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A Freshwater Ramsar Site under Pressure- Assessing Threats and Identifying Conservation Needs for Lower Himalayan Lake, Mansar (India)

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ABSTRACT: Lakes are the unique body of water reflecting many characteristics of surrounding watershed and climate. They provide shoreline stabilization and protection against nutrient and sediment retention, mitigate effects of climate change and pollution and are resources for recreation and tourism. But these fresh water resources at present are vulnerable to human induced changes which can bring drastic negative changes in these valuable resources. The study assessed the impact of human activities on lake Mansar and during the study various physico-chemical parameters were assessed for a period of one year (2011-2012) in which turbidity was found above the permissible limits. Lake Mansar due to poor management and increasing human habitation near and around has also being facing major impacts and anthropogenic threats. So immediate conservation measures and management stratergies are of eminent importance.

KEYWORDS: Mansar, anthropogenic pressure, conservation, physico-chemical parameters.

I. INTRODUCTION

Lakes are the prime source of water for drinking, irrigation and other domestic purposes. The lakes contribute globally 0.088% to fresh water resource, which is generally available for drinking [1] and domestic purposes. Lakes are the most productive ecosystems which play a vital role in ensuring both the quantity and quality of water for human beings and the entire range of flora and fauna. They play a crucial role in hydrological cycle, storm and flood control, water supply, providing food, fibre and raw materials, and in recreational benefits besides being a rich repository of biodiversity, and are known to play a significant role in carbon sequestration. They also provide shoreline stabilization and protection against nutrient and sediment retention, mitigate effects of climate change and pollution and are resources for recreation and tourism, transport and other services. However, in recent years, because the rapid development of the local economy and subsequent intensive use of water resources,surface water pollution has become increasingly serious, restricting the sustainable development of the local economies [2] and [3]. Anthropogenic activities result in significantly decrease of surface water quality of aquatic systems in watersheds [4].

As elsewhere the wetlands play an important role in the economic, socio-cultural and religious activities of the people in Jammu and Kashmir. Jammu and Kashmir abounds a number of lakes which in the recent decades have undergone varying degrees of environmental degradation due to encroachment, eutrophication and silt. Most of them have became sink and dumping ground for contaminants and waste material. Lakes all over the world are dying as they have turned into dumping grounds of sewage, industrial and other hazardous waste. Usage of more land for agricultural purposes, soil salinization, and increase in the use of agricultural fertilizers, common pesticide use, and erosion have become problems threatening natural water sources [5].

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II. RELATED WORK

Lakes are unique body of water but at present these fresh water resources are receiving heavy pollution load from surrounding areas in the form of domestic sewage, agriculture waste, eroded soil, surface runoff etc. A lot of work has been done by various workers from different parts of world ([6], [7], [8], [9], [10] and [11]), India ([12], [13], [14], [15], [16], [17], [18], [19] and [20]) as well as in J&K ([21], [22], [23], [24], [25], [26], [27], [28], [29] and [30]) to highlight physico-chemical characteristics of water as well degradation of water quality due to pollution. They have also suggested various remedial measures for conservation and management of these water bodies.

III. STUDY AREA

Mansar lake, the area of present study, lies between 32^0 48'N latitudes and 75^0 23'E longitudes in the Siwalik terrain (Figure 1**).** It is a sub-tropical fresh water lake located 62 km from Jammu, at an elevation of 666 m above mean sea level and has been given the Ramsar status along with another important lake, Surinsar in the region. The lake is surrounded by steep mountain slopes of lower Siwalik hills with surface area of about 0.58 km^2 and lake basin covering an area of about 1.67 km^2 **(**NIH, 1998). Maximum width and length of lake is 1204 and 645 metres, respectively. Circumference of lake is 3.4 km. and maximum depth is 38.25 m.

