WETLANDS RESTORATION AND CONSERVATION

T.V. Ramachandra and *N. Ahalya*

Proceedings of National Conference on
'Control of Industrial Pollution and Environmental Degradation'

Organised by
Department of Civil Engineering,
PSG College of Technology,
Coimbatore,
September 14th and 15th 2001,
pp 262-275

Dr. T.V. Ramachandra
Energy and Wetlands Research Group, Centre for Ecological Sciences, Indian Institute of Science, Bangalore 560 012, India
Tel: 91-080-3600985 / 309 2506
Fax: 91-080-3601428/ 3600085/3600683 [CES-TVR]
E Mail: cestvr@ces.iisc.ernet.in, energy@ces.iisc.ernet.in

N. Ahalya
Energy and Wetlands Research Group, Centre for Ecological Sciences, Indian Institute of Science, Bangalore 560 012, India
E Mail: ahalya@ces.iisc.ernet.in

ABSTRACT:

Wetlands are probably the earth's most important freshwater resource and are also the most threatened. They perform manifold functions in the maintenance of the ecological balance of the region. Some of the important functions include water storage, protection from storms and floods, recharge of ground water, water purification, fisheries, agriculture, wildlife resource, transport, recreation, etc. India is richly endowed with wetlands evident from the high-altitude lakes of the Himalayas; floodplain wetlands of major river systems and their extensive network of tributaries draining from the Indian landmass in all directions. They are fragile ecosystems that are susceptible to damage even with only a little change in the composition of biotic and abiotic factors. They are threatened due to inadequate water holding capacity, excessive withdrawal, pollution due to raw sewage and sullage, industrial effluents, eutrophication, leached fertilizers and insecticides. Bangalore (Karnataka state) is endowed with rich wetland resources that are also facing degradation by the aforementioned threats. The degradation in the water quality affects the floral and faunal population along with the people dependent on these ecosystems. Socio - economic surveys indicate that lakes with water quality conforming to the prescribed standards have a high economic dependence (Rachenahalli - as high as Rs. 10,000/day), whereas for eutrophic lakes, it may be as low as Rs. 20/day (Amrutahalli). This necessitates the need for restoration and formulation of conservation strategies for sustainable

management of wetlands. This paper suggests suitable strategies for the restoration of lakes with an overview on the status of wetlands and prevailing legal measures to protect them.

INTRODUCTION

Wetlands, as the term implies, are 'Wet' lands that exist because the inflow of water exceeds the outflow for brief to extended periods of time during the growing season. Inland wetlands receive water from precipitation, snow melt, river outflow, surface overland flow, ground water discharge, lake seiches and seepage from streams, lakes, ponds and irrigation systems. Most natural wetland functions are a result of or closely related to wetland hydrology. Wetland food chain, fish and wildlife habitat value, nutrient cycling, socio-economic values, heritage and even aesthetic values are tied to the source, velocity, frequency, timing and quantity of water.

The fact that lakes occupy such a small fraction of the landscape belies their importance as environmental systems and resources for human use. They have intrinsic ecological and environmental values. Besides, humans use lakes for many commercial purposes including fishing, transportation, irrigation and industrial water supply, and lakes function as receiving waters for wastewater effluents.

They moderate temperatures and affect the climate of the surrounding area. By storing water they help regulate stream flow, recharge ground water aquifers and moderate droughts. They provide habitat to aquatic and semi aquatic plants and animals, which in turn provide food to many terrestrial animals, adding to the diversity of the landscape.

