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Physiochemical analysis of water quality in Surha Lake, India

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ABSTRACT

The Surha Lake is an important freshwater body in eastern Uttar Pradesh, India. The aim of the present study is to investigate the concentration of water quality parameters like pH, BOD, DO, COD, EC etc. in the lake water. The results indicate that the water quality of the lake is deteriorating and is not suitable for drinking purpose. Therefore, it has been suggested to check the input of nutrient in the lake and the water must be treated before used for drinking.

Keywords: Surha Lake, water quality, drinking purpose.

INTRODUCTION

Water is an important sustainable resource gifted to human by nature. The water quality is expressed in terms of its physiochemical and biological parameters. The Criteria of Water Quality are defined as the permissible concentrations of specific water quality parameters that may vary with the type of use such as drinking, bathing, domestic use, irrigation, and industrial use.[1] In the recent decade, due to rise in population and its needs, a heavy excavation of freshwater and direct discharge of untreated waste into the water bodies is being worked out, which has degraded the water quality.[2, 3] Such degradation led to the incidence of water borne diseases and loss of quality water for use. The evaluation of water quality in the developing countries is a critical issue,[4, 5] especially due to the concern for the availability of fresh water resources in the future. Therefore, it has become an important measure to regularly monitor the water quality, thereby to attain the developing water resources of wholesome quality, i.e. water free from visible suspended matter, objectionable dissolved matter, dissolve oxygen.[6] Sometimes, it is difficult to evaluate the overall water quality from a large number of samples which contain the varying concentrations different parameters.[7] Such monitored parameter could be analyzed alone to ascertain the water quality status. The present study is focused to assess the water quality of Surha Lake which is an important water resource and holds the livelihood of large population in the district Ballia of eastern Uttar Pradesh in India. However, a number of studies have been done for identification of zooplanktons, molluscan fauna,[8] diversity of aquatic insects,[9, 10] aqua status[11] and diversity of fishes[12] in catchment of Surha Lake. The diversity of the lake is reported to be in decline phase.[12] The present work reports the water quality of the lake based on physiochemical parameters like dissolve oxygen, conductivity, pH, total alkalinity etc.

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MATERIAL AND METHODS

[A] STUDY SITE

The Surha Lake is an ox-bow lake lies in the Indo-gangetic plain i.e. located in the area of Jai Prakash Narayan Bird Sanctuary in the district Ballia of U.P, India at coordinates of $26^{0}40'$ to $26^{0}42'$ E and $84^{0}11'$ to $84^{0}14'$ N. It covers a catchment area of about 34.33 km^2 in the rainy season, joined by three small streams Katehar nala Gararai, and Madha that drains the major water carrying from Saryu River (Ghaghra River) and Ganga into the lake. The Lake watery area shrinks to about 11.23 km^2 in the summer and the rest of the area is used for crop cultivation by the local farmers. The area receives an average annual rainfall of about 1000 mm with maximum of $43^{0}C$ in summer and a minimum temperature of $4^{0}C$ in winter. The lake is major source of water to the local population for various purposes like drinking, bathing, agriculture, fisheries, etc. and also supports the diversity of rich bird species in the area. A location map of the Surha Lake

