Conservation and Management of Mansagar Lake of Jaipur - A Model Study

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ABSTRACT

A lake is an ecosystem, a community of interaction among animals, plants, microorganisms and the physical and chemical environment in which they live. Critical to any lake ecosystem is the lake’s watershed, the surrounding land area that drains into that particular lake. Most of the lakes in India, both natural and man-made, are in different states of degradation. Watershed degradation, which occurs through deforestation, overgrazing, intensive agriculture, urbanization and industrial development, is the most important cause of degradation of both natural and man-made lakes. The degradation of lakes has both direct and indirect consequences for humans. Conservation of lakes requires several actions to be taken together. The first and foremost are the actions required to prevent further degradation by controlling and regulating various activities that cause it. Recognizing the many functions and values of lakes, particularly those in or near major urban areas and the need to conserve and manage these waterbodies, the Government of India is putting in efforts through National Lake Conservation Plan (NLCP) to cater to the need in different states. The present Paper highlights some of the major issues / activities involved under National Lake Conservation Plan in the conservation and management of Mansagar Lake of Jaipur (Rajasthan) as a model study.

Keywords: ecosystem, watershed, degradation, regulation, environment, model, study

INTRODUCTION

The inland freshwater eco-systems both lentic and lotic, are being increasingly subjected to great stress from various human activities (National Academy of Science 1969, and Duncan and Rzoska 1978). Watershed degradation, which occurs through deforestation, overgrazing, intensive agriculture, urbanization and industrial development, is the most important cause of degradation of both natural and man-made lakes. The eutrophication of water, which means enrichment with nutrients and the resulting degradation of its quality accompanied by luxuriant growth of micro- and macrophytes, is recognized as a major problem for lake ecosystems in the developed as well as developing countries. The enrichment of nutrients occurs due to the disposal of domestic and farm sewage, industrial effluents and from the runoff from surrounding areas especially the eroded catchments and agricultural lands. Vollenwieder (1968), reviewing the literature on eutrophication of lakes and flowing waters, pointed out that the domestic sewage is a major source of eutrophication. In developing countries, in general, there are hardly any facilities for sewage treatment. In India only a few of the cities with more than a million population have sewage treatment plants for a part of their total sewage. The domestic sewage is disposed of in many surface waters with partial or no treatment. Many other human activities such as solid waste disposal and land reclamation in shallow margins of lakes are also serious problems in the management and conservation of lakes, particularly those in urban areas.

In India there are large number of man made lakes in and around urban centers. These lakes were created for irrigation, drinking water supply or recreation by the former rulers. During past few decades most of these lakes have become highly degraded due to neglect and waste disposal. Recognizing the many functions and values of lakes, particularly those in or near major urban areas and the need to conserve and manage them, the Ministry of Environment & Forests (MoEF) has initiated a National Lake Conservation Plan (NLCP) with a focus on important lakes throughout the country.

NATIONAL LAKE CONSERVATION PLAN

The Government of India approved the National Lake Conservation Plan in May, 2001 with the objective to restore and conserve the polluted and degraded urban lakes of the country. To begin with, NLCP covered urban lakes, especially those not covered under the Wetlands programme of the Ministry, with the scope of activities to be expanded to include the rural waterbodies at a later date. The activities under NLCP include the following:-

- Prevention of pollution from point sources by intercepting, diverting and treating the pollution loads entering the lake.
• In situ measures of lake cleaning such as Desilting, Deweeding, Bioremediation, constructed wetland approach etc. depending upon the site conditions.
• Catchment area treatment and Lake Beautification, which may include bunding, fencing, creation of facilities for public recreation and entertainment (Children Park, boating etc.) and public area.
• Public awareness and public participation.
• Other activities depending upon location specific conditions including the interface with human population.

The implementation of NLCP is expected to result in improvement of lake ecology and add to the aesthetic and tourism value. The beneficiaries of the scheme would be the State Governments, local bodies and the local population.

During the execution of lake management plan, it will be essential to ensure that the lake water quality conforms to the mandatory quality standards. The first and foremost are the actions required to prevent further degradation by controlling and regulating various activities that cause it, and therefore, the NLCP lays great stress on the abatement of pollution and improvement of the catchment on priority.

