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Research Paper

Trophic status of Manasbal Lake: A high altitude deep lake water body of Kashmir, India

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ABSTRACT

Water is one of the precious natural resources present on earth and it is very important for survival of flora and fauna. Human-driven loads of water-borne nutrients to aquatic ecosystem have led to worldwide eutrophication. To understand the eutrophication processes, the present study was planned to investigate the impact of nutrient-related water quality conditions over a period of six months at three different sites in Manasbal lake, located in Ganderbal district of Jammu and Kashmir. Significant increase in free carbon dioxide (10.17±1.01mg/l); nitrate-nitrogen (252.5±30.41µg/l); ammoniacal-nitrogen (52.72±12.41µg/l) and total phosphorus (231.11±14.42 µg/l) indicating increased levels of eutrophic conditions were seen. The observed increase of these nutrients could be attributed to anthropogenic activities in the immediate catchment, like agricultural practices and discharge of sewage resulting in deterioration of water quality and decreased fish yield. Further, the amount of dissolved oxygen in the lake water was low, posing a direct threat to lake ecosystem. The study provides the baseline information signaling to frame effective management strategies for improving the water quality.

Key words: Manasbal lake, physico-chemical parameters, trophic status, water quality.

A lake is a reflection of its watershed and as watershed landscape- the topography, soil, geology and vegetation- determines the kind of materials entering into the lake that inturn reflects on its water quality (Dong *et al.*, 2010). Nutrient enrichment of lakes is one among the major environmental problems in many countries (Oczkowski and Nixon, 2008). Though it stimulates the growth of plants (algae as well as higher plants), nutrient enrichment ultimately leads to deterioration of water quality and degradation of the entire ecosystem (Guyuan *et al.*, 2011). In recent decades, population growth, agricultural practices and sewage run-off from urban areas have increased nutrient inputs mani-folds than the level of their natural occurrence, resulting in accelerated eutrophication and pollution (Zan *et al.*, 2011).

Water quality degradation by various sources becomes an important issue around the world. Usage of more land for agricultural purposes, soil salinization, increase in the use of agricultural fertilizers, common pesticide use and erosion have become problems threatening natural water source (Zalids *et al*., 2002). The urban aquatic ecosystems are strongly influenced by long term discharge of untreated domestic and industrial waste-waters, storm water runoff, accidental spills and direct solid waste dumping (Sarika and Kumar, 2008).

Manasbal Lake, the deepest natural freshwater lake of Kashmir valley has special ecological significance, located in district Ganderbal about 32 Kilometers away towards North-west of Srinagar city. The lake lies at an altitude of 1,585 meters above mean sea level and has a maximum length of 5 km and maximum width of 1 km **(**Rashid *et al.*, 2013). The lake has an area of 280 ha with a maximum depth of 12.5 m and remains stratified for eight to nine months from March/April to November and most probably the only one that develops stable summer stratification (Yousuf, 1988). Manasbal is classified as warm monomictic lake and circulates once in a year for a very short time. Manasbal, a marl lake, has predominantly rural surroundings. The lake harbors rich biodiversity and is among the largest habitat for aquatic birds of the region. The lake is of high economic importance to the area as it provides water for irrigation and domestic use to Yangoora and Safapora towns. The drainage basin for the lake, covering an area of 33 km^2, has no major inlet channels and is thus fed mainly by precipitation (rainfall and snow fall) and springs (more than 1,200 springs). Lake water outflows to the River Jhelum through a regulated outflow channel Naninar Nallah about 1.6 km near Sumbal village.

In the recent past, the lake has been besieged by a myriad of ecological disruptions. Thus the present study was aimed at evaluating the trophic status of the lake as a rationale for developing effective management strategies.