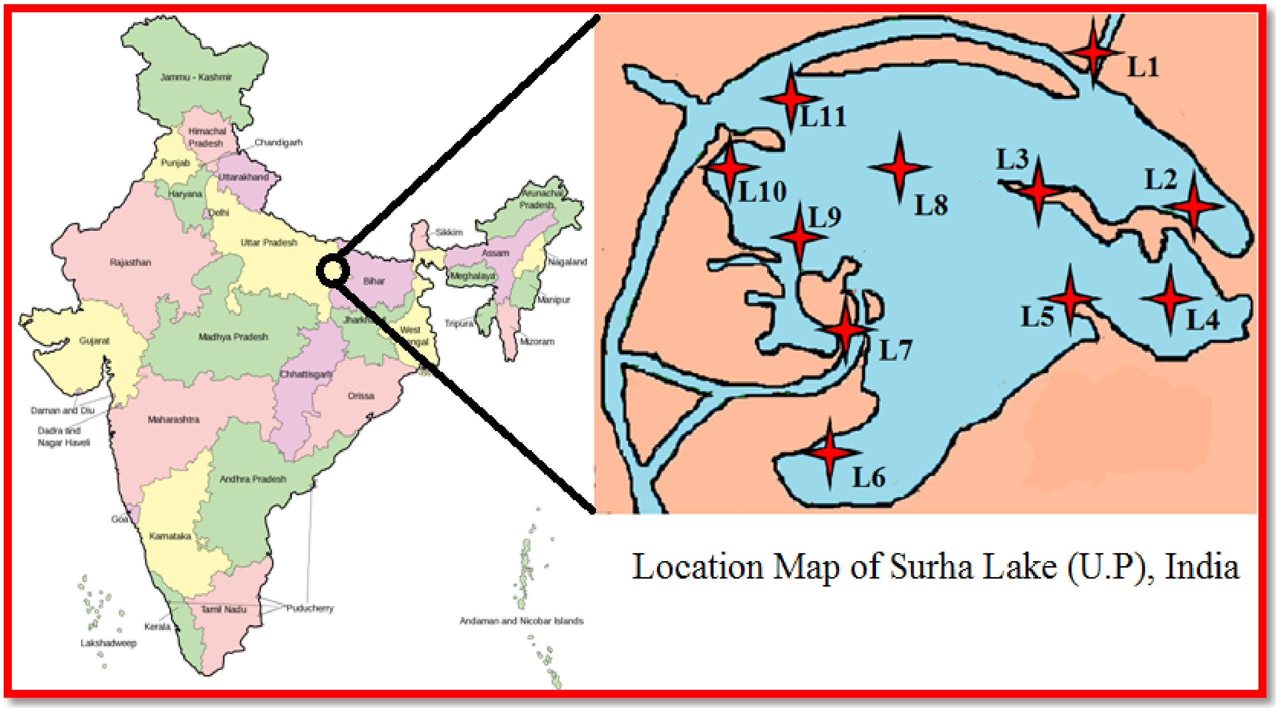

Figure 1: Map of sampling locations in Surha Lake of U.P, India

with water sampling locations is shown in Figure 1 and the details of locations are given in Table 1.

Table 1: Details of sampling locations

S. code.	Sampling locations	Longitude	Latitude
L1	Maritar	25°86′11″	84°19′11″
L2	Rajpur	25°84′80″	84°20′30″
L3	Kathar nala merge point 1	25°85′11″	84°18′20″
L4	Narayanpur	25°83′81″	84°20′31″
L5	Kathar nala merge point 2	25°83′70″	84°18′90″
L6	Fulwaria	25°82′41″	84°16′50″
L7	Bhikampur Medha nala merge point	25°85′31″	84°16′81″
L8	Middle of lake	25°85′30″	84°17′10″
L9	Basantpur	25°84′51″	84°16′11″
L10	Shivpur	25°85′21″	84°15′30″
L11	Kaithauli	25°85′90″	84°15′91″

[B] Data Collection and Analysis

The surface water samples were collected from L1, L2, L3…..L11 sampling locations in the Surha Lake and analyzed in laboratory during wet and dry seasons in year 2014-15. The water quality parameters like pH, electrical conductivity, and dissolve oxygen, were measured on location using portable equipments. For further analysis of the water quality parameters like biochemical oxygen demand, total hardness, total alkalinity, chloride, total dissolved solid, turbidity, Nitrate, total phosphate (TP), and trace metals (Fe, Cu, Cr, Zn), the collected samples were preserved at 4^{0}C and transported to laboratory within 24 hrs where. The samples for BOD$_3$ testing were collected in BOD bottles and fixatives (MnSO$_4$ and KI). The experimental tests were performed using analytical methodologies as per the APHA.[13]

Results And Discussions

[A] Status of Water Quality

The following results have been found during the analysis of water quality parameters:

pH: It was found to be very high at L3 and L7 location as compared to the other locations while at L2, L4, L8, L9, L10 and L11 locations it was found to be within the prescribed limit for drinking water (BIS and WHO)[14, 15] i.e. 6.5-7.5 in January as shown in Figure 2 (a). While in the march, the major variation was observed at L7 location where, pH was found to be very low i.e. less than 6.5 indicating the influence of acidic waste and organic loading in the water. The increase in pH was found at L4 and L8 locations where it exceeds the prescribed limit.