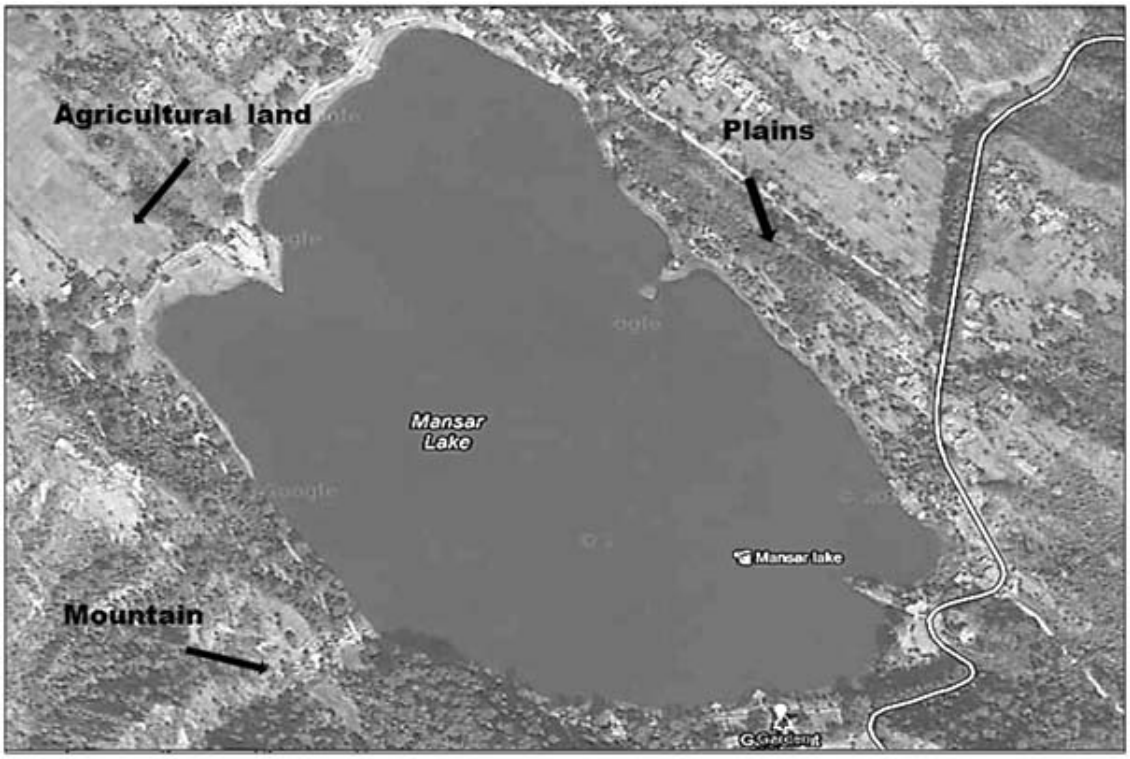

Figure 1. Map of Lake Mansar (India**).**

Considered as a holy site from mythological period, this lake shares the sanctity and legacy of Mansarovar and is socially and culturally very important. It owes its origin to Mahabharata period. Besides, lake also provides an important habitat and breeding ground for fishes and other aquatic life. Numerous migratory birds visit the lake during winter.

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The catchment of the lake comprises of mixed scrub forest which consists of broad leaved plant species. The lake is surrounded by tree species like *Pinus roxburgii* (Pine), *Acacia nilotica* (Kikar), *Mangifera indica* (Mango), *Mallotus phillipnensis (*Kamela), *Bauhina verigata* (Kachnar), *Morus nigra* (Toot), shrubs like *Calotropis procera* (Ak), *Solanum nigrum, Adhathoda vesica* (Adusa), *Ipomea fistulosm* and herbs like Parthenium spp., *Cannabis sativa* and *Xanthium* spp. Ornamental plants around the lake include *Vinca rosea*, Bottle brush, *Thevetia, Tradescantia.* Macrophytic vegetation of the lake is composed of emergent vegetation such as *Hydrilla verticellata, Najas indica, Chara hyaline, Polygonum* spp. *Vallisneria spirallis, Potamageton nodosus, Potamageton crispus, Nitella* spp. and floating vegetation like *Nelumbo nuciferum* and *Nymphoides cristatum*. The lake is the habitat of variety of fishes like *Chana gachua, Puntius conchonius, Rasbora rasbora, Danio rerio* and *Trichogaster fastiatus* and some carps have been introduced in the lake. Due to religious significance fishing is not encouraged in this lake. The lake supports two important species of turtles namely *Lissemys punctata* and *Trionyx gangeticus* listed in CITES - IUCN Redlist 2003. The lake supports very rare Medusae *(Mansariella lacustris*).