MATERIALS AND METHODS

Study area / sampling sites

For obtaining the present objective, the following three sampling sites has been selected with a brief description given below and shown on the map as well (Fig. 1.):

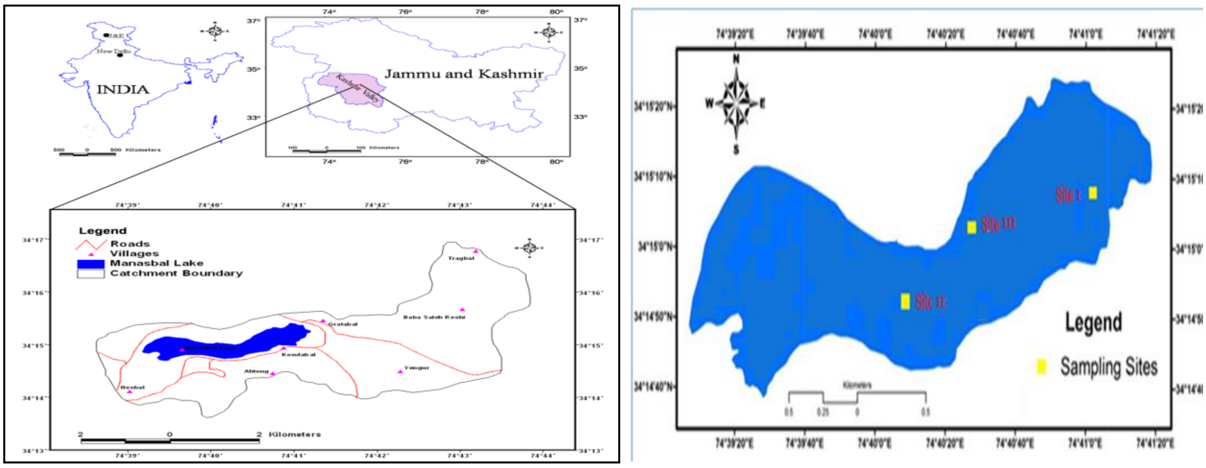

Fig. 1: Map of Manasbal Lake Kashmir showing location of sampling stations (Source:www.maps-india.com)

Site (I): The first site is selected very close to the entry of Laar Kuhl into the lake at 34º15´N and 74º41´E. The maximum depth at this site is 1.5 m with silty sand type of sediments.

Site (II): This site is located in the centre of the lake at 34º14.916' N and 74 º 40.015' E. This site has a maximum depth of about 12.5 m.

Site (III): The third site is located in the littoral area near Hanji Mohalla, Gratbal at 34º 15.040' N and 74º 40.385'E. At this site, sediments were brown in color with silty texture.

SAMPLING

Surface water samples were collected manually at designated sites using sampling bottles between 900-1100 hrs. For dissolved oxygen, D.O. bottles of 125ml capacity were used and the fixation of the samples was done on the spot. Air temperature, water temperature, depth, transparency and pH were determined at the sampling spot and for detailed analysis *viz*., (free CO_2 (mg/L); total alkalinity (mg/L); nitrate-nitrogen (µg/L); ammoniacal-nitrogen (µg/L); orthophosphorus (µg/L) and total phosphorus (µg/L)) samples were immediately transported to the Aquatic Environmental Laboratory, Faculty of Fisheries, Rangil, Ganderbal. The water analysis was carried out as per Adoni (1985) and APHA (2012).

RESULTS AND DISCUSSION

Air temperature:

Air temperature strongly influences lake temperature because it affects three important heat-exchange processes between water and the atmosphere - convective heat exchange, evaporative heat exchange, and the atmospheric emission of long-wave radiation (Edinger *et al.*, 1968). The atmospheric temperature depicted a definite seasonal trend during the entire period of study and changed with the change in the seasons. Air temperature varied from 4.5^{o}C (January) to 21^{o}C (May). The overall mean air temperature was 12.25±6.20^{o}C as shown in (Table 1, Fig 1). The variation in temperature that the air temperature increased during warmer months and decreased during colder months has also been reported by many workers (Balkhi *et al.*, 1985).

Water temperature:

Water temperature exerts a major influence on biological activity and growth, has an effect on water chemistry, can influence water quantity measurements, and govern the kind of organisms that live in a water body. The water temperature ranged from 2.5^{o}C (January) to a 12.5^{o}C (May). The overall mean water temperature was 7.45±3.62^{o}C as shown in (Table 1, Fig 2). The highest summer and lowest winter seasonal values in the water temperature is in broad agreement with the findings of (Gulzar and Abubakr., 2019).