One such important lake is Mansagar popularly known as Jalmahal (Fig 1), presently under a phase of major shift in its limnology in near future due to ongoing MoEF, New Delhi supported lake restoration program to Jaipur Development Authority (JDA), Jaipur. Government of India under its National Lake Conservation Plan has undertaken ecological restoration of Mansagar Lake in December, 2002 at a cost of Rs. 24.72 crore with 70:30 funding pattern between the Central and the State Government. With a view to manage the lake sustainably on a long-term basis, various potential project components have been integrated into a comprehensive development plan. Since Mansagar Lake lies on the tourist belt of Jaipur and offers potential for other tourism attraction sites, it was considered to be pertinent to link the lake management plan with the potential tourism attraction sites. The project area comprises of three main project components namely
(i) Mansagar Lake, (ii) Jalmahal Monument and (iii) Mansagar Lake Precinct

The present paper deals with the issues related to the Mansagar Lake only. However as regards other two components as mentioned above Government of Rajasthan (GOR) proposes to implement the same on public - private partnership model by way of restoration of Jalmahal monument and development of tourism and recreation facilities in an environment friendly manner along the developed lake front area.

MANSAGAR LAKE

Mansagar Lake is located on the northern out-skirts of the Jaipur city (26° 49' N Lat., 75° 48' E Lat.) in the semi-arid monsoonic climate zone in western India. The reservoir, constructed about 400 years ago is flanked by hills on western, northern and eastern sides (Fig 2). The Mansagar Lake is a man made waterbody, created by damming Darbhawati river on the north side of the Nahargarh fort around 1610 A.D. by Raja Man Singh I, the then ruler of Amer, for irrigation and recreation. A palace was built in the middle of the lake and a temple on its northeastern end. In 1962, the sewage from the walled city of Jaipur was diverted into the lake as it was no more used for recreation and the palace had been abandoned. It resulted in rapid silting; the water storage capacity decreased considerably and the palace got submerged to a depth of 3 m or more during the rainy season. The hills surrounding the lake have for decades been subjected to extensive deforestation rendering them almost bare.

The lake was approximately 139 ha in its full spread (in 1970s) and has a catchment area of 23.5 sq. km. Out of the total catchment area approx. 40 % falls inside dense urban area. Rest of the catchment area is in the form of denuded Aravalli Hills.

Silting of the lake occurs mainly from this part of the catchment. The average depth of the lake varies between 1.5 to 4.5 metres. Fig 3 illustrates the location of Mansagar Lake in Jaipur city. During the past half century, considerably large area of the lake on its south have been reclaimed and encroached upon by construction. Most of the shallow marginal areas of the remaining lake have been under agriculture - mostly vegetables, for the past several decades. In 1981, unprecedented heavy floods in Jaipur brought enormous quantities of silt and sand from the south east side and very large area of the lake got silted up further within a few days.
ISSUES RELATED TO LAKE POLLUTION

The major issues in Lake Mansagar are related to pollution and catchment degradation. These are discussed below briefly:

Inflow of Wastewater: The lake on the natural course of drainage of north Jaipur in the past few decades has been receiving a steadily increasing flow of partly treated wastewater and untreated wastewater with severe contamination. During heavy showers, the wastewaters and runoff waters get mixed and enter the lake through the various influent nallas. The foremost problem affecting the lake is the inflow of wastewaters through the Nagatalai and Brahampuri Nallas (Table 1). Prior to major urbanization in the area, these were probably seasonal streams bringing in the rainwater runoff from the hills. However, consequent to uncontrolled urbanization without sewerage facilities, the two nallas now flow regularly bringing in a heavy load of pollutants into the waterbody leading to an undesirably high level of nutrients. The catchment area of these nallas now appears to have several household industries, which also contribute their pollutant load en route. This has lead to the growth of algal bloom and weeds resulting in turbidity and oxygen depletion affecting aquatic biota and decreasing sunlight penetration. The decay of plants and their settlement on the lakebed lead to land formation and reduction of lake volume. Additionally, suspended matter settles in the lake, which acts as a settling pond.

Table 1: Physico-chemical characteristics of Mansagar Lake in May, 2000

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Brahmpuri Nala</th>
<th>Nagtalai Nala</th>
<th>Lake (Center of water body)</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.6</td>
<td>7.7</td>
<td>8.2</td>
</tr>
<tr>
<td>B.O.D.</td>
<td>230</td>
<td>140</td>
<td>46</td>
</tr>
<tr>
<td>C.O.D.</td>
<td>707.2</td>
<td>457.6</td>
<td>130</td>
</tr>
<tr>
<td>Chloride (Cl')</td>
<td>280</td>
<td>330</td>
<td>500</td>
</tr>
<tr>
<td>Sulphate (SO4&quot;)</td>
<td>5</td>
<td>38</td>
<td>55</td>
</tr>
<tr>
<td>Phosphate (PO4&quot;)</td>
<td>13.45</td>
<td>10</td>
<td>1.75</td>
</tr>
<tr>
<td>Nitrate (NO3&quot;)</td>
<td>37</td>
<td>33</td>
<td>19</td>
</tr>
<tr>
<td>Total Dissolved Solids</td>
<td>1840</td>
<td>1840</td>
<td>1830</td>
</tr>
<tr>
<td>Total Suspended Solids</td>
<td>560</td>
<td>490</td>
<td>180</td>
</tr>
<tr>
<td>Turbidity</td>
<td>80</td>
<td>34</td>
<td>14</td>
</tr>
</tbody>
</table>

Note: All results are in mg/l except pH.

North Zone Sewage Treatment Plant (STP): The north zone sewage treatment plant treats domestic wastewater only partially, leaving the effluent with primary treatment characteristics. The STP has limited capacity to treat the wastewater and requires expansion.

Eutrophication: Due to water stagnation and limited net outflow from the lake, the quantity of nutrient in the lake builds up constantly. This resulted in rapid eutrophication. The high amounts of nutrients encourage excessive phytoplankton and algal growth that covers the water surface. Due to this, light is unable to penetrate to lower levels affecting the survival of submerged macrophytes.

Siltation: Erosion of soil from the hills north of the lake during rains brings in silt deposits into the lake adding to turbidity and reduction in the water holding capacity. This process has been going on for several decades. Each year, silt deposits are added to the lakebed turning the lake shallow and the bed rich in nutrients.

Water Balance of the Lake: A significant issue in the lake management is the amount of water, which changes seasonally. Over the duration of a year, the water volume in the lake declines from a maximum of 3.13 million cubic metres (MCM) to a minimum
of 0.36 MCM from October to following June. Similarly, the surface spread over the same period declines from 139 ha to 49 ha. Correspondingly, the depth decline from a maximum of 4.5 m to only 1.5 m at the deepest location. The lake being on the natural course of drainage of North Jaipur, receives a steadily increasing flow of partly treated and untreated wastewater. During heavy showers the wastewater and runoff water gets mixed and enters the lake through the Nagatalai and Brahmpuri Nallas. Presently, the water balance in the lake is based on the following factors:

**Inflows:**
- Direct rainfall over the lake surface
- Runoff from the catchment and
- Partially treated wastewater inflow from the north zone STP which is coming mixed with untreated wastewater inflow from the Nagatalai and Brahmpuri Nallas catchment.

**Outflows:**
- Percolation losses through lakebed
- Evaporation losses from water surface
- Spill over of monsoon waters and
- Outflow for irrigation

While natural losses by evaporation and percolation cannot be controlled, the deliberate letting out of the waters for irrigation can be controlled in a balanced way so as to maintain a certain requisite minimum water quantity in the lake. Siltation has reduced the water storage capacity and is another factor influencing water balance.

**Lake Water Quality:** The lake is suffering from serious problems of siltation and settled deposits containing nutrients and other contaminants from the inflow of wastewaters, decrease in surface area due to artificial land formation as a result of eutrophication especially in south – east corner, decline in surface area spread with the onset of summers in part due to the outflow of waters for downstream irrigation. There is a difference in water quality of the lake on its northern and southern side due to the latter receiving the sewage inflows resulting in chemical and organic waste depositions. Owing to a high level of pollutants in various influent flows, the surface water quality of the lake is rated very poor. The resultant high level of nutrient has led to the algal bloom (microphytes). Land formation as a result of decayed plant deposits is evident especially near the outfalls of the major nallas. The lake thus tends towards hypertrophic to dystrophic condition. The dissolved oxygen is low and thus there is a near absence of fish in the lake.

