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Tragedy of the Commons – Bhoj Wetland

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ABSTRACT: The tragedy of the commons concept was first introduced by Garrett Hardin. It focuses on how the common resources are exploited according to individual's self interest to the extent that it becomes difficult to retain it to its original form. This paper shows how individual's benefits outweighed his costs and he overused the Bhoj wetland, which is a Ramsar site comprising of Upper and Lower lakes of Bhopal, Madhya Pradesh, India. These lakes are of immense importance since they are inseparably linked with the socio, economical and cultural aspects of the people of Bhopal and are referred as lifelines of the city. But this wetland faced a tragedy which the legal framework has tried to control. The basic objective of the paper is to study and compare the changes this common property suffered before and after the implementation of an integrated lake conservation programme during 1995-2005 through a Project Directorate directly controlled by Housing & Environment Department with the financial assistance of JBIC (Japan Bank of International Cooperation) under the Government of Madhya Pradesh. Recommendations of strategies for sustainable management of these wetlands are made which needs to be implemented.

Keywords: Tragedy of The Commons, Sustainability, Integrated Lake Conservation Programme, Bhoj Wetland

I. INTRODUCTION

Around 58.2 million hectares wetlands of India are important repositories of aquatic biodiversity. A variety of wetland systems ranging from high altitude cold desert wetlands to hot and humid wetlands in coastal zones with its diverse flora and fauna [1] resulted due to diverse eco-climatic regimes extant in the country. These wetland resources are depleting at a fast rate now. The conversion of wetlands to other forms of land is because most of the benefits from the wetlands are non – marketable and hence not valued. Therefore, they are facing this tragedy.

The tragedy of the commons concept was first introduced by Garrett Hardin where he concluded that commonly held resources are exploited according to individual self interest and the resources will be overexploited and destroyed by the same people who benefit from them. There is a maximum sustainable yield level, a balance at which they may be exploited indefinitely with no reduction of productivity. Development of wetlands often leads to loss of environmental benefits which are unfortunately understated. The reason is that they have never been valued are due to the lack of suitable market for them

The master plan for Upper Lake (Bhoj Wetland) is being prepared by Urban Administration and Development Directorate, Govt. of M.P. through Centre for Environmental Planning and Technology (CEPT) University Ahmadabad, Gujarat. The lake master plan would define the land use in and around the catchment area of the Upper Lake and will suggest the conservation work. Draft master plan has been prepared. Suggestions were also sought from people, experts, and stakeholders keeping in view water management, environmental aspects, heritage and socio – economic development of people. Besides this, Urban Administration and Development Department through Bhopal Municipal Corporation is preparing conservation plan of 10 lakes of Bhopal for external funding.

Valuation is thus an important step towards improving the management of these wetlands.

Economic value can be defined as an attempt to assign quantitative values to the goods and services that are provided by environmental resources, whether or not market prices are available for them.

Table 1: Salient Features of the Upper Lake &Lower Lake of Bhopal.
(Source: SAPROF Report, 1994. FTL – Full Tank Level, MGD – Million Gallons per Day)

S. No.	Item	Lower lake	Upper Lake
1.	Constructed in	Late 18th century	11th century
2.	Type of dam	Earthen dam	Earthen dam
3.	Location : Longitude Latitude	$77^0$24' – $77^0$26' $23^0$14'30" – $23^0$15'30"	$77^0$18'-$77^0$24' $23^0$13' - $23^0$16'
4.	Catchment area km sq. (sq. miles)	9.6	361 (141)
5.	Submergence area at FTL / water spread area km sq. (sq. miles)	0.90	30.72 (13.9)
6.	Maximum water level RL m (ft)		508.65 (1666.80)
7.	Dead storage level RL m (ft)	499.88	503.53 (1652.00)
8.	Storage capacity 10^6 m^3 (mft cube)	8 (282.5)	101.6 (3588)
9.	Deepest bed level RL m (ft)		499.26 (1638.00)
10.	Maximum depth m (ft)	9.4	11.7 (38.4)
11.	Mean depth m (ft)		6.0 (19.7)
12.	Total length of weir m (ft)		102.1 (335)
13.	Crest level of spillway RL m (ft)		504.38 (1654.80)
14.	Designed flood discharge m3/sec		2208
15.	Moderate flood discharge m3/sec		538.02
16.	Sewage water inflow m3/day (MGD)		33080 (7.3)

