Chilika as a part of Orissa Water Consolidation Project.

MOEF has increased the allocation of funds for the restoration of lakes under its NLCP to Rs. 22,000 million during the current 10th Plan period (Year 2002-2007). The assistance is limited to a few lakes while the requirement is for restoration of a very large number.

MANAGEMENT OF RESERVOIRS

India has a large number of reservoirs built behind dams to store monsoon flows for use during the lean season as a dependable source for drinking water, irrigation, hydropower, ecological use, industrial use, navigation, etc. They also provide flood moderation. These reservoirs are generally located far from population centres and do not receive domestic effluents directly. Some are, however, recipients of industrial effluents and non-point pollutants from irrigated agriculture.

The water quality in the reservoirs is generally not much affected since the reservoirs are operated year round to utilize the entire live storage created behind the dams. However, sedimentation of these reservoirs is the important environmental phenomenon. Based on available data, average annual loss in gross storage due to siltation is computed as 0.44 % and, the annual loss in live storage as 0.31%.

The reservoirs have created new ecosystems, supporting life growth even in dry period when the environment tends to be hard and inhospitable. It is generally noted that a forest far superior to the submerged original forest comes up along the rim or in the vicinity of the reservoir.

The environmental conditions of the reservoirs are monitored regularly by the Central and State govt. Water Resources/Irrigation organizations. The catchment areas of the reservoirs are, however, the responsibility of the Forest and the Agricultural Departments of the State and the Central Governments.

Sediment Management

The techniques, which have been considered, are detailed below:

a) Source area control

India has several programmes of water shed management. The watershed of the reservoirs is subjected to catchment area and soil conservation treatment to reduce

the rate of silt flow. Studies show that in catchments where such measures have been undertaken, sediment production rate has reduced.

b) Hydraulic management

Though it is known that the reservoir operation is amenable to silt flushing by way of reservoir draw down, and venting density currents, no such provision was envisaged in the dams built in the early years. However, large size bottom outlets are being considered in the planning of new dams.

The management of reservoirs is the responsibility of the well-established Irrigation or Water Resources departments of the States. By and large, the reservoirs are functioning well from the environmental point of view except for the siltation problem.

MANAGEMENT OF TANKS

Tanks, which are also subsets of water bodies, though not called Lakes, symbolize an ancient tradition of harnessing local rainfall for irrigated agriculture. With major and medium reservoirs providing large scale storages for irrigation and with increased extraction of ground water under minor irrigation programmes, the emphasis on tanks diminished during the 20th century. These water bodies, mostly ephemeral in nature, as per survey of selected tanks, indicate widespread decay and decline, mainly due to heavy siltation and inadequate maintenance. The varying status of disrepair are attributed to i) change in the institutional mechanism and its weakening over the years, ii) intense demographic pressure, iii) social composition of land ownership, and iv) spread of well irrigation. In spite of all these problems many tanks are still functional and continue to be maintained by informal community institutions. During the last decade both the Government and some international agencies have been trying to revive, expand and revitalize the tanks.

ROLE OF JUDICIARY AND LEGAL INTERVENTIONS TO STOP DEGRADATION OF LAKES

A major development in stopping the continuing degradation of lakes has been the involvement of the Judiciary (some times at the highest level, the Supreme Court). The Indian law courts have been extremely proactive on the issue of environmental protection. Groups of affected people and public spirited citizens have been filing Public Interest Litigations (PIL) in courts across the country seeking 'mandamus' for remedial actions, specifically in respect of highly polluted urban lakes and water bodies. The 'mandamus' is sought, interestingly, under the current constitutional provisions and legislations.

The Supreme Court, in a PIL in the case of Badal Khol and Surajkund lakes in Haryana state, near Delhi, held that " Precautionary Principle" has been accepted as part of the law of the land. The court observed that the "Precautionary Principle" makes it mandatory for the state government to anticipate, prevent and attack the causes of environment degradation. In order to protect the two lakes from environmental degradation and pollution it limited the construction activity in close vicinity of the lakes.

The Court further directed that no construction of any type shall be permitted within four km radius of the lakes and that all open area shall be converted into green belts.