The lake had been studied extensively during 1978-79 for water quality changes and plankton communities and their production (Sharma et al. 1978, Goel et al. 1980 a,b). A survey of the water quality was made during the year 2000 (Table 1) and is again being carried out currently with the help of University of Rajasthan, Jaipur. The data (Sharma et al. 2006-07) show that the water quality has continuously deteriorated even in recent years (Table 2 a, b) through a program for monitoring of water quality initiated for the following parameters:

### Table 2a: Physico-chemical characteristics of lake water in July, 05 & 06.

<table>
<thead>
<tr>
<th>Sites/Year</th>
<th>pH</th>
<th>EC</th>
<th>Dissolved Oxygen</th>
<th>Chemical Oxygen Demand</th>
<th>Biological Oxygen Demand</th>
<th>Sulphate</th>
</tr>
</thead>
<tbody>
<tr>
<td>15th July, 05 *</td>
<td>5.2</td>
<td>2.8</td>
<td>2.8</td>
<td>228</td>
<td>210</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td>7.7</td>
<td>2.5</td>
<td>4.9</td>
<td>224</td>
<td>115</td>
<td>117</td>
</tr>
<tr>
<td>13th July, 6 *</td>
<td>8.12</td>
<td>3.21</td>
<td>1.84</td>
<td>240</td>
<td>167</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>8.32</td>
<td>3.24</td>
<td>1.91</td>
<td>256</td>
<td>159</td>
<td>194</td>
</tr>
<tr>
<td>29th July, 06 **</td>
<td>9.55</td>
<td>2.98</td>
<td>14.6</td>
<td>205</td>
<td>149</td>
<td>328</td>
</tr>
<tr>
<td></td>
<td>9.74</td>
<td>2.81</td>
<td>13.6</td>
<td>184</td>
<td>124</td>
<td>296</td>
</tr>
</tbody>
</table>

Sampling time: * Morning at 7.30am; ** Noon at 12.30pm

### Table 2b: Physico-chemical characteristics of sediment samples of Mansagar Lake

<table>
<thead>
<tr>
<th>Sample site</th>
<th>pH</th>
<th>EC</th>
<th>Chlorides</th>
<th>Organic matter (%)</th>
<th>TKN mg/100g</th>
<th>IP mg/100g</th>
<th>TP mg/100g</th>
<th>Na mg/100g</th>
<th>K mg/100g</th>
<th>Ca mg/100g</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Sediment: Fresh deposit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.0m</td>
<td>7.6</td>
<td>0.2</td>
<td>3.0</td>
<td>0.135</td>
<td>4.4</td>
<td>2.57</td>
<td>31.1</td>
<td>550</td>
<td>2300</td>
<td>900</td>
</tr>
<tr>
<td>0.5m</td>
<td>7.5</td>
<td>0.1</td>
<td>2.0</td>
<td>0.883</td>
<td>12.9</td>
<td>2.75</td>
<td>42.9</td>
<td>825</td>
<td>2950</td>
<td>975</td>
</tr>
<tr>
<td>1.0m</td>
<td>7.4</td>
<td>0.2</td>
<td>2.0</td>
<td>0.260</td>
<td>4.4</td>
<td>4.55</td>
<td>38.3</td>
<td>775</td>
<td>2500</td>
<td>1025</td>
</tr>
<tr>
<td>1.5m</td>
<td>8.0</td>
<td>0.2</td>
<td>2.5</td>
<td>0.105</td>
<td>3.1</td>
<td>2.41</td>
<td>22.1</td>
<td>650</td>
<td>2825</td>
<td>1000</td>
</tr>
<tr>
<td>2. Sediment: Old deposits</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lake bed</td>
<td>7.2</td>
<td>1.4</td>
<td>2.7</td>
<td>9-52</td>
<td>2.1-2.3</td>
<td>147-214</td>
<td>15-20</td>
<td>256</td>
<td>383</td>
<td>115-255</td>
</tr>
<tr>
<td></td>
<td>7.3</td>
<td>1.4</td>
<td>2.7</td>
<td>9-52</td>
<td>2.1-2.3</td>
<td>147-214</td>
<td>15-20</td>
<td>256</td>
<td>383</td>
<td>115-255</td>
</tr>
</tbody>
</table>

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**Physico-chemical:** pH, EC, total dissolved solids (TDS), dissolved oxygen (DO), phenolphthalein alkalinity (PA), total alkalinity (TA), chlorides (Cl), total hardness (TH), chemical oxygen demand (COD), bio-chemical oxygen demand (BOD), total kjeldhal nitrogen (TKN), inorganic phosphorous (IP), total phosphorous (TP) etc.

**Biological:** MPN Counts for E. coli, Pseudomonas aeruginosa and species of Klebsiella

A comparison of 2005 and 2006 data revealed an increase in the values of almost all parameters, more particularly pH, conductivity and sulphate content (Table 2a). The notable exception was dissolved oxygen (morning) content that decreased markedly in morning hours. A very high value of dissolved oxygen is ascribed to maximum rate of photosynthesis in the noon. The leachate of freshly deposited sediment from the allocated area of Jalmahal Resorts Pvt. Ltd. may also be toxic to lake fauna. Thus lack of oxygen and heavy metal toxicity seems to be the possible explanation of mass mortality of fish in the Jalmahal. Old deposits are also found to have good reservoir of biogenic minerals responsible for algal bloom in the lake.

**Migratory Bird Habitat:** Mansagar Lake is the habitat to a variety of migratory and resident birds. Water provides sustainable living to countless species of the aquatic ecosystem like fish, birds, insects, microorganisms and aquatic vegetation. The lake attracts more than 150 species of migratory and resident birds especially from September to March-April, which feed upon the aquatic fauna and flora. These birds give Jalmahal and the lake a fascinating natural character. However, owing to deficiency of fish population as well as a lack of habitat, the residential or migratory bird population is not high. The adjacent reserved forest area is scantily vegetated and thus does not offer much by way of food or habitat

**LAKE MANAGEMENT AND RESTORATION PLAN FOR MANSAGAR**

For the Mansagar Lake, pollution control through diversion and treatment of wastewaters, desilatation, bioremediation and catchment treatment have been included. Various activities that have been approved and/or implemented under it are:

- Realignment of Drains
- Desilting of Lake
- Settling Tank near Amer Road
- STP & Wetland construction
- Insitu Bioremediation
- Analysis of Water Quality and Sludge/sediment

- Afforestation of the Lake
- Lake Front Promenade
- Nesting Island
- Checkdam

The objective of the project is to supply a regular flow of tertiary treated wastewater to the Mansagar Lake to maintain the lake water level within a desirable range and control the nutrient inputs to the lake. The makeup water required will vary from 4 million liters per day (MLD) during post monsoon and winter season (October to March) to 7 MLD during the summer months (April to June). Generally no wastewater inputs will be required during the monsoon (July to September). In the years of deficient rainfall, however, it may be necessary to input upto 7 MLD treated wastewater into the lake to makeup for the deficiency of surface run-off.

At present, there is only one sewage treatment plant with a treatment capacity of 27 MLD with an extended aeration process. The effluent of this plant has become vital to the sustenance of the lake, which would otherwise dry up in summers. In order to ensure the good condition of lake, it would be essential to maintain the following water quality parameters at post-STP stage:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>6.5 - 8.5</td>
</tr>
<tr>
<td>BOD</td>
<td>&lt; 20 mg/l</td>
</tr>
<tr>
<td>COD</td>
<td>&lt; 20 mg/l</td>
</tr>
</tbody>
</table>