Economic valuation is actually concerned with the proper allocation of environmental resources in order to improve human welfare. It thus serves as a very important tool in the hands of the decision of policy maker.

Presently, Bhoj Wetland of Bhopal, Madhya Pradesh, India, is one of the identified wetland of India as Internationally known Ramsar Site [2]. It comprises of two lakes – the Upper and the Lower Lakes. It originated as manmade lakes primarily to supply drinking water to the city's population and over the years they attained features of wetland and started providing multiple functions like commercial fishing, recreation etc [3]. It has so happened that multiple benefits are extracted but little attention has been paid on the maintenance of these wetlands and so this natural resource is being overexploited [2].

II. FUNCTIONS AND VALUES OF BHOJWETLANDS

The water quality in the lakes has deteriorated largely mainly over the last couple of decades. The urban wetlands are constantly degrading on account (2) of various anthropogenic activities like urban development encroachment, flow of domestic sewage, pesticides, fertilizers and industrial effluents, over fishing, boating, infestation with aquatic weeds and eutrophication, disturbances from excessive recreational activities and tourism, diversion of water from irrigation, domestic use or industrial uses [2]. The silting rate is estimated to be about 1 cm to 2.58 cm per year on an average. The estimated sedimentation rate from the catchment area is in the tune of 3.67 ha.m/100 km^2 / year (SAPROF Report, 1994), which is a major threat to the Bhoj wetland. Despite multiple direct and indirect benefits like for domestic use, generating employment, maintaining microclimate stability and providing ample recreational opportunities, etc. , the very existence of the wetland is threatened due to solid waste pollutants, sewerage (7,500 m3/ day of sewage water and 360 m3/ day of animal liquid discharge [1] washermen, trap cultivators, encroachment, weeds and eutrophication idol and tadia immersion etc.

It has been found that there are some 8359 huts and houses in the catchment area of the Upper Lake. The total population in the area amounts to nearly 44,166. Everyday some 2000 persons use the lake waters for bathing, washing clothes and cleaning vehicles. Some 15,000 domestic animals such as buffaloes, cows, oxen, pigs, goats etc are to be found in the catchment area. 2845 hectares of land is used for agriculture and 692 as pastureland for grazing animals. The farmers usually grow two crops in a year of wheat, rice, jowar, makka, pulses, gram, vegetables, etc. For all these crops fertilizers like Urea, Growmore, Compost, etc. are used. Few farmers also use herbicides and pesticides. Most of the agriculture residues find their way into the Upper Lake as run-off. (Environmental Status Report of Upper Lake, Bhoj Wetland, Bhopal).

III. TECHNIQUE OF VALUATION OF BHOJ WETLAND

The major techniques of valuation were used to capture varied values and were direct valuation by summing up direct prices obtained either from market price or otherwise estimated.

It delivers significant 'ecological services' like those of stabilization of the local (micro) climate, maintenance of a rich biodiversity and re-charging of underground aquifers besides having huge 'heritage value'. (HT, 2007) The Economic Valuation of the Bhoj Wetland encompasses all values that have been currently extracted and have been calculated as part of this study. The values are supposed to capture intrinsic values as well as the extrinsic ones.

Their economic valuation could yield a decision to generate the much-needed funds (currently unavailable) for the lake's protection and copybook upkeep by levying appropriate 'conservational cess' on the users of its 'consumptive' products and 'non-consumptive' services, and by way of sanction of appropriate governmental grants for its 'ecological services'.(HT, 2007).