Electrical conductivity (EC): The prescribed limit of EC in the drinking water is 300µmho/cm (WHO).[13, 16] Except L7 location, the EC at rest other location in both sampling months were found within the prescribed limit, as shown in Figure 2 (b). The change in EC at L7 location may be due to input of waste from the Nallas joining the river.

Dissolve oxygen (DO): It was found to be within the prescribed limit for drinking water i.e. 5 mg/l (BIS and WHO)[14, 15] in both sampling months. Even, the DO was found to be less in March as compared to the DO in January, this significant decrease in DO was due to increase in decay of submerged and floating vegetation that increases the organic loading in the lake. The lowest DO was found at L7 location in March and the highest was L9 location in January, as shown in Figure 2 (c).

Biochemical oxygen demand (BOD): At L10 and L11 location, the BOD was found to be within the prescribed limit for drinking water in month of January, while at other locations was found above 5 mg/l (BIS and WHO).[14, 15] Even, the BOD was found to be more in March as compared to January at all locations as shown in Figure 2 (d). It clearly indicates the increase in organic pollution loading in March which also being validated by decrease in DO. As the BOD increases, DO gets reduced.

Chemical oxygen demand (COD): It was found to be above the prescribed limit for drinking water i.e. 20 mg/l (BIS and WHO)[14, 15] during both sampling months as shown in Figure 2 (e). The COD values at all locations indicate the influence of heavy agricultural runoff from the surrounding crop fields into the lake. At L3, L5 and L7 locations, the COD value was found to be maximum than other locations, because at these locations, the major small streams Katihar and Medha nalla that carry domestic waste while passing though the urban areas of the district Ballia joins the lake.

Total alkalinity (T-Alk): It was found to be above the prescribed limit for drinking water i.e. 200 mg/l (BIS and WHO)[14, 15] at all locations in both sampling months as shown in Figure 2 (f). The maximum concentration was observed at L7 location and minimum at L2 location.

