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Pollution Studies of a Monomictic Lake, Srinagar, Jammu and Kashmir, India

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Abstract

In fresh water ecosystems water quality plays an important role in determining the status and condition of that fresh water ecosystem. During the present study an attempt was made to analyse some of the important physico-chemical parameters of the water samples of the Monomictic Manasbal Lake, Srinagar, Jammu and Kashmir, located at a distance of 30 km north from the Srinagar to check the pollution load and human pressure on the lake. Various physico-chemical parameters were analysed during 2008-2009 at four different sites at monthly intervals by following standard methods. Among the various parameters recorded the overall surface water temperature ranged from 4.4°C to 23.5°C; Air temperature ranged from 6.1°C to 32.9°C; Turbidity index (Secchi-disc transparency) from 3.35 to 4.58; Dissolved oxygen from 6.8 to 8.6 mg L^{-1}; pH from 7.29 to 8.98 ; Electric Conductivity varied from 333 to 387 µs cm^{-1}; Total Alkalinity varied from 121 to147 mg L^{-1}; Chloride values ranged from 15.3 to 23.30 mg L^{-1}; Total Hardness ranged from 121 to 186 mg L^{-1}; Ammonical Nitrogen varied from 49.21 to 70.84 µg L^{-1}; Nitrate Nitrogen varied from 130.3 to 166.2 µg L^{-1} Nitrite Nitrogen ranged from 2.87 to 21.49 µg L^{-1}; and Phosphate Phosphorous ranged from 1.54 to 16.16 µg L^{-1}. Almost all the above parameters show that the pollution load is increasing due to anthropogenic pressure and climatic factors which results the eutrophic condition of the lake, so immediate remedial measures should be taken for its protection from further pollution.

Keywords: Manasbal Lake; Physico-chemical parameters; Monomictic; Eutrophic; Pollution load; Anthropogenic pressure; Climatic factors

Introduction

Lakes and rivers 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 and domestic purposes. Today many water bodies in India receive millions of liters of water from agricultural run-off with different concentrations of pollutants in various forms. Since water affects our life at every step, it has become the prime responsibility to maintain the quality of water supplies and to conserve natural fresh water aquatic environment for a balanced eco-system [1].

Water is the single most vital component of the earth that made possible for life to originate, evolve, flourish and reach the present form that we have today. Earth is called wet planet as two thirds of it is occupied by water. About 99.7% of water found on earth is in the oceans and seas and is not available for human consumption. Rest of 0.3% is fresh water. A good proportion of this water (22.7%) is available in glaciers ice caps, atmospheric moisture and ground water [2]. The fresh water ecosystems cover only 0.2% of the earth's surface [3].

Limnological studies on the polluted water bodies, which cannot be used as a source of drinking water, are of considerable importance. Such waters can be fruitfully used for recreational purposes and fisheries, if properly managed. Thus the present study has been taken up to analyse the Physico-chemical characteristics of water samples of Manasbal Lake, Srinagar.

Materials and Methods

Manasbal Lake is situated in the Srinagar district of Jammu and Kashmir at a distance of 32 km from the Srinagar city. It lies between 34° 15 N latitude and 74° 40 E longitudes. The lake is located about 1583m above sea level with an area of 2.81 km^2. It is an ancient lake and is one of the important lakes in Srinagar. The water samples were collected at regular fortnightly intervals from different study sites (Site I to IV Figure 1) in the lake. Samples were analysed according to the methods given in APHA [4] and Golterman et al. [5]. Some of the variable parameters like Dissolved Oxygen (DO), pH, Free CO_2 were determined at the field site during collection of the water samples, whereas the other parameters were analysed at the laboratory.

Morphometric features of the manasbal lake

Location: Lat. 34° 15N

: Long. 74° 40E

Lake type: Fresh water

Catchment area: 33 km^2

Surface area: 2.81 km^2

Length: 5 km

Width: 1 km

Maximum depth: 13 m

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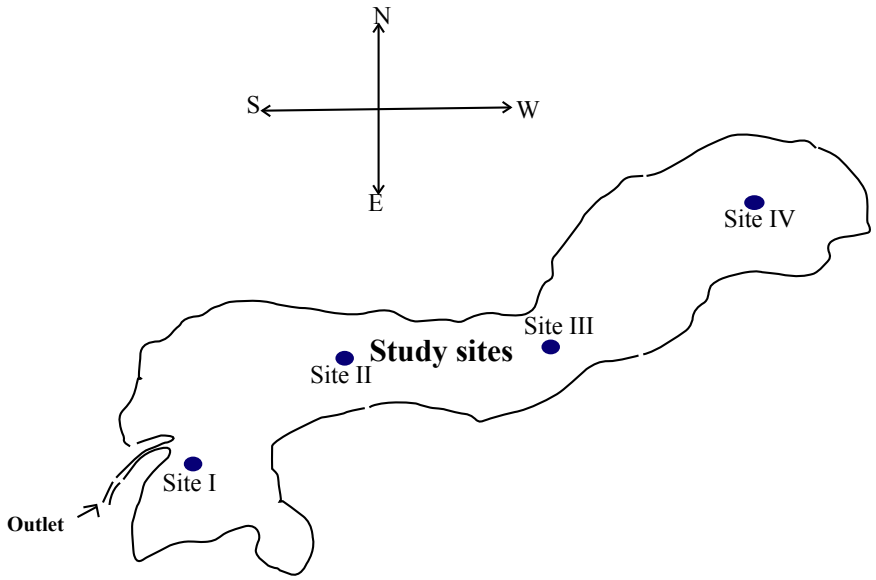

Outline sketch of the Manasbal lake showing the study sites

Figure 1: Outline sketch of the Manasbal Lake showing study sites.

Mean depth: 4.5 m

Volume: 0.0128 km^3

Residence time: 1.2 years

Results and Discussion

Evaluation of physico-chemical parameters is basic to the understanding of the status of water body. The results of various physico-chemical parameters of the water samples of Manasbal Lake are presented in Table 1.

Temperature

The surface Air and water temperature of the different study sites during the study period ranged from 4.4°C to 23.5°C and 6.1°C to 32.9°C. The maximum water temperature was recorded in august and minimum temperature was observed in December, while as for Air temperature the maximum was recorded in June and minimum in January. The monthly variation was noticed during the present investigation in both air and water temperature, which is in accordance with Yousuf and Qadri [6]. A close relation relationship between the air and surface water has been reported by Wanganeo [7].

Turbidity index (Secchi-disc transparency)

The turbidity index values ranged from 3.35 to 4.58 in all the study sites throughout the whole study period. The present study revealed low secchi values. The low values have been attributed to different factors, viz. plankton population [8], setting of materials in calm weather, suspension of phytoplankton in water [9], glacial silt [10]. The incoming sewage and high loading dissolved organic matter is also the factor for low secchi values [7].

Dissolved oxygen (DO)

Dissolved oxygen is one the most important parameters in water quality assessment and important regulator of metabolic processes of organisms and also the community as a whole [11]. In the present study, the DO concentration in all the study sites varied from 6.8 to 8.6 mg L^{-1} through the study period, but it was absent in bottom waters for all the study sites throughout the study period. The maximum concentration of D.O. was observed in February in surface waters can be attributed to vigorous photosynthetic activity of the autotrophs. A marked decrease of DO in July can be the result of increasing water temperature and rate of consumption. A prominent decrease in DO content from surface to its complete absence in the bottom water showed that the vertical profiles of DO would be a clinograde type. The present findings are in broad agreement with Wanganeo [7] and Wanganeo and Wanganeo [12].

pH

During the present study the values of pH ranged between 7.29-8.98. Variations of pH over a high range are often observed in the lakes due to several factors such as influence of fresh water inputs, pollution, photosynthesis interaction with suspended matter etc. High range of pH at surface (7.3 to 8.6) indicates the higher productivity of the water body. The present values recorded in all the study sites are in agreement with the findings of Qadri and Yousuf [13] in Lake Malpur Sar, Kashmir, Qadri and Yousuf [14] in Lake Manasbal, Kashmir, Devi [15] in Loktak Lake, Manipur (7.4 to 8.9), Vyas et al. [16] in Udaipur (7.1 to 9.1) and Billore and Vyas [17] in pichhola lake, Udaipur (7.46 to 8.64).

Electrical conductivity

The present values of electric conductivity varied from 333 to 387 μScm^{-1}. The highest value was recorded in July where as the lower value was recorded in January in all the study sites. In the present study very high Electric conductivity values was observed throughout the study period. This enhancement of conductivity values is due to periodical sedimentation of decomposing organic material. The present values are in broad agreement with Sarwar and Irfan-ul-Majid [18] in Wallur Lake, Kashmir and Wanganeo [7] in the Manasbal Lake, Kashmir.

S. No.	Parameter	Site I	Site II	Site III	Site IV
1	Air Temperature (°C)	6.2 ± 0.15	6.1 ± 0.11	6.3 ± 0.10	6.7 ± 0.05
		32.7 ± 0.25	32.4 ± 0.15	32.9 ± 0.20	32.3 ± 0.17
2	Water temperature (°C)	4.5 ± 0.26	4.4 ± 0.15	4.6 ± 0.30	4.5 ± 0.32
		23.4 ± 0.20	23.2 ± 0.32	23.5 ± 0.23	23.1 ± 0.26
3	Turbidity Index (cm)	3.35 ± 0.04	3.47 ± 0.04	3.5 ± 0.13	3.35 ± 0.03
		4.58 ± 0.03	4.57 ± 0.04	4.43 ± 0.27	4.39 ± 0.07
4	Dissolved Oxygen (mgL^{-1})	6.8 ± 0.26	6.9 ± 0.25	7.1 ± 0.25	7.1 ± 0.10
		8.4 ± 0.20	8.5 ± 0.25	8.6 ± 0.26	8.5 ± 0.26
5	pH	7.33 ± 0.05	7.35 ± 0.03	7.29 ± 0.06	7.33 ± 0.04
		8.97 ± 0.03	8.94 ± 0.02	8.98 ± 0.08	8.94 ± 0.02
6	Electrical Conductivity (Scm^{-1})	335 ± 3.60	333 ± 5.68	334 ± 6.55	335 ± 3.60
		387 ± 3.60	385 ± 3.51	387 ± 4.35	379 ± 5.50
7	Total Alkalinity (mgL^{-1})	123 ± 2.08	121 ± 2.51	123 ± 2.08	127 ± 3.05
		147 ± 4.04	144 ± 2.64	145 ± 2.64	145 ± 2.55
9	Chloride (mgL^{-1})	16.3 ± 0.35	15.8 ± 0.26	15.3 ± 0.37	15.5 ± 0.35
		23.3 ± 0.26	23 ± 0.23	22.9 ± 0.30	22.7 ± 0.34
10	Total Hardness (mgL^{-1})	123 ± 3.05	121 ± 1.52	123 ± 2.64	127 ± 3.51
		184 ± 3.21	181 ± 2.64	186 ± 3.46	184 ± 2.64
11	Ammonical Nitrogen (μgL^{-1})	50.13 ± 0.03	50.47 ± 0.12	50.23 ± 0.12	49.21 ± 0.58
		70.84 ± 0.05	70.63 ± 0.32	70.3 ± 0.16	67 ± 0.43
12	Nitrate Nitrogen (μgL^{-1})	131.4 ± 3.78	130.3 ± 2.10	131.2 ± 2.65	131.1 ± 2.21
		163.2 ± 2.62	163.1 ± 3.31	166.2 ± 5.07	164 ± 3.82
13	Nitrite Nitrogen (μgL^{-1})	2.87 ± 0.04	2.89 ± 0.08	2.94 ± 0.12	3.1 ± 0.13
		21.13 ± 0.60	21.11 ± 0.48	21.49 ± 0.22	21.45 ± 0.07
14	Phosphate Phosphorus (μgL^{-1})	1.67 ± 0.02	1.56 ± 0.03	1.59 ± 0.05	1.54 ± 0.05
		14.13 ± 0.06	14.11 ± 0.06	15.12 ± 0.32	16.16 ± 0.56

Table 1: Physico-chemical characteristics of water samples in the different study sites of Manasbal Lake (2008-2009).

Total alkalinity

The Total alkalinity values in all the study sites during the study period ranged from 121 to 147 mg L^{-1}. This was due to intense photosynthetic activity removing free as well as bound carbon dioxide from bicarbonates. As a result calcium carbonate got precipitated and pH value increased. In the present study the bottom water showed high total alkalinity in close relation with decomposition process. The present values are in broad agreement with Wanganeo [7] in Manasbal Lake, Kashmir, Hussainy [19], and Sreenivasan [20].

Free CO_2

In the present study, concentrations of free carbon dioxide varied between 15 ± to 36 ± mg L^{-1}. Absence of free carbon dioxide at the surface and up to 2.5m was frequent and was associated with the precipitation of carbonate. Deeper layers exhibited an increasing trend concerning free CO_2 with reaccumulation at the bottom. Similar observations were made by Hussainy [19], Ebel and Koski [21].

Chloride

The chloride contents of the water samples in all the study sites throughout the study period varied from 15.3 to 23.30 mg L^{-1}. The present study found a narrow fluctuation for chloride both vertically as well as with time (i.e. throughout the study period). This may be due to the organic load and sewage in the water body. Similar findings were observed by Ali et al. [22] in regulated water bodies of Egypt in Aswan Reservoir.

Total hardness

The values of total hardness ranged from 121 to 186 mg L^{-1}. Hardness is the concentration of multivalent metallic cations in solution and, due to carbonate and bicarbonate of calcium and magnesium salts from detergents and soap. Similar observations were noticed by Wanganeo [7], Trisal [23] and Pandith [24].

Ammonical nitrogen

In the present study, Ammonical nitrogen values ranged from 49.21 to 70.84 µg L^{-1}. A decreasing trend in ammonical nitrogen was observed throughout the study period (i.e. from January to November) this may be due to nitrification or direct absorption by many phytoplanktons' [25,26]. In bottom waters it may be due to decomposition of organic matter present in the anoxic hypolimnetic sediment and near mid water interface.

Nitrate nitrogen

In the present investigation period Nitrate nitrogen ranged from 131.1 to166.2 µg L^{-1}. In the present study period an increase in concentration of nitrate nitrogen was observed, can be related to oxidation of ammonical nitrogen to nitrate [27].

Nitrite nitrogen

The Nitrite nitrogen values during the study period ranged from 2.87 to 21.49 µg L^{-1}. Nitrate nitrogen is an unstable product of either nitrification of free ammonia or denitrification of nitrates. The lowest value was observed in July and highest value in March.

Phosphate phosphorus

In the present study Phosphate phosphorus ranged from 1.54 to 16.16 µg L^{-1} in all the study sites. In vertical column, values were generally increasing from surface to bottom, Wanganeo [7]. This may be due to both allochthonous and autochthonous inputs, when the metabolic activity in the water starts to gear up.

Conclusion

In the present study, the physico-chemical parameters at different sites varied considerably during the study period. The high values of the physico-chemical parameters obtained in the present study indicate the eutrophic status of the Lake. Hence immediate remedial measures should be taken up for protection and conservation of this monomictic lake in order to save it from further pollution and deterioration.

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