As treated wastewaters are needed to replenish the lake, a tertiary treatment system is proposed, which would receive wastewaters after above-mentioned secondary treatment from the STP. Constructed Wetlands are proposed to be developed for the purpose. Constructed wetlands are now emerging as a low cost, eco-friendly alternative to conventional treatment systems for tertiary treatment of wastewater. The objective of the TTF is to exercise control on the bio-chemical oxygen demand (BOD) as well as nutrient inputs in the lake in terms of total phosphorus (TP) and total nitrogen (TN). Wetlands are able to filter and hold 60-90% of suspended solids and sediments from wastewaters. The main types of aquatic plants used in constructed wetlands are the common reeds Eichhornia Crassipes (Phragmites Australis) and Cattails (Typha latifolia). These plants have a root system of rhizomes that are capable of releasing oxygen in the root zone or sub surface zone, developing an aerobic zone around the rhizomes and base of stems. Consequently wastewater passing through the wetland encounters alternate aerobic and anaerobic zones. The root zones support aerobic and anaerobic populations and the rest supports anaerobic microbial populations.
PUBLIC-PRIVATE PARTNERSHIP

Given the nature and characteristics of the project, a public-private partnership was considered desirable so as to sustain the lake maintenance on a continuous basis. The following activities have been proposed in the lake precinct after restoration to be used for tourism and recreation facilities:

- Development of sports and sailing club in the lake
- Development of new restaurants, handicraft-shopping complex etc.
- Development of traditional food restaurants, amusement park and children parks in the surrounding area
- Development of bus stops, private car/two-wheeler parking area

The revenue generated from the above activities managed by the private partner will be used for the maintenance of the lake, thereby ensuring sustainability. Thus, the management plan expects that the lake water quality will gradually improve, and future pollution will be prevented. The lake surroundings will be enhanced aesthetically, and the recreational facilities will provide revenue for the management.

Whereas considerable amount of work as regards the two components of the plan i.e. Precinct area and the Jalmahal Monument, are in different stages of progress, as regards the Mansagar Lake component, following has been achieved till date (Fig 4 & 5)

- The desilting work is completed
- Excavation work regarding diversion of Nallas is complete and 90% masonry work is over
- Land leveling and dressing work in the precinct area is virtually completed. Landscaping work is under process
- Sedimentation basin along with natural wetland has been created to tap silt and organic load before the water gets into the lake and arrangements have been made for regular mechanical/manual cleaning

The Mansagar Lake Area comprises of components that are diverse in nature and hence the project beneficiaries and stakeholders also reflect diversity

Tourism Community: The Amer Road, along which Mansagar lake is situated, is a major tourism strip of Jaipur City. The establishments along the road house number of handicraft emporiums and eateries. Apart from these attraction points, a network of tourist interest sites is situated in the project influence area. The Maharani ki Chattri on the Amer Road, the Kanak Temple Complex in North, the Parasram Dwara on the Amber road, and the Royal Cenotaphs on Amer road are major tourist attraction. Restoration of Mansagar Lake Area including Jalmahal Monument would be major stimulus for the conservation of important elements of cultural heritage of the project area.

Figure 4: Lake Monument & Precinct

Figure 5: Lake Precinct

BENEFICIARIES OF THE LAKE RESTORATION PLAN

The Project would integrate these tourism sites and lead to the conservation and revitalization of traditional arts, food handicrafts, festivals, drama, customs and ceremonies will add to the cultural benefits to the city. From an economic perspective the project would generate additional economic benefits as well provide for employment generation

Improvement of ground water: At present since the majority of the sewage is flowing to the lake body untreated there is severe contamination of the ground water in and around the lake area. This contamination makes the ground water unfit for drinking and in addition results in a serious health hazard. Through the project the lake would receive treated water and the lake would be maintained on a continuous basis. This is expected to drastically reduce the extent of health hazard presently posed by the contaminated lake

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Migratory birds: The project area attracts a number of migratory birds during the winter season. In order to enhance the projects’ attractiveness to the various species, special attention is being made to develop nesting islands within the lake. Further, the attractiveness of the annual bird watching fair would be further enhanced.

State Government: The project provides a replicable format for Lake Restoration Projects to be implemented on public - private partnership basis. This would strengthen the Public - Private Enterprises in developing their expertise and skills in project implementation. This is the first lake conservation project sanctioned by MoEF, GoI for the State of Rajasthan. Further, while sanctioning the grant amount, MoEF, GoI has been quite appreciative of the sustainability model, and has recommended that a similar structure be considered for other Lakes and other such environmentally sensitive restoration. An effort has thus been made to address the project in a replicable format so that the issues and the lessons learnt can be utilized elsewhere for a similar project to rescue another wetland from eutrophication and extinction.

REFERENCES


