Environmental Status Of Hosakote Lake, Bengaluru, Karnataka, India

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Abstract
The present research work carried out to determine the environment status with the physiochemical property and heavy metals pollution of Hosakote Lake, Bengaluru, Karnataka, India. Study was conducted in the months of November 2017 to March 2018. Lake was highly contaminated with domestic sewage, solid wastes and highly toxic compounds generated from local small scale industries. Water samples were collected and studied for physical, chemical and heavy metal studies. The samples were analyzed and the average range of pH (7.95), Total Dissolved Solids (345.8ppm), Electrical Conductivity (831.8µs/cm), Turbidity (1.72NTU), Alkalinity (258.33mg/L), Hardness (192.57mg/L), Calcium (137.09mg/L), Magnesium (55.34mg/L), Nitrate (0.273mg/L), Phosphate (0.344mg/L), Fluoride (0.977mg/L), Sulphide (0.501mg/L), Chloride (183.27mg/L), Sulphate (0.268mg/L), Sodium (24.8mg/L), Potassium (27.2mg/L), TSS (7.37mg/L), Boron (0.396mg/L) and heavy metals were Chromium (0.0492ppm), Lead (0.1012ppm), Copper (0.0393ppm), Iron (0.5586mg/L), Nickel (0.1805ppm) and Zinc (0.0470ppm). The water quality was heavily contaminated with many pollutants and severe conservation strategies are most essential for the sustainable development of the lake.

Keywords: Hosakote Lake, Physicochemical, Heavy metals, Domestic sewage, Solid waste.

Introduction
Water is an inexhaustible, most wonderful, abundant and most useful chemical compound gifted with physicochemical properties of nature. It is the most precious resource and important component for the survival of organism in Earth. About 97% of the Earth's water is found in ocean, 2% in poles as ice and remaining 1% is available as fresh water in lakes, rivers, groundwater and streams (Kudesia and Kudesia, 1998; Goswami et al., 2020). It is a very good solvent and essential for the survival of all the organisms in the world. The quality of water depends on many factors such as physical, chemical, biological and hydrological factors.

The water required for human consumption should be free from microorganisms and chemicals which are hazardous to human health and well-being. Water plays a vital role not only for the survival of aquatic organisms but also for human beings. The improvement of the water quality of lakes and rivers has received much attention in recent years (Moss et al., 1996; Goswami et al., 2020a, b). