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# Seasonal Water Quality Assessment of Lake Mansar, Jammu, J&K (India)

Environment

**KEYWORDS :** Lake Mansar, Water quality, Dissolved Oxygen, pH, Chloride.

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## ABSTRACT

*Present work focused on the seasonal variation in the water quality parameters of lake Mansar (J&K) for a period of one year (2011-2012). The water samples collected were analysed for various physico-chemical parameters such as air temperature (A.T), water temperature (W.T), electrical conductivity (EC), total dissolved solids (TDS), turbidity, salinity, pH, free carbon dioxide ($CO_2$), carbonate, bicarbonate, dissolved oxygen (DO), biological oxygen demand (BOD), chloride (Cl-), calcium (Ca), magnesium (Mg), total hardness (TH), sodium (Na+) and potassium (K+). The results have indicated that the lake is receiving heavy pollution load from surrounding areas due to discharge of domestic sewage, agricultural runoff and other anthropogenic activities. Measures for minimization of organic load in the water body have been suggested.*

## Introduction

Water is vital to the existence of all living organisms and is essential for all socio-economic development and for maintaining healthy ecosystems. It is one of the abundantly available substance in nature, which man has exploited more than any other resources for the sustenance of life. As a matter of fact fresh water resources all across the globe are under sustained anthropogenic pressure due to high population growth. So fresh water resources need special care and attention to make it available sustainably for the present and future generations. Lakes are a very important part of our natural heritage and have been widely utilized by mankind over centuries. These freshwater resources provide innumerable benefits but now a days these water bodies are shrinking rapidly because of urbanization, industrialization and pollution load. The contamination of such unique water bodies with high concentrations of domestic sewage, agricultural and surface runoff and other organic pollutants of anthropogenic origin is deteriorating the water quality of these valuable resources and therefore require regular monitoring and assessment. Monitoring water resources will quantify water quality, identify impairments, and help policy makers make land use decisions that will not only preserve these precious resources but improve the quality of life. In the present study an effort has been made to assess the seasonal variation in water quality parameters of lake Mansar (J&K) which is receiving heavy pollution load from catchment area due to various anthropogenic activities.

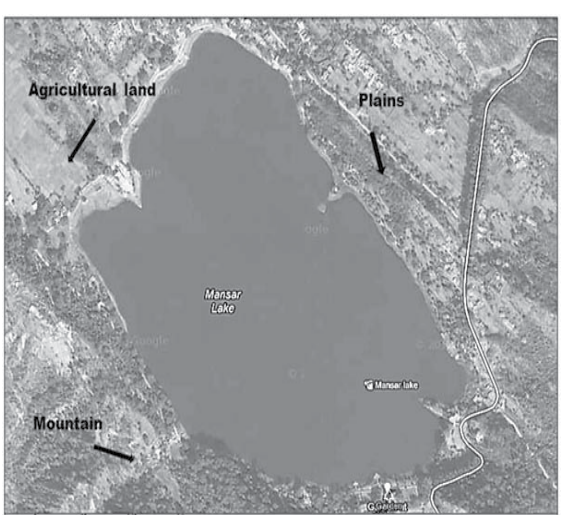


**Figure 1: Satellite image of lake Mansar.**

## Physicochemical analysis

Physicochemical analysis of water samples was carried out for one year (2011-2012) using standard methods given in APHA (1998). 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); free carbon dioxide, carbonate and bicarbonate, DO, BOD, chloride, calcium, magnesium by titration method; sodium and potassium by flame photometry.

## Material and methods

### Study area:

Mansar lake (32$^0$ 48'N latitudes and 75$^0$ 23'E longitudes) the area of present study, is a sub-tropical fresh water lake located 62 km from Jammu, at an elevation of 666 m above msl (Figure 1). Owing its origin to Mahabharata period, the lake shares the sanctity and legacy of Mansarovar and is socially and culturally very important. The lake with circumference-3.4 km, maximum length- 1204m, width-645m and depth- 38.25m supports two important species of turtles namely *Lissemys punctata* and *Trionyx gangeticus* listed in CITES - IUCN Redlist 2003 and very rare Medusae *(Mansariella lacustris).* The lake is the habitat of variety of fishes and is an attractive breeding and feeding ground for migratory waterfowls like Large Cormorant, Darter, Night Heron, Grey Heron, Indian Coot, Indian Golden Oriole etc. visiting the lake during winter season. The catchment of 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).