Depth:

Depth of an aquatic body plays an important role in concentrating ions in water mass, besides being an important determinant for the growth and development of various life forms of vegetation (Kaul and Handoo, 1980). Depth ranged from 0.80 m (January) to 12.5 m (May). The mean depth was found to be 4.76±5.35 m as shown in (Table 1, Fig 3). The variation in the water level fluctuations during the course of the study depended upon the amount of precipitation received in the form of rain and snow. This is in confirmation with the studies of Vass and Zutshi (1978).

Transparency:

Water transparency is an important measure of light penetration, which is crucial to the hydrobiology of all aquatic systems. The transparency was found to be ranging from 0.4m (December) to 3.8m (May). Overall mean transparency was 1.49±1.32 m as shown in (Table 1, Fig 4). Nutrient enrichment due to fertilizers and wastes from the inhabitations also reduce light penetration. The results are in confirmation with (Gulzar and Abubakr., 2019), who ascribed the low secchi values in Anchar Lake, Kashmir to the incoming sewage and high load of dissolved organic matter.

Hydrogen ion concentration (pH):

The pH of any aquatic system is suggestive of the acid-base equilibrium maintained by various dissolved compounds. Further, pH is one of the very significant chemical characteristic of water, which explains certain significant biotic and abiotic ecological characteristics of aquatic systems. The pH value ranged from 7.6 (December) to 8.0 (April). The overall mean pH was 7.81±0.11 as shown in (Table 1, Fig 5). High range of pH at surface 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 (1980) in Lake Malpur Sar, Kashmir.

Dissolved oxygen:

Dissolved oxygen is one the most important parameter in water quality assessment and an important regulator of metabolic processes of organisms and also the community as a whole. The value of dissolved oxygen ranged from 6.8 mg/L (May) to 8.2 mg/L (February). Mean D.O. was found to be 7.26±0.35 mg/L as shown in (Table 1, Fig 6). The present findings are in broad agreement with (Dar, 2013). The low values of D.O. in summer are due to low dissolution at high temperature and is also due to use by decomposers in the water body. Gulzar and Abubakr (2019), while studying fresh water lake of Kashmir has attributed the low D.O. concentration to high trophic status and high biological oxygen demand.

Free Carbon dioxide:

Carbon-dioxide alters the pH of water by forming carbonic acid, which further dissociates into carbonates and bicarbonates. Free carbon dioxide values ranged from 7.9 mg/L (April) to 11.5mg/L (January). The mean free CO_2 was found to be 10.17±1.01 mg/L as shown in (Table 1, Fig 7). The higher value can be attributed to the presence of high amount of organic matter which on microbial decomposition release large amount of free CO_2 as a by-product of their metabolic activity (Todda ,1970., Coole 1979).

Total alkalinity:

As per Moyle (1945) classification wherein lakes with waters having alkalinity up to 40mg/L are soft, with 40-90mg/L are medium and above 90mg/L are hard, the manasbal lake is classified under hard lakes. Total alkalinity is a measure of buffering capacity of water and is important for aquatic life in a freshwater system. The lake recorded values of total alkalinity from 164 mg/L (February) to 188 mg/L (March). Overall mean alkalinity was found to be 170.77±10.2 mg/L (Table 1, Fig 8). This could be due to the intense photosynthetic activity removing free as well as bound CO_2 from bicarbonates. These findings are in agreement with Wanganeo (1980).

Nitrate-nitrogen:

Inorganic nitrogen present in water as Nitrate (NO^{3-}) is the main nutrient that accelerates the growth of hydrophytes and algae. Nitrates are essential nutrients for many photosynthetic autotrophs and in some cases have been identified as the growth limiting nutrient. In the present study, nitrate-nitrogen content ranged from 212 µg/L (April) to 315 µg/L (May). Overall mean value was found to be 252.5±30.4 µg/L (Table 1, Fig 9). In the present study, the higher nitrate may be attributed to the direct discharge of large quantity of untreated domestic sewage, decaying of organic matter and the agricultural runoff that brings along with it nitrates. Gulzar and Abubakr (2019) also reported the progressive increase in nitrogen and phosphorus in Anchar lake, Kashmir and attributed it to sewage contamination.

Ammoniacal nitrogen:

Ammonia in surface water can be of various sources like organic origin, inorganic origin and the air deposition. This is one of several forms of nitrogen and considered as most important indicator for soil contamination (excessive use of ammonia rich fertilizer), excretion of nitrogenous wastes from animals, and sewage contamination in aquatic environments. Although ammonia is a nutrient required for life, it is toxic for aquatic organism and excess of ammonia can accumulate in the organism cause alteration in metabolism or increase body pH. In the present study, ammoniacal-nitrogen values ranged from 43 µg/L (February) to 76 µg/L (April). Mean ammonical-nitrogen was found to be 52.72±12.41 µg/L (Table 1, Fig 10). Gulzar and Abubakr (2019) also reported relatively higher concentration of ammonical- nitrogen in fresh water lake of Kashmir and attributed it to the entry of domestic sewage, use of nitrogenous fertilizers in the catchment areas.

Orthophosphorus:

Phosphorous, is generally recognized as one of the key nutrients in the productivity of freshwaters as it is essential element determining fertility of lakes. The orthophosphate concentration ranged from 58.5 µg/L (Feb) to 81.0 µg/L (May). The overall mean orthophosphate was 63.52±13.25 µg/L (Table 1, Fig 11). Abubakr and Kundangar (2004), while studying the changing biodiversity of seven lakes of Kashmir also reported an increase in nitrogen and phosphorus and attributed to sewage contamination.

Total phosphorus:

Total phosphorus concentration ranged from 210 µg/L (February) to 254 µg/L (December) with an overall mean of 231.11±14.4 µg/L (Table 1, Fig 12). The high anthropogenic pressure, contaminated with sewage and other pollution effluents have been ascribed high concentration of phosphorus (Bhat *et al.*, 2001).

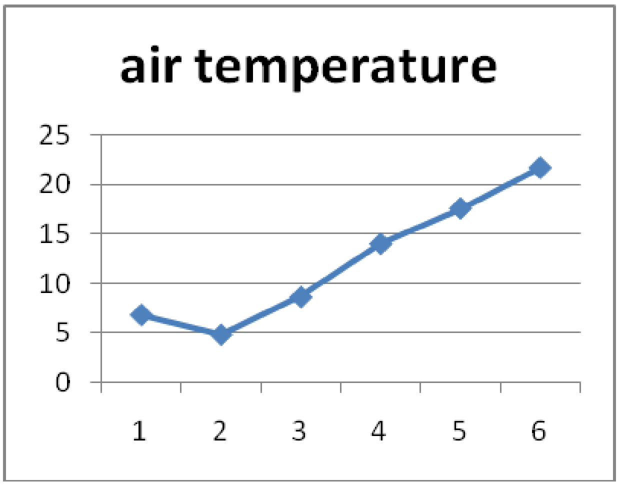

Fig. 1: Monthly variations in air temperature in Manasbal

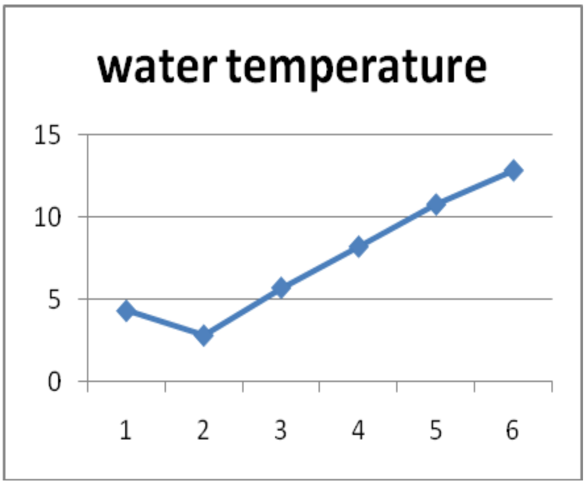

Fig. 2: Monthly variations in water lake temperature in Manasbal lake

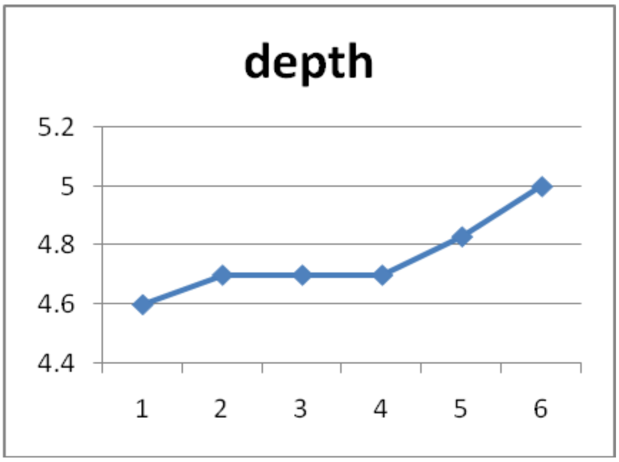

Fig. 3: Monthly variations in depth in Manasbal lake

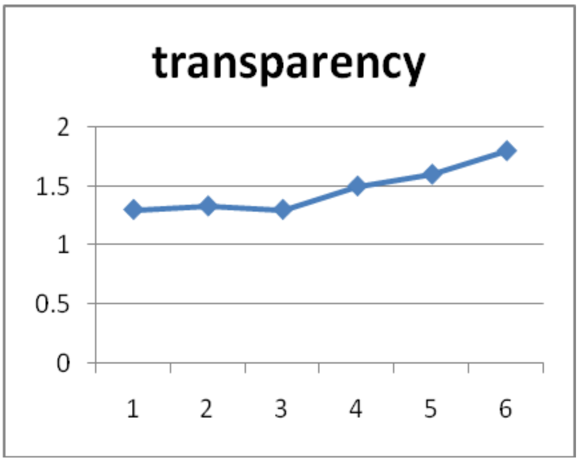

Fig. 4: Monthly variations in transparency in Manasbal lake

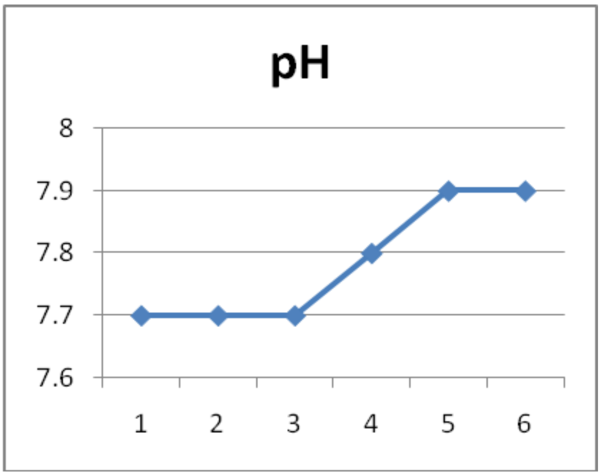

Fig. 5: Monthly variations in pH in Manasbal lake

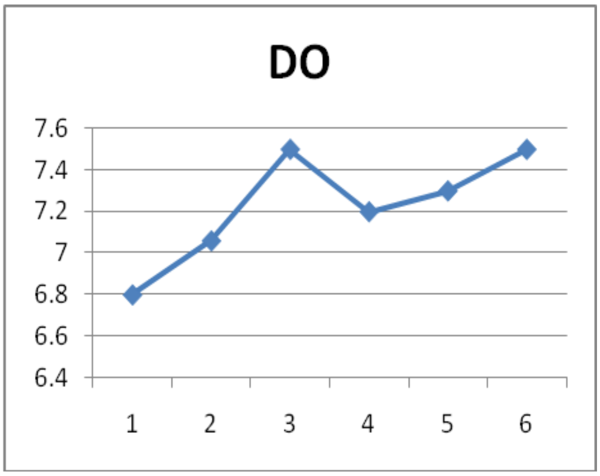

Fig. 6: Monthly variations in DO in Manasbal lake

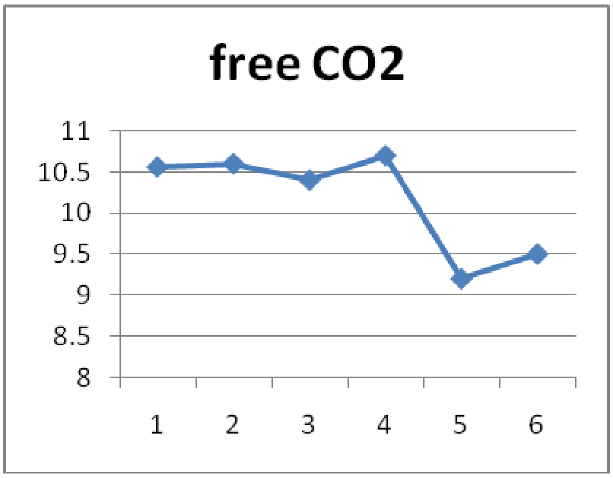

Fig. 7: Monthly variations in free CO_2 in Manasbal lake

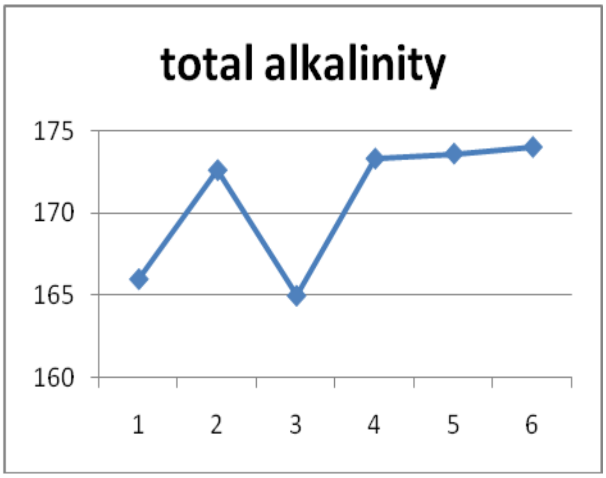

Fig 8: Monthly variations in total alkalinity in Manasbal lake

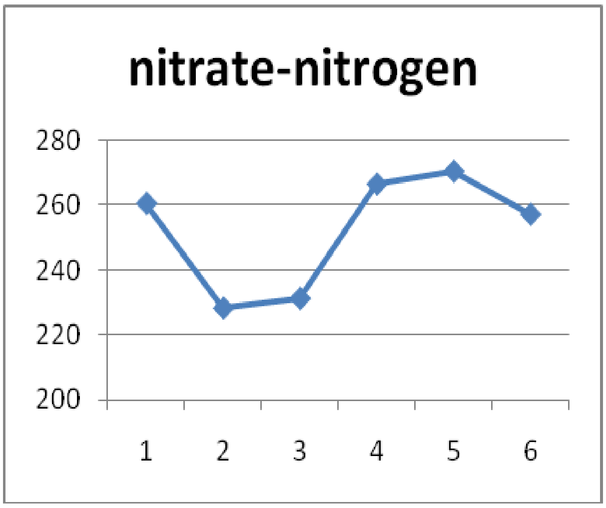

Fig. 9: Monthly variations in nitrate-nitrogen in Manasbal lake

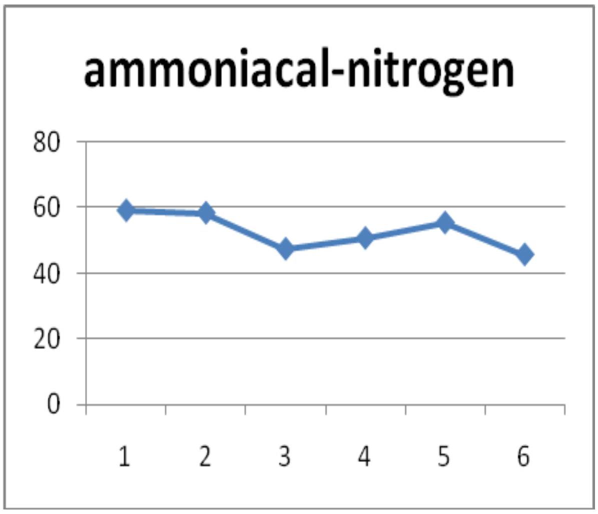