However, the problem is that the Municipalities, the local governing bodies, are themselves the cause for concern as they are the chief polluters. Though PILs have generally helped in restoration of lakes, there are also instances of the opposite, as in the case of Rabindra Sarovar lake in West Bengal, where the PIL was for the legalization of the encroachments. With funds provided by the MOEF under NLCP, Rabindra Sarovar is now under conservation by the Government of West Bengal.

LEGAL FRAMEWORK

Constitutional Provisions

India has a plethora of Policies, Acts, Rules and Laws in the Water Resources, Environment, Forest, Agriculture, Fisheries and Social sectors, directly or indirectly related to lake management. The Indian Constitution provides, in clear and unambiguous terms, for the State's commitment to protect the environment. Article 48-A of the directive principles states, "The State shall endeavor to protect and improve environment and to safeguard the forests and wild life of the country". Under Article 51-A (g), it is the fundamental duty of every citizen of India "to protect and improve the natural environment, including forests, lakes, rivers and wild life, and to have compassion for living creatures". The Constitution empowers Panchayats and Urban local bodies with functions and responsibilities, as relevant to Lakes Environment:

Bombay Land Revenue Code declares all lakes and tanks which are not individually owned, to be the properties of the Government. The High Court has made it clear that "The State as the trustee of all natural resources meant for public use, including lakes and ponds, is under a legal duty to protect them." The problem is in making the governments act accordingly.

Other legal instruments

Several acts and notifications issued by the Ministry of Environment and Forests (MOEF) provide the legal framework for protection of lakes and reservoirs (wetlands). These deal with environmental protection, pollution control, specific natural resources protection acts, hazardous waste management and the National Environment Tribunal.

The Coastal Zone Regulation Notification, 1991 under the provisions of Environment (Protection) Act, 1986 declares the coastal stretches of seas, bays, estuaries, creeks, rivers and backwaters which are influenced by tidal action in the landward side upto 500 meters from the high tideline and the land between the low tideline and the high tideline as coastal zone where restrictions are imposed on setting up and expansion of industries and such other operations and processes. This notification is important for conservation of coastal lakes such as Chilika, Kolleru, Kuttanad, Pulicat, Sasthamkotta, Vembanad, etc. Under the Environment (Protection) Act, a number of wetland ecosystems in the country are being notified for protection as ecologically fragile areas. The Government of India has advised all the State Governments to formulate integrated

coastal zone management plans for conservation of Wetlands, mangroves and coral reefs which are designated as ecologically fragile areas. The Supreme Court of India has also made implementation of Coastal Zone Management Plans mandatory for the State Governments

NATIONAL POLICY

The National Water Policy, revised in 2002 gives importance to Institutional mechanism by a directive that gives effect to the planning and management of the water resources on a hydrological unit basis, along with a multi-sectoral, multidisciplinary and participatory approach as well as integrating quality, quantity and the environmental aspects. The existing institutions at the various levels under the water resources sector will have to be appropriately reoriented/reorganized and even created, wherever necessary.

LESSONS LEARNT

Data Gap

What is lacking even now is a census of lakes and identification and assessment of their problems both in the urban and rural areas. A listing done by the MOEF identifies 2167 natural lakes (wetlands) and 65,253 man-made lakes (wetlands) but the detailed listing is limited to only 340. However, attempts are being made to publish a directory giving the latest information both on the basis of ground verification and remote sensing technology

Common Problems

Public Interest Litigation has shown up the following problems as common to all lakes:

- Apathy of the executive in preventing discharge of domestic and industrial effluents into the lakes,
- Lack of proper sewage system
- Encroachments due to the nexus between the executive and the builders lobby
- Lack of access to scientific data and scientific norms for restricting building activity around the lakes
- Ineffective technology for cleaning up pollutants
- Unclear laws, too many corrupt and confused authorities (numerous govt. departments), plethora of land owning govt. agencies, political vested interests, and absence of a clear lake environment policy.