## Results and Discussion

Table 1 shows the seasonal values, their range and mean ± standard deviation of lake Mansar.

**Table 1: Seasonal water quality variations in lake Mansar during study period**

| Parameters | Winter | Summer | Rainy | Mean± SD |
|---|---|---|---|---|
| A.T (°C) | 21.91 | 33.06 | 32.29 | 29.08±6.23 |
| W.T (°C) | 18.80 | 25.83 | 28.80 | 24.48±5.14 |
| EC (µS/cm) | 241.80 | 213.07 | 193.30 | 216.06±24.39 |
| TDS (mg/l) | 119.78 | 108.02 | 95.17 | 107.66±12.31 |
| Turbidity (NTU) | 14.83 | 27.21 | 20.14 | 20.73±6.21 |
| Salinity(ppt) | 0.02 | 0.00 | 0.03 | 0.02±0.01 |
| pH | 8.00 | 8.12 | 8.15 | 8.09±0.08 |

| | | | | |
|---|---|---|---|---|
| Free $CO_2$ (mg/l) | 7.81 | 1.89 | 2.59 | 4.10±3.23 |
| Carbonate (mg/l) | 6.26 | 16.32 | 15.84 | 12.81±5.67 |
| Bicarbonate (mg/l) | 211.68 | 115.13 | 112.08 | 146.30±56.64 |
| D.O (mg/l) | 6.86 | 7.06 | 7.68 | 7.20±0.43 |
| B.O D (mg/l) | 1.45 | 0.57 | 0.95 | 0.99±0.44 |
| Chloride (mg/l) | 13.71 | 4.95 | 16.90 | 11.86±6.19 |
| Calcium (mg/l) | 28.59 | 16.67 | 24.63 | 23.30±6.07 |
| Magnesium (mg/l) | 12.58 | 10.17 | 9.30 | 10.68±1.70 |
| TH as $CaCO_3$ (mg/l) | 124.71 | 83.58 | 99.86 | 102.72±20.72 |
| Sodium (mg/l) | 27.96 | 26.04 | 36.59 | 30.20±5.62 |
| Potassium (mg/l) | 4.83 | 8.39 | 6.39 | 6.54±1.78 |

**Air Temperature and Water Temperature**

Air and water temperature of Mansar lake ranges from 21.91°C to 33.06 **°C** and 18.80**°C** to 28.80**°C** respectively. The highest and lowest air temperature has been noticed during summer and winter season respectively and is in agreement with Slathia and Dutta (2008) Water temperature recorded monsoon highest and winter lowest observation and is in agreement with the findings of Pawar (2010). Longer photoperiod, intensified bright sunlight and clear sky during summer may result in high air temperature while shorter day length and reduced bright light may explain winter decrease in atmospheric temperature.

**Electrical Conductivity (EC)**

Electric conductivity in Lake Mansar vary from 193.30 to 241.80 µS/cm. Electrical conductivity recorded high and low value during winter and monsoon respectively. Mineral upwelling from the bottom sediments during winter lake overturn may account for winter rise in electrical conductivity and coincided with rise in TDS. A direct relationship between electrical conductivity and total dissolved solids is already on record (Untoo, 1989; Wetzel, 2001). Dilution caused by heavy rains during monsoon may explain lowest record of electrical conductivity and is supported by the finding of Verma, Chandawat and Solanki(2011)

**Total Dissolved Solids (TDS)**

During investigation of Mansar lake the amount of total dissolved solids vary from 95.17 to 119.78 mg/l. The highest and lowest value of TDS has been recorded during winter and monsoon respectively. Upwelling of inorganic salts and ions released after degradation of organic debris from bottom layers during lake overturn and homogenous mixing of water during winter months may explain rise in TDS in winter and is already on record (Kumar, Rai and Singh, 2006; Venkatesharaju, Somashekar and Prakash, 2010). Effect of monsoon rains may explain low TDS during rainy period this season and is supported by the findings of Verma *et al.* (2011).

**Turbidity**

Turbidity has been recorded within the ranges from 14.83 NTU to 27.21 NTU. The maximum value was recorded during summer season. Increased decomposition at high temperature and water level decrease due to evaporation may explain summer rise in turbidity. Winter season recorded low value and abrupt dip in turbidity during this period may be attributed to settlement of clay, silt and suspended matter and reduced entry of eroded material from the catchment area due to absence of monsoon rains (Verma *et al*., 2011).

**Salinity**

Salinity in the water samples of lake Mansar ranges from nil to 0.03 ppt. The maximum and minimum value of salinity was observed during monsoon and summer respectively. Increased inflow of surface water, drainage basin, wind blown material containing sodium chloride, calcium salt and death and decomposition of aquatic vegetation may explain high monsoon record of salinity and is in agreement with the findings of Mathur, Agarwal and Nag (2007).

**pH**

Water samples of lake Mansar has been found alkaline throughout the study period. pH was recorded within the range from 8.00 to 8.15. The highest value of pH was recorded during monsoon season and the lowest was recorded during winter season. Winter decline in pH value has its relation with high record of free $CO_2$ during this season as an inverse relation of pH with free $CO_2$ has already been reported by workers like Wetzel, (2001) and Hutchinson, (2004)

**Free Carbon Dioxide**

Free $CO_2$ in the present study vary from 1.89 mg/l to 7.81 mg/l. The maximum and minimum value of free carbon dioxide was observed during winter and summer respectively. Winter increase in free $CO_2$ in lake Mansar is attributed to mixing of $CO_2$ rich water of hypolimnion with epilimnion during lake overturn and is in agreement with earlier findings of Sehgal (1980), Kumar *et al.* (2006), Slathia and Dutta (2008). Liberation of free $CO_2$ during decomposition of dead organic matter including aquatic vegetation (macrophytic vegetation in lake Mansar starts perishing during post-monsoon) and less uptake of carbon dioxide due to reduced rate of photosynthesis due to shorter photoperiod may explain winter rise in free $CO_2$ (Manjare and Mulley, 2010). Summer free $CO_2$ decline may be ascribed to luxuriant growth of algae and accelerated photosynthetic activity due to longer photoperiod accounting for more free $CO_2$ utilization (Manjare and Mulley 2010).

**Carbonate ($CO3^{2-}$)**

The carbonate content has been recorded within the range from 6.26 mg/l to16.32 mg/l. The highest observation during summer may probably due to increased photosynthetic activity and luxuriant growth of algae utilizing free $CO_2$ which account for increased carbonate concentration in summer (Shiddamallayya and Pratima, 2008)). Winter low temperature resulting in reduced photosynthesis due to shorter photoperiod and winter lake overturn may account for low/absence of carbonates during this season. Also, conversion of carbonates into bicarbonates due to excess amount of free $CO_2$ may add to this decrease (Narayan, Saxena and Chauhan, 2007).

**Bicarbonate ($HCO_3^-$)**

In lake Mansar, bicarbonate ranges between 112.08 mg/l (monsoon) to 211.68 mg/l (winter). Winter rise in bicarbonate may be attributed to absence of $CO_3^{2-}$ and presence of free $CO_2$ during this period. Conversion of carbonates into bicarbonates in presence of free $CO_2$ results in bicarbonate increase and is already on record (Narayan *et al.*, 2007). Dilution caused by rains may explain bicarbonate dip during monsoon. Unfavourable condition for conversion of carbonates into bicarbonates in absence or low record of free $CO_2$ may explain this decline and is supported by findings of Narayan *et al.* (2007).