The myriad ways in which humans use lakes, along with numerous pollutant generating activities of society, have stressed lake ecosystems in diverse ways, frequently causing impairment of lake quality for other uses. Stresses to lakes arise from easily identifiable point sources such as municipal and industrial wastewater, non-point degradation like urban and agricultural run-off within a lake's watershed, and the most insidious long-range atmospheric transport of contaminants. Major degrading factors include excessive eutrophication due to nutrient and organic matter loading; siltation due to inadequate erosion control in agricultural, construction, logging and mining activities; introduction of exotic species; acidification from atmospheric sources and acid mine drainage; and contamination by toxic (or potentially toxic) metals such as mercury and organic compounds such as poly-chlorinated biphenyls (PCBs) and pesticides. In addition, physical changes at the land-lake interface (eg. draining of riparian wetlands) and hydrologic manipulations (eg. Damming outlets to stabilise water levels) also have major impacts on the structure and functioning of these ecosystems.

Lakes have played a major role in the history of Bangalore and served as an important water source for drinking and irrigation. Wetlands of Bangalore occupy about 4.8% of the city's geographical area (640 sq.km) covering both urban and non-urban areas. The spatial mapping of the water bodies in the district revealed that the number of waterbodies has decreased from 379 (138 in north and 241 in south) in 1973 to 246 (96-north and 150-south) in 1996. This overall decrease of 35.09% was attributed to urbanisation and industrialisation. The tanks were reclaimed for various purposes such as residential layouts, commercial

establishments, sport complexes, etc. At present only 30% of the lakes are used for irrigation. Fishing is carried out in 25% of the lakes surveyed, cattle grazing in 35%, agriculture in 21%, mud-lifting in 30%, drinking in 3%, washing in 36% and brick-making in 38%. This highlights the need for appropriate conservation and management measures.

WATER QUALITY

A suitable restoration action plan could be devised only if characterisation of the type and source of pollutants entering the ecosystem is known. Investigation of the physico-chemical and biological parameters in this regard helps in assessing the status, which is required for evolving appropriate restoration methods towards conservation and management. In order to characterise the water quality of wetlands, sample lakes/tanks were chosen in and around Bangalore for monitoring, depending on the location and type of pollutants getting in to the system. Nine lakes were monitored from 1996 to 2000. The investigations revealed that most of the analysed parameters for the lakes (e.g. Ulsoor, Hebbal, Yediur, Kamakshipalya and Madivala) exceeded the limits set by Indian standards for industrial and sewage effluents discharge [IS 2490 -1982].

- The water quality of Kamakshipalaya tank revealed that the tank was highly polluted due to the inflow of sewage and industrial effluents from the neighbouring areas. The turbidity of the water body was high along with parameters like electrical conductivity (EC), dissolved oxygen (DO) and biological oxygen demand (BOD).
- Madivala lake receives inflow of sewage from the surrounding residential areas as elucidated by high values of pH, EC, BOD and COD.
- Yediyur tank receives industrial and domestic effluents, which has given rise to algal blooms, mainly microcystis. Quality monitoring revealed high turbidity, low transparency, alkaline pH, and high sodium, potassium, calcium and magnesium.
- Hebbal tank, situated in the northern part of the city, supports agriculture, fishing, etc. The tank receives untreated sewage from the adjacent residential layouts, contributing to alkaline pH, high EC, high total solids, low dissolved oxygen and high nitrate and phosphates.
- Ulsoor tank receives untreated sewage from the nearby industries and residential layouts contributing to high pollution loads in the tank. The parameters that exceeded the standard values include turbidity, transparency, EC, BOD and COD
- Amruthalli lake, situated in Bangalore North, has attained eutrophic condition (excessive input of nutrients and organic matter from the inflow of sewage, industrial effluents and dumping of organic waste matter from the surrounding areas) evident from high levels of phosphates, TSS, alkalinity, hardness, weed infestation and low DO. Dependency of people residing around this wetland (in financial terms) based on socio-economic surveys was about Rs.20/day. The eutrophic condition of the lake has made this resource unusable. Similar exercise carried out in a relatively clean wetland ecosystem reveals the dependency as about Rs.10,470 per day, which highlights the benefits of cleaner environment.

Most of the lakes in Bangalore city are highly eutrophic (as exemplified by water quality analyses) and demand the immediate attention of civic authorities towards restoration and conservation.