IV. PROJECT UNDERTAKEN FOR CONSERVATION AND PROTECTION OF WETLAND

An integrated plan for the conservation and management of the lakes was conceived by State Government and implementation of the same was started in 1995 through financial assistance of Japan Bank for International Corporation of Japan.

Considering the importance of water resources of the State, Ministry of Environment & Forests, Govt. of India has recognized the Upper & Lower lakes of Bhopal as wetland of national importance and designated them as Bhoj Wetland and in 2002, it was declared a Ramsar site. The conservation and management action plan implemented under Bhoj wetland Project through 18 sub – projects.

V. ANALYSIS & RESULTS

The values so estimated using various valuation techniques are summarized in the following table.

Thus the exercise presented above demonstrates substantial generation of values in terms of actual use values and shows high dependence of people for various uses of Bhoj Wetland.

The conservation and management action plan implemented under Bhoj Wetland Project through 18 sub-projects are as follows, helps us identify the changes in the wetland due to the projects.

Table 2: Estimation of Economic Values of Bhoj Wetland.
(Source : M. Verma, Economic Valuation of Bhoj Wetland)

Value (in Rs)	Uses / Impacts
9,54,13,962	**Drinking Water**
49,20,000	**Fish Production**
24,37,880	**Boating**
36,00,000	**Washing of clothes**
12,00,254	**Water borne Diseases**
4,84,68,956	**Recreation**
50% difference in property prices	**Increase in property Prices**

VI. CONCLUSION

The environmental health of the Bhoj Wetland gets duly reflected in prevalence of water borne diseases. Water purification cost incurred by individuals is a reflection of people's willingness to pay for obtaining pure water. (Verma, Economic Valuation of Bhoj Wetlands for Sustainable Use, 2011)

Finally, using the results that have emerged from the entire project, a set of recommendations –technical and policy related have been developed in order to provide a firm basis for further activities concerning the Bhoj Wetland. It is hoped that the authorities that matter would keep the recommendations in mind while implementing the current work and also before taking up fresh activities in the Wetland.

Table 3: Projects and the changes caused due to them in the Wetland.
(Source : file:///C:/Users/A/Downloads/Reply-on-behalf-of-Madhya-Pradesh.pdf)

S.No.	Sub - Project	Conservation Works Implemented
1.	Sewerage System	Sewerage Infrastructure of laying of 86.7 km sewer pipeline through congested human settlements and construction of 8 sewage pump houses and 4 treatment plants for diversion and treatment of 56 MLD domestic sewage were developed.
2.	De-silting & Dredging	About 85,000 mt.^{3} silt was removed through dredging from Lower lake. 2.93 M mt.^{3}silt was removed from 5 zones around the periphery of the Upper Lake. The storage capacity of Upper Lake was increased by 3% and 1.06% in lower lake due to de-silting and dredging.