Fig. 10: Monthly variations in ammoniacal-nitrogen in Manasbal lake

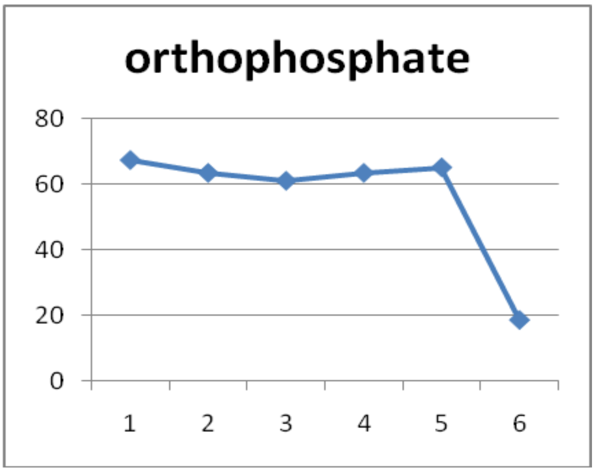

Fig. 11: Monthly variations in orthophosphate in Manasbal lake

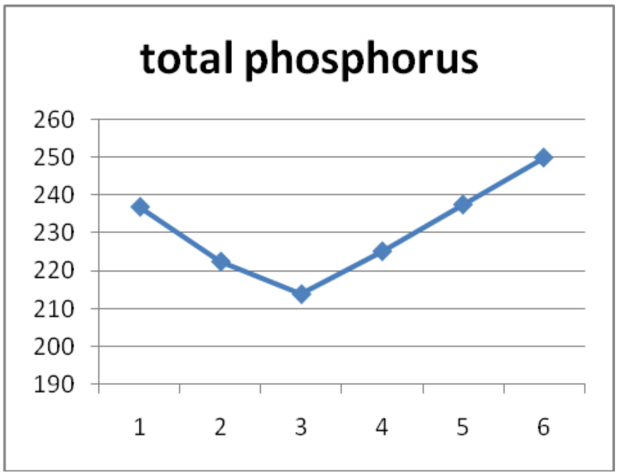

Fig. 12: Monthly variations in toital phosphorus in Manasbal lake

Fig's. 1-12: Graphs showing monthly variations in physico-chemical parameters

Table-1: Some important physico-chemical parameters of Manasbal Lake with Mean ± S.D.

S. No.	Parameters	Manasbal (Mean ± S.D)
1.	Air temp. (^oC)	12.25±6.20
2.	Water temp. (^oC)	7.45±3.62
3.	Max. depth (m)	4.76±5.35
4.	Transparency (m)	1.49±1.32
5.	Ph	7.81±0.11
6.	Dissolved oxygen (mg/L)	7.26±0.35
7.	Free CO_2 (mg/L)	10.17±1.01
8.	Total alkalinity(mg/L)	170.77±10.20
9.	Nitrate-nitrogen (µg/L)	252.5±30.41
10.	Ammonical-nitrogen (µg/L)	52.72±12.41
11.	Orthophosphorus (µg/L)	63.52±13.25
12.	Total phosphorus (µg/L)	231.11±14.42

CONLUSION

The increasing trend of some parameters revealing accelerated eutrophication phenomenon warrant identification of the sources of pollution and institution of different measures to control the anthropogenic influx of pollutants to achieve the goal of sustainability of water resources. It is suggested that an appropriate mechanism be established for continuous monitoring of the lake and the government should come up with robust policies for conservation of this fresh water body through Integrated Water Resources Management (IWRM). Further, restriction and reduction of the number of settlements around the shore to prevent uncontrolled water usage and pollution (i.e. nutrient overload) need to be considered.

REFERENCES

Abubakr, A. and Kundangar, M.R.D. 2004. National seminar on "State Art on Conservation of Biodiversity in India with Particular Reference to Himalaya". CORD and PG Department of Environmental Science, University of Kashmir, March 22-24.