Migratory birds visiting the lake during winters include Large Cormont, Darter, Night Heron, Grey Heron, Indian Coot, Common Sandpiper, Indian White wagtail, Rufous black Shrike and Indian Golden Oriole.

Climatically, the area is humid sub tropical (Monsoon type). Average annual rainfall is 1500 mm. and temperature varies from 3^0C (minimum) in winter to 43^0 C (maximum) in summer. Depending upon the temperature and rainfall, there are three main seasons which include summer (mid April to mid June), rainy season (mid June to mid October) and winter season (late November to late February). Two transitional periods representing spring (early March to mid April) and autumn (mid October to late November). Monsoon rains are received from late June to September. Winter is mostly dry with occasional rains during the month of December and January.

Geologically, catchment area of Mansar lake is composed of fine grained sand stone, alternating with silt stone, mud stone and clay of lower Siwalik. Crushed rock substrate of lower Shiwalik forms the porous and permeable zone for recharge of the lake [31].

Habitation and agriculture fields cover the northern and eastern part of the lake catchment. Paddy, wheat and maize are mainly cultivated in farmlands. Northwestern flank is mainly covered with farmlands. Western and southern part of catchment covers about 0.39 km^2. Rainwater enters the lake as overland flow. An initial water balance of lake indicates that the lake is also fed by ground water. Lake receives most of the dissolved constituents from drainage basin and ground water [22].

IV. MATERIALS AND METHODOLOGY

The study of physico-chemical parameters of water samples of lake Mansar was carried for a period of one year (2011-2012). Physico-chemical analysis of water samples was done using standard methods given in [32]. Air and water temperature was measured by mercury bulb thermometer (^{0}C); electrical conductivity, TDS, salinity, pH were measured by Century water/ soil analyser kit, CMK 731; turbidity was observed by turbidity meter (model 331 E), DO, BOD by titration method.

V. RESULTS AND DISCUSSION

Lakes are the unique body of water reflecting many characteristics of surrounding watershed and climate. These are the life supporting systems providing water for drinking purpose, irrigation, recreation and tourism. Degradation in lakes is primarily due to encroachment (structure development, housing pressure and construction work), agricultural, forestry and other land use activities in the catchment contributing nutrients to the lake and leading to cultural eutrophication of these lakes. Lake Mansar owing to poor management and increasing human habitation near and around has also being facing major impacts and anthropogenic threats. The water from lake is currently being used for many purposes including irrigation of agricultural fields around the lake, domestic uses such as bathing, washing and recreation purposes. Also lake is receiving significant pollution load and dissolved constituents from catchment area, drainage basin, agricultural fields, forest area and wildlife sanctuary in the vicinity. Tourism is another major activity of the area as it is one of the most famous tourist spot of the state. Adventure boating, fish watching, picnic, visit to wildlife sanctuary, visit to famous Sheshnag temple etc are the major tourism activities. Lake water was assessed for various physico-chemical parameters. Table 1 shows the average values of various water quality parameters of lake Mansar

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which are influenced by various factors like tourism, intensive agricultural activities, domestic sewage and other pollution sources.