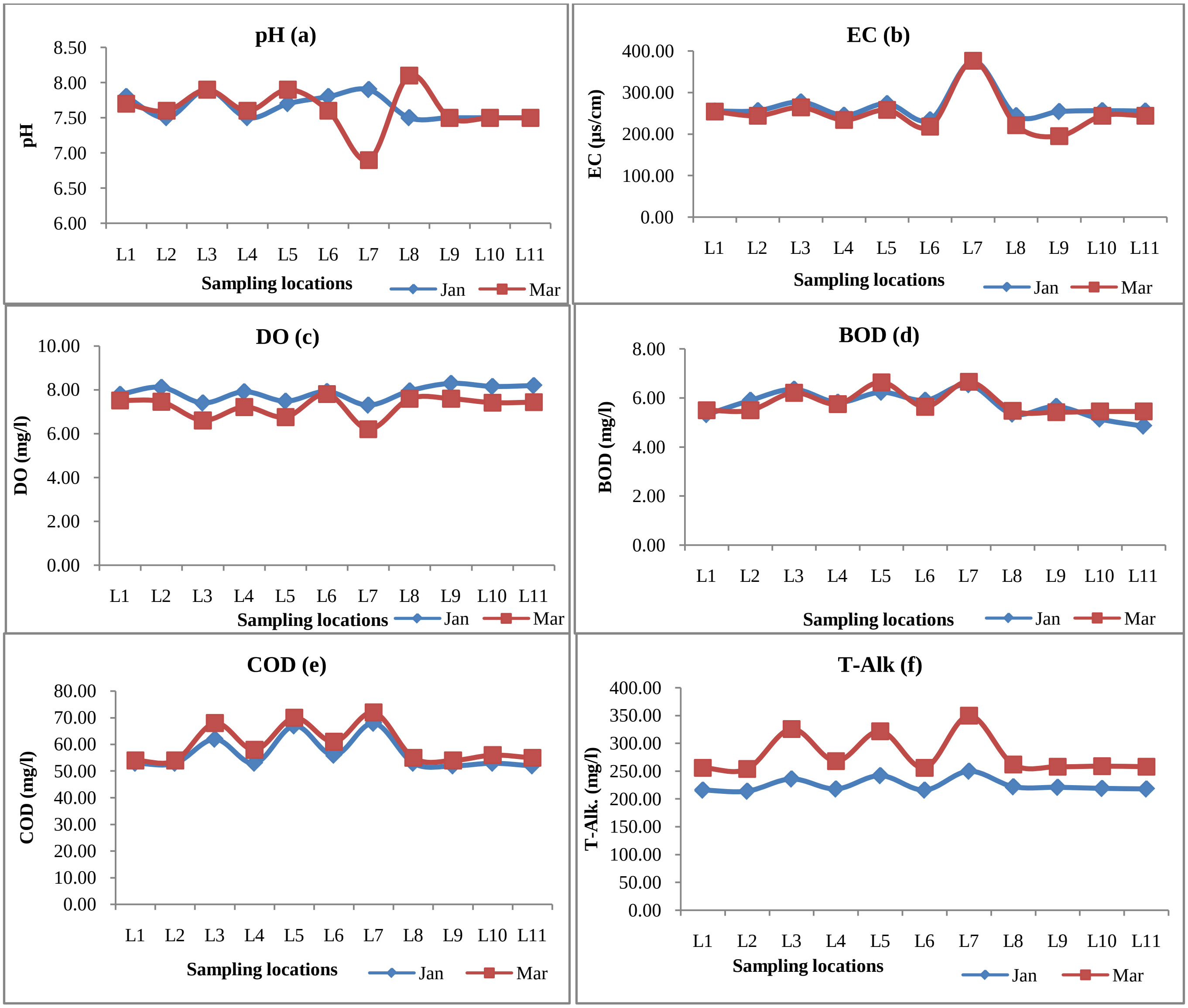

Figure 2: Variation of water quality parameters {pH (a), EC (b), DO (c), BOD (d), COD (e), T-Alk (f)} in the month of January and March, 2015

Total hardness (TH): It was found to be within the prescribed limit of drinking water i.e. 300 mg/l[14, 15] at L2 location in the month of January as shown in Figure 3 (a), while at other locations it was above the limit. During the sampling month of March TH concentration was found to be more than the limit.

Chloride (Cl): Its concentration was found to be almost similar in both sampling months and all locations. The increase in Cl concentration was observed at L8 which may be due to addition of agricultural runoff as the crop field was very near to the location as shown in Figure 3 (b). The concentration of Cl at all sampling locations was found within the prescribed limit i.e. 250 mg/l for drinking water. [14, 15]

(d). While it was found to be beyond the limit in March indicating increased pollution in the water of the lake.

Nitrate (NO_3): The measured nitrate concentration was also found within the prescribed limit for drinking water i.e. 45 mg/l