Delays in Restoration

Restoration actions taken/initiated in lakes such as the Chilika , Loktak , Dal and Nagin , the Bhoj Wetland (Bhopal lakes), Harike etc., were often delayed due to

involvement of several sectoral ministries/agencies at the Central and State level which lacked basic understanding in adopting a joint approach since lakes or wetlands are not delineated under any specific administrative jurisdiction. The delays were due to:

- Improper appreciation of the hydrological regimes at the river basin level and allocation of water, particularly for ecological purposes
- Inadequate understanding of the sound ecological basis for interactions amongst various sectors
- Conflict of interests among various land & water use sectors and their failure to evolve common strategy
- Lack of involvement of Stakeholders in planning and implementation processes
- Paucity of overall understanding of the nature and benefits of lakes in economic and ecological terms

Lack of Co-ordination

Co-ordination is a major stumbling block in effective management of water resources in the country, which inter-alia includes Lake Management. Hence, water is the fundamental problem of Lake Management. Any actions taken to address the bio-diversity issues would not revive the lakes unless the availability of water is assured.

Ineffectiveness of Legislation

Some lakes/wetlands have been provided protection under the Wildlife Protection Act, which is generally ineffective. This is due to lack of pragmatic regulatory regime for an integrated development and management of a drainage basin and involving joint decisions of several sectoral agencies. Effective coordination between the different ministries (energy, industry, fisheries revenue, agriculture, transport and water resources) is essential for the protection of these ecosystems.

Lack of IWRM Approach

The management of lakes is still considered, predominantly, from environmental angle only. The initiative for their restoration rests with the MOEF at the National level and with the state level organizations set up exclusively for the purpose. There is inadequate recognition that IWRM is very essential at the Basin level to ensure environmentally sustainable lakes and reservoirs, though it is established that these water bodies cannot be isolated from their drainage basin.

Economic Valuation

Economic Valuation of some wetlands (Lakes) undertaken including two Ramsar sites viz. Harike lake and Keoladeo National Park (Bharatpur Lake) have indicated that economic valuation is an effective tool for wise-use of wetlands (lakes). It has been, therefore, proposed by MOEF to carry out economic valuation of wetlands with

clear focus on use of such studies for resource development and management of wetlands and sustainable resource utilization by the local communities.

Summary

All the lakes, all over the country, without exception, are in varying degrees of environmental degradation. Since the data on lakes is not scientifically compiled, it is difficult to provide analytical solutions to the problems and hence a generic approach.

The main cause for continued degradation of lake environment has been public apathy and government indifference. The situation has changed in the last decade due to public awareness of the need for sustainable environment in general, not of lakes alone. This awareness has led to public protestations, legal interventions and also public participation in restoration actions.

The legal framework for protection of lakes and reservoirs (wetlands) is at present indirectly covered under several acts and notifications issued by the MOEF. A major development in stopping the continuing degradation of lakes has been the involvement of the Judiciary (some times at the highest level, the Supreme Court).

The NLCP is envisaged to play an important role in restoration of lakes. International institutions such as the WWF, UNDP, UNEP, ADB, World Bank and many other funding agencies are all involved in providing technical and financial assistance. The wetland restoration policy encompasses lakes and reservoirs as well.

Funding and other assistance for scientific study, preparation of management plans and restoration of lakes provided by the Govt. of India and International funding agencies covers only a very small number of the problem lakes in the country.

Several organizations, both Government, Non-Government and at Community levels, have been participants in lake restoration. But it is seen that the coordination is a major stumbling block in effective management.

Some Special Purpose Vehicles (SPVs) have been setup for Lake Management and conservation with a unified mandate. More are being planned.

The Way Forward

The way forward for better management of the lakes, reservoirs and tanks in the country could be achieved by evolving strategic integrated management action plans. The guidelines issued by MOEF in this regard are a good beginning. They need to be pursued to ensure their effective implementation.

The first step is to survey and inventarise all water bodies and categorize them, utility, problem, and region wise, to enable impact analysis of ecosystem and evolve suitable restoration works for problem lakes. The surveys should cover Post Project Evaluation of the SPVs and Hydrological studies of the lakes, as part of the drainage basins.

The next step is to initiate action on Integrated Water Resources Management (IWRM) with specific emphasis on lakes and reservoirs at the basin or sub-basin levels. Lake Management should be a subset of IWRM at the basin level.