Table 1. Physico-chemical Parameters of Lake Mansar

S.No.	Parameters	Values
1	A.T (°C)	28.15
2	W.T (°C)	23.89
3	EC (µS/cm)	218
4	TDS (mg/l)	108.63
5	Turbidity (NTU)	19.69
6	Salinity(ppt)	0.1
7	pH	8.07
8	D.O (mg/l)	7.18
9	B.O D (mg/l)	1.81

The pH recorded during the present study 8.07 (annual average) is an indicative of alkaline nature of water. The air and water temperature with annual mean values were observed as 28.15 ^{0}C and 23.89 ^{0}C respectively (Table 1). Surface water temperature is one of the most important parameter as it influences inborn physical qualities of water [33].Turbidity recorded an annual average value of 19.69 (NTU) (Table I) and is in agreement with [34] [17] and [35]**.** However the value of turbidity was found above the permissible limits as prescribed by WHO(2008). The annual mean value of electrical conductivity was recorded as 218(µS/cm). Influx of sewage, agricultural runoff, other nutrients and inorganic salts from drainage basin may cause increase in electrical conductivity. A direct relationship between electrical conductivity and total dissolved solids is already on record [36], [37] and [38]. The annual mean value of DO was recorded as 7.18 (mg/l) (Table 1). Low concentration of DO indicates the presence of organic matter in water. With high organic load, dissolve oxygen is consumed rapidly during the decomposition of organic substances contained in the lake bottom. The average BOD value during the study period was 1.81(mg/l). Disposal of garbage and animal waste, bathing and washing activities may increases BOD and is documented by various workers like [39], [40] and [41]. Salinity recorded annual mean value of 0.1 (ppt). Increased inflow of surface water, drainage basin, wind blown material containing sodium chloride, calcium salt and death and decomposition of aquatic vegetation are the sources for salinity value.

HUMAN IMPACT ON LAKE MANSAR.

Lakes are the unique body of water reflecting many characteristics of surrounding watershed and climate. These are the life supporting systems providing water for drinking purpose, irrigation, recreation and tourism. Degradation in lakes is primarily due to encroachment (structure development, housing pressure and construction work), agricultural, forestry and other land use activities in the catchment contributing nutrients to the lake and leading to cultural eutrophication of these lakes. Lake Mansar owing to poor management and increasing human habitation near and around has also being facing major impacts and anthropogenic threats. The water from lake is currently being used for many purposes including irrigation of agricultural fields around the lake, domestic uses such as bathing, washing and recreation purposes. Also lake is receiving significant pollution load and dissolved constituents from catchment area, drainage basin, agricultural fields, and forest area and wildlife sanctuary in the vicinity. Tourism is one of the major activities of the area as it is one of the most famous tourist spot of the state. Adventure boating, fish watching, picnic, visit to

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wildlife sanctuary, visit to famous Sheshnag temple etc are the major tourism activities. The present condition of lake is not good and the main causes for the impaired conditions of lake could be summarized as under:

HABITATION AND ENCROACHMENT

Unplanned growth of human habitation in the vicinity of lake and increased pressure on the catchment of the lake has resulted in the deterioration of water quality as well as aquatic life. Concrete construction along the periphery of lake as well as construction of building structures (shops, *dhabas*, sitting sheds and other commercial sheds) around the lake have greatly reduced the area for percolation of rainwater into the soil and is responsible for declining water level in the lake. Besides, floating population of nomadic tribes like Gujjars, visit the area during winter putting additional pressure on the lake. Being a tourist spot, tourists visit the area throughout the year to enjoy the scenic beauty of the area.

POLLUTION SOURCES

Inspite of multifarious uses, lake Mansar is under tremendous pressure due to either direct entry of sewage drains from market area and habitation into the lake or indirectly in the form of solid waste arising out of the houses, restaurants, market area etc. along with the runoff from catchment. Other sources of pollution include entry of residues of construction activities, agricultural waste, animal excreta, dumping of garbage and waste coming from wildlife sanctuary (located near the periphery) as well as waste arising out of various rituals like mundan ceremonies performed along the lake periphery. Also, various religious activities like mass bathing, organizing of fares etc aggravated this pollution problem. Mansar, being an important tourist spot, is visited by number of tourists throughout the year and their activities like boating, offering food to fishes in the form of flour balls, eating and throwing waste into lake puts additional pressure on the lake. These entire practices increase pollution load in lake and further degrade its water quality.