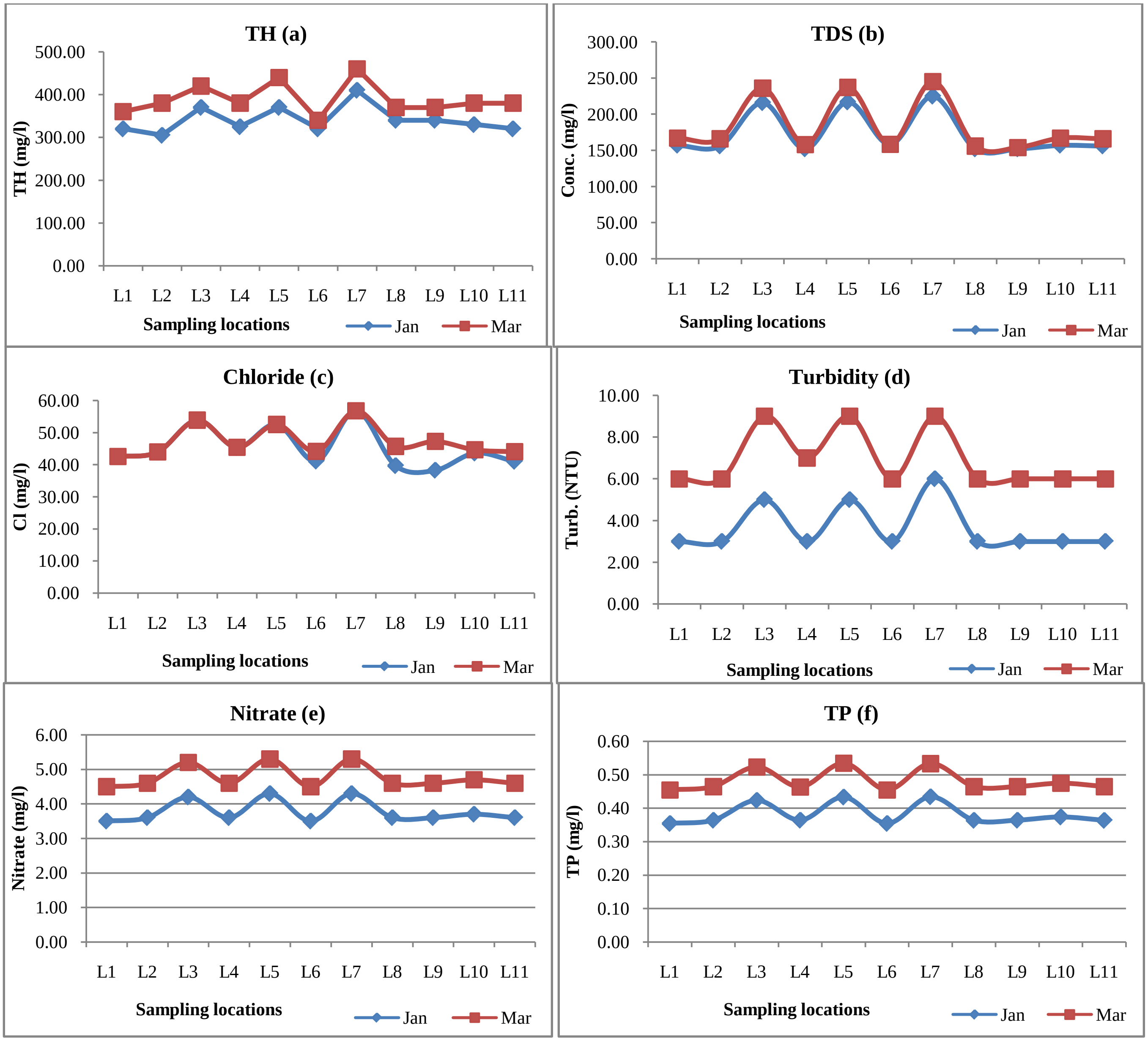

Figure 3: Variation of water quality parameters {TH (a), TDS (b), Cl (c), Turbidity (d), Nitrate (e), TP (f)} in the month of January and March, 2015

(BIS and WHO) [14, 15] at all locations in both sampling months. The concentration of nitrate was found to be more in month of March as shown in Figure 3 (e). It may be due to increase degradation of organic waste in the water of the lake.

Total dissolved solid (TDS): It was also found within the prescribed limit for drinking water i.e. 500 mg/l (BIS and WHO) [14, 15] at all locations in both sampling months. The very same trend, as of other parameters, was also observed for TDS, when compared in sampling months, shown in Figure 3 (c). It was found to be more at L3, L5 and L7 locations.

Turbidity: It was found to be within the prescribed limit of drinking water i.e. 5 NTU (BIS and WHO) [14, 15] at all location except at L7 in sampling month of January as shown in Figure 3

Total phosphate (TP): As nitrate, the similar trend of variation was also observed for total phosphate. The concentration of TP was also found within the prescribed limit for drinking water i.e. 5 mg/l (BIS and WHO). [14, 15] The almost constant increase in the concentration was observed at all location as shown in Figure 3 (f).