Permanent solution depends on Institutional restructuring for effective governance. The components which need to be addressed are a) enabling environment and b) Institutional frame work

The enabling environment: To deal with problems of Lakes and Reservoirs and their restoration, the existing Acts, Legislations, and Laws need to be integrated suitably into a single specific legislation together with new legislation. There is need for assessment of water availability and land use in catchments of lakes and reservoirs etc. The national and state policies in respect of water and environment need to be integrated. Standards for lake and reservoir management have to be framed.

The institutional frame work: Establishment of River Basin Organisations is the most important step towards sustainable lake management. Their functions and responsibilities have been widely discussed. They can be made to have specific emphasis on sustainable management of lakes (wetlands). In this, ILEC could probably play an effective role.

ANNEXURE-1: Details of Inland Water Resources of various types (100,000 ha)
Sources: Hand Book of Fisheries 1988, M/O Agriculture (Fisheries Division).

Name of the State/UT	Rivers & Canals (Km)	Reservoir	Tanks and Ponds	Beels, Oxbow Lakes & derelict water	Brackish water
Andhra Pradesh	11514	2.34	5.17	-	0.64
Assam	4820	0.02	0.14	1.00	-
Bihar	3200	0.60	0.95	0.05	-
Goa	250	0.03	Neg	-	0.04
Gujarat	1192	2.04	0.09	-	0.95
Haryana	5000	Neg	0.10	0.10	-
Himachal Pradesh	3000	0.40	0.06	-	-
Jammu & Kashmir	27781	0.07	0.11	0.04	-
Karnataka	9000	2.22	2.37	2.37	0.08
Kerala	3100	0.30	0.03	2.43	2.43
Madhya Pradesh	12000	2.91	0.69	-	-
Maharashtra	3200	1.65	0.53	-	0.14
Manipur	3360	Neg	0.03	0.29	-
Meghalaya	1000	0.01	0.02	Neg	-
Nagaland	1600	2.27	0.50	Neg	-
Orissa	N.A	2.56	0.59	1.80	5.74
Punjab	15270	Neg	0.07	-	-
Rajasthan	N.A	1.20	1.80	-	-

Tamil Nadu	4493	0.53	2.24	5.24	0.56
Tripura	1200	0.06	0.07	0.06	-
Uttar Pradesh	31200	1.50	1.62	1.33	-
West Bengal	2526	0.17	2.76	0.42	2.10
Arunachal Pradesh	2000	-	0.01	0.03	Neg
Andaman & Nicobar	48	Neg	Meg	-	1.15
Chandigarh	2	-	Neg	Neg	-
Delhi	150	0.04	-	-	-
Lakshadweep	-	-	-	-	-
Pondicherry	247	-	Neg	Neg	Neg
Total	164153	18.92	19.96	15.16	13.83

N.A - Not available; Neg - Negligible

ANNEXURE-2: LIST OF LAKES

A. Urban lakes

1. Bangalore city Lakes - Karnataka - 20 odd lakes out of 257, considered worth restoration. Four lakes under restoration - Vengaihnakere, Kamakshipalya, Jarganhalli & Nagavara. (NLCP)
2. Bhopal's Upper and Lower Lakes - also named Bhoj Wetland, Madhya Pradesh - 3201 ha. (R)
3. Bombay (Mumbai) city's lakes, Maharashtra - Powai, Tulsi, Vihar lakes -2200 ha. (NLCP)
4. Dal & Nagin Lakes, Jammu and Kashmir –1720 ha - Nagin - Jewel in the Ring. (NLCP)
5. Howrah's urban water bodies, West Bengal. 5. Howrah's urban water bodies, West Bengal.
6. Hyderabad city lakes, Andhra Pradesh - Hussain Sagar (3,300 ha) & Saroornagar (400 ha), Osmansagar (4,016 ha) and Himayatsagar (3,584ha) and other lakes. (NLCP)
7. Jalmahal Lake also called Mansagar lake, Jaipur city, Rajasthan -110 ha (after restoration).
8. Jaisamand lake or Dhebar lake, Rajasthan, -7224 ha.
9. Kodaikanal Lake & the Ooty lake, Tamil Nadu. (NLCP)
10. Lakes of Kumaon hills - Nainital, Bhimtal, Sat-Tal, & Naukuchiatal, Uttaranchal - 'Lake District' of India, Uttaranchal. (NLCP)
11. Mirik Lake called 'Sumendu Lake', Darjeeling District, West Bengal - 47 ha. (NLCP)
12. Mysore city's five lakes- Kukkarahalli, Lingambudhi, Karanji, Devanoor, and Dalavai, Karnataka - 363.5 ha. (NLCP)
13. Nangal Lake and Hussainiwala lakes, Punjab – 1088 ha.