Adoni, A.D. 1985. Workbook in limnology. *Pratibha Publisher*, C-10 Gour Nagar, Sagar (M.P).

American Public Health Association. 2012. Standard Methods for Examination of Water and Waste Water. 22nd Edition, *American Public Health Association Press*, Washington, DC.

Balkhi, M.A., Yousuf, A.R and Qadri, M.Y. 1985. Summer and winter cladocera communities of Anchar Lake, Kashmir. *Geobios*, **3**: 66-69.

Bhat, S.A., Rather, S.A. and Pandit, A.K. 2001. Impact of effluents from SKIMS, Soura on Anchar lake. *Journal of Research and Development*., **1**: 31-38.

Coole GR. A Text book of Limnology, 2nd ed. The Mosley Co. London, New York, 1979.

Dar, J.A., Mir, F.M., Bhat, N.A. and Bhat, M.A. 2013. Pollution Studies of a Monomictic Lake, Srinagar, Jammu and Kashmir. *Indian Forest Research*, **2**: 1.

Dong, J.D., Zhang, Y.Y and Wu, M.L. 2010. Identification of temporal and spatial variations of water quality in Sanya Bay, China by three-way principal component analysis. *Environmental Earth Science*, **60**:1673-1682.

Edinger, J.E., Duttweiler, D.W. and Geyer, J.C. 1968. The response of H_2O temperature to meterological conditions. *Water Resources Research*, **4**: 1137-1143.

Gulzar, B and Abubakr, A. 2019. Present trophic status of Anchar Lake, Kashmir: Assessment by water quality parameters. *Journal of Pharmacognosy and Phytochemistry*, **8**: 2018-2023.

Guyuan, L and Weiqun, S. 2011. Seasonal variation of dissolved inorganic nutrients transported to the Linjiang Bay of the Three Gorges Reservoir, China. *Environmental Monitoring and Assessment*, **73**:55-64.

Moyle, J.B. 1945. Some chemical factors influencing the distribution of aquatic plants in Minnesota. *Journal of American Midland Nauralist*, **34**: 402-426.

Oczkowski, A and Nixon, S. 2008. Increasing nutrient concentrations and the rise and fall of a coastal fishery: A review of data from the Nile Delta, Egypt. *Estuarine, Coastal and Shelf Sci*.**,** **77**: 309-319.

Qadri, M.Y and Yousuf, A.R.1980. Limnological studies on Lake Malpur Sar. The Biotope *Geobiosciences*, 117-119.

Rashid, I., Farooq, M., Muslim, M. and Romshoo, S.A. 2013. Assessing the Impact of anthropogenic activities on Manasbal lake in Kashmir Himalayas *International Journal of Environmental Science*, **3**: 6.

Sarika, P.R and Kumar, N.2008. Geochemistry of heavy metals in the surfacial sediments of Mangroves of the southwest coast of India. *Chemical Ecology*, **24**:437–447.

Todda, B.K. 1970. *Water Encyclopedia*. Water Information Centre. Port Washington, New York.

Wanganeo, A. 1980. Phytoplankton photosynthesis, Nutrient dynamic and trophic status of Mansabal Lake Kashmir, Ph.D. Thesis of Kashmir University, India.

Yousuf, A.R. 1988. Copepod plankton of Manasbal Lake, Kashmir. *Journal of Indian Institute Science*, **68**: 307-313.

Zalids, G., Stamatiadis, S., Takavakoglou, V., Eskridge, K. and Misopolinos, N.2002. Impacts of Agricultural Practices on soil and water quality in the Mediterranean region and Proposed Assessment Methodology. *Agriculture, Ecosystems and Environment*, **88**: 137-146.

Zan, F., Huo, S., Xi, B. and Zhang, J. 2011. Phosphorus distribution in the sediments of a shallow eutrophic lake, Lake Chaohu, China. *Environmental Earth Sciences*, **62**:1643-1653.

Zutshi, D.P. and Vass, K.K. 1978. Limnological studies in Dal Lake. Indian, *Journal of Ecology*, **5**: 90-97.