**Dissolved Oxygen (DO)**

Dissolved oxygen concentration ranges from 6.86 mg/l to 7.86mg/l. The maximum and minimum value was recorded during monsoon and winter respectively. Agitation and turbulence due to monsoon rains may explain highest record of DO during monsoon and is in agreement with the findings of Sehgal (1980). Winter low record of DO may be attributed to increased free $CO_2$ concentration caused by homogenous mixing due to lake overturn (Kumar, Rai and Singh, 2006). An inverse relationship between free $CO_2$ and DO is already on record ( Marjare *et al.* 2010 ).

**Biological Oxygen Demand (BOD)**

In the present investigation, the biological oxygen demand in Mansar Lake varied from 0.57 mg/l (summer) to 1.45 mg/l (winter). Maximum concentration of BOD during winter may be due to reduction in water level; increased load of bird guano as

the lake is a preferred abode for many migratory aquatic birds during winter; reduction in phytoplankton population leading to a decrease in DO content of the lake water (Zubair and Ahrar, 2013).

**Chloride ($C^{-l}$)**
Chloride in Mansar Lake ranges between 4.95 mg/l (Summer) to 16.90 mg/l (monsoon). High chloride content in surface water is an indicator of organic pollution of animal origin (Mathur *et al.* 2007). Entry of domestic sewage, irrigation drainage, human and animal excreta along with surface runoff during monsoon may explain high amount of chloride during this period. Continuous uptake of chloride by aquatic vegetation and other organisms may account for its summer low record in lake water.

**Calcium, Magnesium and Total Hardness**
A look at Table 1**,** reveals seasonal variation of calcium, magnesium and total hardness between 16.67mg/l (summer) to 28.59 mg/l (winter); 9.30mg/l (monsoon) to 12.58 mg/l (winter) and 83.58mg/l (summer) to 124.71 mg/l (winter) respectively. Winter rise in these nutrients may be attributed to mixing of nutrients by the swimming activities of migratory birds, lake overturn and conversion of insoluble marls into soluble form in presence of free $CO_2$ during this season and is in agreement with the findings of Welch (1952), Untoo (1989) and Hutchinson (2004). Uptake of calcium by luxuriant growth of phytoplankton and marl forming plants like *Chara* and *Potamogeton* in presence of increased photoperiod and high temperature may account for calcium decline in summer. However, summer decline in magnesium may be attributed to luxuriant growth of aquatic vegetation which takes up this nutrient for chlorophyll growth. Dilution caused by rains during monsoon may explain dip in these nutrients during monsoon.

**Sodium ($Na^{+}$)**
Sodium shows a variation from 26.04 mg/l to 36.59 mg/l and observed monsoon highest and summer lowest record. Allochthonous input of weathered rock material, sewage and sediments, agricultural drainage, animal and human waste into lake along with monsoon runoff may account for sodium rise during this period (Arain, Karzi, Jamali, Afridi, Baig, Jalbani and Shah, 2008). However, low rainfall during the summer season may account for low record of sodium during this period.

**Potassium ($K^{+}$)**
Potassium maxima (8.39 mg/l) in summer may be caused due to increased evaporation at high temperature, increased salt concentration due to water level decline and decomposition of organic matter (Shiddamallayya and Pratima, 2008) while winter reduced evaporation and reduced inflow of sewage, weathered rock material and agricultural runoff due to low winter rains may explain winter minimum(4.83 mg/l) of Potassium.

**Conclusion**
The present study suggested that most of the physical-chemical properties of lake Mansar were within desirable limits except turbidity. The study of lake Mansar indicates that lake is receiving discharge of domestic wastes, fertilizers and pesticides from agricultural land, waste from wildlife sanctuary, dumping of solid wastes near the vicinity of lake. Also poor drainage facilities and increased tourist pressure is disturbing the potable nature of the water and made it unfit for human consumption. Acceleration of the process of eutrophication is deteriorating the water quality of lake and in turn is affecting the health and well being of the inhabitants living in the vicinity.

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