S.No.	Sub - Project	Conservation Works Implemented
3.	Deepening and widening of the Spill Channel	The deepening and widening works were carried out in 2.6 km of the spill channel to accommodate a required discharge of 566 cum/sec. and about 0.987 M m^3. of silt was removed to increase storage capacity.
4.	Creation of buffer zones between the lake and the human settlements	Encroachments from the shore of Upper Lake were removed and a 5.4 km Link road on the north-east and a 2.5 km long Lake View Promenade on the south east fringe of Upper Lake were constructed. About 17 lakhs plants have been planted in over 1000 hectare land for over a period of 12 years in the catchment area of the lake to create buffer zone and to control soil erosion and human intervention. Besides this, about 2.02, lakhs of plants were distributed to the farmers and planted in the catchment area under social forestry program.
5.	Weed Removal	Nutrient enrichment of lakes due to inflow of untreated sewage and run off containing organic wastes from urban and rural areas caused excessive growth of aquatic vegetation within the lake area. Different types of weed such as shoreline (Ipomeafistulosa), emergent (Scirpusroylie& Cyprus rotandus, Polygonumglabrum& Ipomoea aquatic), floating weed (Water hyacinth) and an assemblage of submerged weeds were removed with a view to offload nutrients and prevent accelerated evapotranspiration of lake water, controlled weed removal operation in and around Upper and Lower Lakes.
6.	Catchment Area Treatment	75 check dams made of loose boulder/gabion structures and 2 silt traps having a cumulative silt trapping capacity of 3.64 lacs cum have been constructed across 31 inlet channels to mitigate inflow of silt, agricultural residues and other wastes into the lakes.
7.	Prevention of pollution due to washing activities	About 250 washer-men families were rehabilitated outside the catchment of Lower Lake having all facilities for living and washing. The vacated land was developed as gardens and parks to create buffer zone.
8.	Improvement of solid waste management system	Bhopal Municipal Corporation was strengthened to cope up additional collection and disposal of 70 MT of solid waste from 18 municipal wards located in the urban catchment of the lakes.
9.	Control of Idol Immersion activities	Alternate idol immersion site on the spillway of Upper Lake was developed and through constant persuasion and intensive awareness campaign, total stoppage of immersion at the traditional site, which was located near the potable water intake point, was brought about. Total diversion of idol immersion from traditional site was achieved in year 2002.
10.	Demarcation of no construction zone	A 50 m and 30 m wide strip of land all along the FTL of Upper and Lower lakes respectively was demarcated as per guidelines of Bhopal Development Plan 2005 to prohibit human intervention.
11.	Restoration of Takiaislan	The Island in Upper Lake has a Mazar of Shah Ali Shah.
12.	Installation of lake water oxygenation systems	15 aeration units (1 ozonizer, 1 ozonizer cum fountain and 4 fountains in Lower lake and 9 fountains in Upper lake were installed for improvement of water quality.
13.	Aquaculture	Herbivore Grass carps along with Indian Major carps were introduced into the lakes to control submerged weeds as well as to maintain ecological balance.
14.	Water Quality Monitoring	Analysis of water quality of Upper lake (18 locations) & Lower lake (14 locations) on regular basis to assess the impact of preventive and curative measures being taken to improve water quality of lakes. Water quality data reveals that there is increasing trend of improvement of water quality in upper lake.
15.	Construction of High level bridge across Bhadbhada spill channel	A 4 lane bridge across Bhadbhada spill channel was constructed in a view of development on the south eastern part of Upper lake and to reduce traffic pressure over the age old Bhadbhada bridge cum spillway.
16.	Public Awareness Campaign	More than 400 awareness programmes were organized during project period. NGOs, colleges, local schools and the general public were involved in creating awareness among the people of Bhopal to save the lakes from deterioration.
17.	Interpretation Center	An Interpretation Centre depicting the origin of Bhoj Wetland, ecosystem structure &function, conservation principles, Bhoj Wetland Project activities, future course of action for the sustainable use of lake eco-system was established near Upper lake to create awareness among the people of all walks of life.
18.	Control of Seepage through the earthen dam of the Upper Lake	The 125 m wide earthen dam of Upper Lake at Kamla Park was built in the 11th century AD with boulder and morrum filling sandwiched between two stone masonry walls at upstream and downstream faces. Later a lime mortar stone masonry tunnel (1.2m wide and 2.9m high) was constructed about 200 years back. This tunnel fitted with a sluice gate is used for releasing seepage/leakage and raw for the Bhopal Municipal Corporation's water treatment Plant. However, due to improper maintenance and growth of vegetation over the bund the displacement of stone masonry wall on the upstream face of the dam took place. There was deterioration of the tunnel. Consequently, seepage through the dam had increased substantially. Moreover, there was a perceived threat to the stability of the dam itself. Reportedly, the leakage had increased to an alarming situation in-spite of corrective measures attempted by the BMC. Considering the distressed status of the dam, the work of restoration and the tunnel and remedial measures to control seepage was done under the project.

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