14. Rabindra Sarovar (lake) or Dhakuria Lake, West Bengal - 31 ha. (NLCP)
15. Sastamkotta Lake , Kerala -373 ha. (R)
16. Sukhna lake, Chandigarh UT -188 ha. (NLCP)
17. Udaipur city's five Lakes - Fatehsagar (400Ha), Rangsagar, Pichola, Swaroopsagar and Dudh Talai (1480 ha), Rajasthan. (NLCP)
18. Wular Lake, Jammu and Kashmir (J&K), 17,300 ha - Called flood-lung of the Jhelum River. (R)

B. Non-Urban Lakes

a) Inland Fresh Water

1. Harike Lake, Punjab - 2850 ha. (R)
2. Kanjli Lake, Punjab, -490 ha - Religious significance. (R)
3. Keoladeo National Park or Bharatpur lake, Rajasthan -2873 ha. - Also called 'Ghana National park' - Most famous waterfowl reserve.(R)
4 Loktak Lake, Manipur - 31,200 ha - 'World's only floating National Park'.(R)
5. Mirik Lake or 'Sumendu Lake' West Bengal – 47 ha. (NLCP)
6. Nalsarovar Lake, Gujarat - 12, 000 ha. (R)
7. Pong Dam lake, Himachal Pradesh - 15,662 ha. (R)
8. Ropar lake, Punjab, -1365 ha. (R)
9. Renuka lake, Himachal Pradesh - 75 ha - Shape of Lady - Embodiment of goddess Renuka (R)

b) Inland Brackish/salt water

1. Lunar Lake, Maharashtra - 1.8 km in diameter, largest and oldest meteoric crater in the world.
2. Pangong Tso lake - Leh, J & K – 4,200 ha (approx) - Greatest lake in the Himalayas-Bi-nation lake (India & China).
3. Sambhar Lake, Rajasthan - India's largest salt lake - 24,300 ha - Ornithologists' delight. (R)
4. Tsokar lake at 4,485 m - Leh, J&K -'Lake of salt'.
5. Tsomoriri lake or "Mountain Lake" at 4,595m , J & K - 12,000 ha -Highest cultivated land in the world. (R)

c) Sacred lakes & Tanks

1. Pushkar lake, Rajasthan.
2. Shambhu Lake, Maharashtra – 16 ha.
3. Sacred Tanks (Lakes), South India - Andhra Pradesh, Karnataka, Kerala Pondicherry, and Tamil Nadu states - Also called 'Ponds', always dug below the ground level.

d) Coastal Estuarine Lakes of brackish water (Salt and Fresh Water Mix)

1) Ashtamudi Lake, Kerala - 61400 ha. (R)

2) Chilika Lake, Orissa - 1,16,500 ha - Largest brackish water lagoon in Asia. (R)
3) Kuttanad lagoon, Kerala, Five major rivers drain - Most area consists of freshwater - 'kayal' or backwaters - 'One of the few places below sea level with farming'
4) Pulicat Lake, Andhra Pradesh & Tamil Nadu, - 77,000ha - Second largest brackish water lagoon in India - Unique for its multi-ecosystem.
5) Vembanad-Kol Lake system, Kerala - 151,250 ha - Fed by 10 rivers -Two distinct segments of fresh water & salt water.(R)

e) Ephemeral Lakes (Beels, Jheels & Tals) of the Ganga - Brahmaputra Basins

1) Deepor beel or lake, Guwahati city, Assam -4,000 ha. (R)
2) Kawar (Kabar) Lake, Bihar- 6737 ha.
3) Kolleru Lake, Andhra Pradesh - 90,100 ha - Hemmed between Godavari and the Krishna river basins. (R)
4) Mokama Tal (Lake), Bihar -106,2 00 ha.

Note: Lakes designated under
(NLCP) - National Lake Conservation Plan
(R)- Ramsar site