WATER ABSTRACTION

Supply of lake water to meet the increasing demand of locals and surrounding villages for domestic purpose and irrigation etc. results in over extraction of water and has reduced water volume in the lake which can bring drastic changes in the near future.

BATHING AND WASHING

Addition of detergents and soaps used for washing and bathing causes nutrient enrichment which accelerates the process of eutrophication in lake that can be highly detrimental to lake water quality and severely limit the use of lake, thereby putting bad effects on human health and aquatic biota.

AGRICULTURAL ACTIVITIES

Domestication of animals and agriculture is the main occupation of the inhabitants of the area. The study has indicated that per capita number of animal in the vicinity is more and their waste in the form of dung is disposed off in the open or is applied in the fields as manure which is adding to the organic load of lake thereby contributing to the pollution. In addition, agricultural practices in the catchment area are the major source of nutrients to lake water. Cultivation of land around lake coupled with use of fertilizers add nutrients into water through agricultural runoff carrying organic manure as well as chemical fertilizers and toxic pesticides in lake, thereby, adding organic and inorganic matter in lake water and posing water pollution and eutrophication problem.

UNRESTRICTED TOURIST PRESSURE

Fish feeding, boating activity, throwing of plastic bottles, polythene wrappers, left over food and other tourist activities is putting more pressure on lake.

SILTATION

Land development, agricultural activities, construction around lake and farming at the steep slopes of lake causes soil erosion which increases siltation load in the lake.

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PROBLEMS OF OPEN DEFECATION

In the absence of public and private convenience, most people (like nomads etc) still defecate in the open and organic pollutants in the form of human and animal excreta, along with other waste of natural and anthropogenic origin, enter the lake during rainy season.

WEED INFESTATION

Mansar lake has exhibited biological nuisances such as dense algal and aquatic weed growths (particularly *Ipomea*) at certain points along the periphery. Also, indiscriminate removal of vegetation through harvesting and cattle grazing and trampling has severe impacts on hydrological and other biotic components operating in the lake ecosystem. After harvesting most of the weeds are either burned along the periphery or are disposed off and during monsoon these find their entry into the lake along with runoff.

DEFORESTATION

To meet the increasing demands of timber and resin (extracted from *Pinus roxburghii* in the catchment**),** excessive deforestation is being done leading to denudation of the catchment which results in increase silt load in the lake.

MANAGEMENT

The presence of a lake, in any region, greatly influences the life of the people living adjacent to it and in turn is influenced by the various activities of these people in its catchment. To understand the vitality of lake and the implications of its mismanagement, it becomes essential to understand its ecological status and the associated processes. The restoration of any water body calls for an integrated approach considering the major problems associated with it. Keeping in view, of all these factors government of J&K have declared Mansar and Surinsar areas as Surinsar-Mansar wildlife sanctuary. Another important benchmark was achieved by government in 2005 when these twin lakes were designated as Ramsar sites. Since the anthropogenic pressure on lake Mansar is increasing, this calls for sound conservation and management strategy to be followed at individual, community and government levels. Based on the problems highlighted in this study, certain measures are suggested for effective management of this lake like regular monitoring of water quality parameters of lake, diversion of pollution load, dredging and deweeding by manual, mechanical and biological methods, watershed and shoreline management which can bring improvement in lake environment, public participation, conducting environmental education programme and creating awareness among the local people. Proper management stratergies and restriction on anthropogenic activities could save the lake from further degradation.

V. CONCLUSION

The study of lake Mansar indicates that lake is under anhropogenic pressure from the various sources like tourism, construction, sewage and domestic waste, agricultural runoff. Therefore, it can be concluded that change in topography, lacustrine ecology and human activities is resulting in acceleration of the process of eutrophication which is deteriorating the water quality of lake Mansar and in turn, affecting the health and well being of the inhabitants living in the vicinity. Thus, proper management stratergies and environmental monitoring of lake water quality is very important and highly recommended in order to control its further deterioration.

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