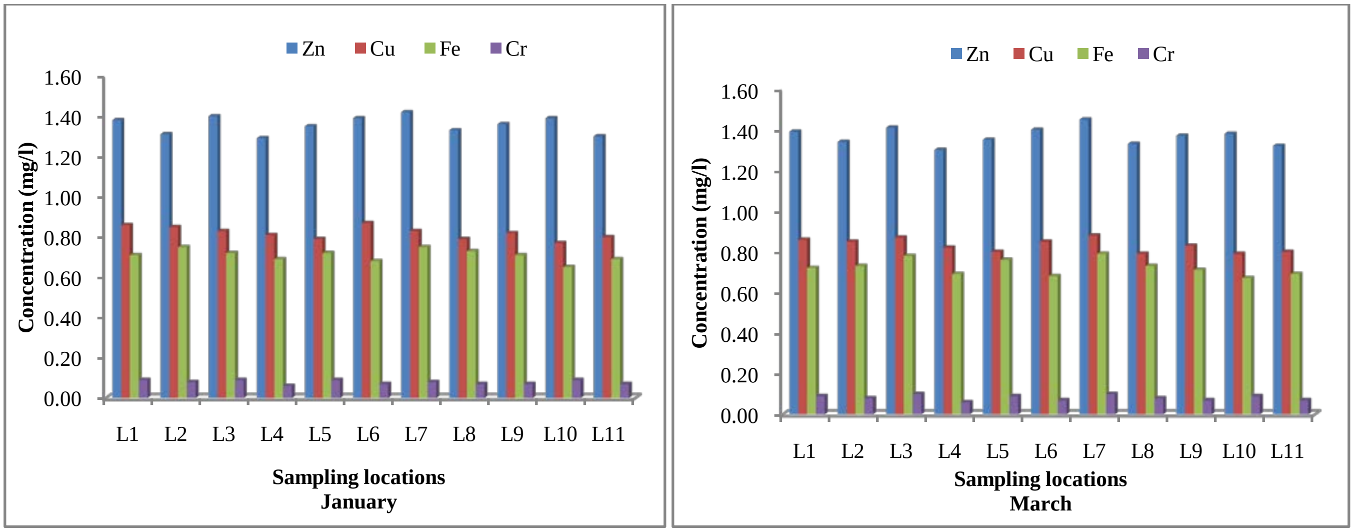

Figure 4: Concentration of heavy metals in January and March, 2015

Trace metals: In the present study, four heavy metals (Fe, Cu, Zn and Cr) have been analyzed in the surface water of the lake in both sampling months and all locations and the results have been graphically represented in Figure 4. The concentration of all metals were found above the prescribed limit {Fe (0.3 mg/l), Cu (0.05 mg/l), Zn (5 mg/l), Cr (0.05 mg/l)} for drinking water quality (BIS and WHO), [14, 15] which signifies the contamination of water due to heavy metal and unfit for drinking. But, with compared to the prescribed limit of water quality for inland environmental discharge (CPCB), the concentration of all metals was within the limit, it indicates that the lake water is suitable for agriculture and fisheries purpose.

[B] Problems Identified

Based on the results obtained, following problems have been identified, which might be responsible for change in water quality:

- With respect to drinking water quality, the concentration of BOD and COD in the lake water is high which could be due to the direct input of domestic waste water through the Katihar and Medha nallas that carry water from the Ganga and Saryu rivers.
- The rise in concentration of total hardness, total alkalinity and heavy metals (Fe, Cu, and Cr) could be due to the agricultural runoffs that enrich the nutrients in the lake.
- The local people do agricultural practices within the lake catchment when lake size shrinks in non rainy seasons. The cultivation of crops add large amount of nutrients that affect the water quality of the lake. No management activity is done to check the addition of residues of crops.

Conclusions

On the basis of the present results, the high concentrations of parameters like COD, BOD, total hardness, total alkalinity and heavy metals (Fe, Cu, and Cr) with respect to drinking water quality have been recognized as the major factors affecting the water quality in the lake. Therefore, it is necessary to control the input of nutrients into lake from the different sources and measures such as desiltation and evacuation of lake, interception and diversion of nallas, aeration and dilution of water should be done in the lake by supplying freshwater, lake shore line improvement etc.

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