RESTORATION OF LAKES IN BANGALORE

The term restoration means the reestablishment of predisturbance aquatic functions and related physical, chemical and biological characteristics. The objective is to emulate a natural, self-regulating system that is integrated ecologically with the landscape in which it occurs. Often, restoration requires one or more of the following processes: reconstruction of physical conditions, chemical adjustment of the soil and water; and biological manipulation, including the reintroduction of absent native flora and fauna.

The conservation and protection involves not only buffering wetlands from direct human pressures, but also maintaining important natural processes that operate on wetlands from outside, which may be altered by human activities. Management towards this end should emphasize the long term sustenance of historical, natural wetland functions and values. Restoration is thus a good opportunity to manage wetlands for broad wildlife goals, as restored wetlands provide enhanced wildlife benefits, in addition to other benefits, concurrently.

Most of the developmental activities are currently concentrated in and around Bangalore city. This has led to large scale migration of people from rural and other areas. This increase in population (due to the short sighted planning strategies) over the last two decades has created lot of pressure on the existing waterbodies. The Bangalore Water Supply and Sewerage Board is unable to meet the requirements for potable water in the city due to dwindling water resources (lakes, wells, etc.). Disappearance of lakes in the city is responsible directly for lowering the ground water table, which is evident from the lowering of levels from 80 feet to 300 feet in certain localities. Increasing demands for potable water in the city necessitates the search for environmentally sound alternate water sources. Otherwise, it will be difficult to meet the water demand for the next decade (leading to water disputes among families within and across streets!). Reclamation with an emphasis on health protection, technical feasibility and economics could be a viable option in this context.

The preliminary step that has to be implemented in restoring lake for their long-term sustenance includes:

- **Pollution impediment: Wastewater, solid and semi solid wastes entering in to the lake from external sources must be stopped before any restoration work is implemented.**
- **Harvesting of Macrophytes: Water hyacinth and other nuisance vegetation present in the lake, causing eutrophication, must be removed manually or mechanically. Weed infestation can also be controlled by applying chemicals like methyl-chlora-phenoxy-acetic acid, hexazinore, etc., and biological control by means of introducing Pila globosa (trophical snail), Chinese grass carp (fast growing fish) etc. that feed on many aquatic plants.**
- **Draining the water: Water present in the lake must be cleaned or drained completely.**
- **Desiltation: Dredging of the sediments in the lake to improve the soil permeability, water holding capacity and ground water recharge. Recent technological developments do permit wet dredging. Studies in Kolar district reveal that desilting of waterbodies helps in lowering fluorosis in borewell water (ground water).**

- **Constructed Engineered Wetlands: A constructed wetland is a water treatment facility that has gained importance in recent years for treatment of lakes. Duplicating the processes occurring in natural wetlands, constructed wetlands are complex, integrated systems in which water, plants, animals, microorganisms and the environment (sun, soil and air) interact to improve water quality. Constructed wetlands mimic nature by mechanically filtering, chemically transforming, and biologically consuming potential pollutants in the wastewater stream. These are shallow pools constructed on non-wetland sites as part of the stormwater collection and treatment system. They provide conditions suitable for the growth of emergent marsh plants. These systems are primarily designed for the purpose of stormwater management and maximum pollutant removal from surface water flows through physical, chemical and biological mechanisms. They are often used in sequence with a sediment basin or stormwater pond.**

As an extension of the restoration programme, watershed management practices are essential for proper land use, protecting land against all forms of deterioration, conserving water for farm use, proper management of local water for drainage, flood protection and sediment reduction and increasing productivity from all land uses. Key steps for best management practices include:

- **Pollution alleviation practices to reduce the engendering of non-point source of pollution (mainly agricultural and storm runoff) through source reduction, waste minimisation and process control.**
- **Afforestation with native species in desolate areas around the wetland (catchment area) to control the entry of silt from run off.**
- **The shorelines of the lakes are lined with bricks or stones in an attempt to control shoreline erosion.**
- **Constructed wetlands for the purpose of stormwater management and pollutant removal from the surface water flows.**
- **Infiltration trenches for reducing the storm water sediment loads to downstream areas by temporarily storing the runoff.**
- **Extended detention dry basins for removing pollutants primarily through the settling of suspended solids.**
- **Gyration of crops rather than monocultures to reduce the need for N and assist with pest control and help in aeration of soil.**
- **Promoting public education programs regarding proper use and disposal of agricultural hazardous waste materials and regular monitoring of lakes, which are rudimentary.**

The restoration programs with an ecosystem approach through Best Management Practices (BMPs) helps in correcting point and non-point sources of pollution. This along with regulations and planning for wildlife habitat and fishes helps in arresting the declining water quality and the rate of loss of wetlands. These restoration goals require profound planning, authority and funding along with financial resources and active involvement from all levels of organisation (Governmental and Non-Governmental Organisations (NGOs), research organisations, media, etc.) through interagency and intergovernmental processes all made favourable in innovating and inaugurating the restoration programs. Network of educational institutions, researchers, NGO's and the local people are suggested to help restore the fast perishing wetland ecosystem and conserve

those at the verge of extinction by formulating viable plans, policies and management strategies.

WETLAND PROTECTION LAWS AND GOVERNMENT INITIATIVES

Wetlands do face the tragedy of commons, as is evident from present quality and steep decline in their numbers. The prime reason for this state is mainly due to lack of coordination among many agencies involved in the management and appropriate legal measures to protect these ecosystems. As on today, Wetlands are not delineated under any specific administrative jurisdiction. Some wetlands are protected after the formulation of the Wildlife Protection Act. However, it is ineffective and most are in grave danger of extinction. Effective coordination between the different ministries, energy, industry, fisheries revenue, agriculture, transport and water resources, is essential for the protection of these ecosystems.

Prevailing laws are ineffective as far as the protection or conservation of aquatic ecosystems are concerned as most of them indirectly touch wetland protection (fragmented approach);

- **The Indian Fisheries Act - 1857**
- **The Indian Forest Act - 1927**
- **Wildlife (Protection) Act - 1972**
- **Water (Prevention and Control of Pollution) Act - 1974**
- **Territorial Water, Continental Shelf, Exclusive Economic Zone and other Marine Zones Act - 1976**
- **Water (Prevention and Control of Pollution) Act - 1977**
- **Maritime Zone of India (Regulation and fishing by foreign vessels) Act - 1980**
- **Forest (Conservation) Act - 1980**
- **Environmental (Protection) Act - 1986**
- **Coastal Zone Regulation Notification - 1991**
- **Wildlife (Protection) Amendment Act - 1991**
- **National Conservation Strategy and Policy Statement on Environment and Development - 1992**

India, inspite of being a signatory to the Ramsar Convention on Wetlands and the Convention of Biological Diversity, there is no significant development towards sustaining these ecosystems, either due to lack of coordination among agencies involved or lack of awareness of the values of wetlands among the policy makers and implementation agencies. The effective management of these wetlands requires a thorough appraisal of the existing laws, institutions and practices. The involvement of various people from different sectors is essential in the sustainable management of these wetlands.

Apart from government regulation, better monitoring mechanisms are needed to increase the knowledge of the physical, chemical and biological characteristics of wetland resources, their values and a better understanding of wetland dynamics. Management based on accurate knowledge and increased awareness of wetland issues involving all stakeholders and all components of ecosystem help in long term sustenance involving restoration and conservation. This would enhance the function and value of the system in terms of natural and socioeconomic factors to satisfy critical resource needs of the human population.

ACKNOWLEDGEMENT

The Ministry of Environment and Forests, Governemnt of India and Indian Institute of Science have provided the financial and infrastructure support. This paper summarises the efforts of many individuals involved in wetlands research. We thank all of them with special reference to Ms. Deepa, R.S., Ms. Ranjani V.G., Mr.Rajinikanth and Mr.Kiran.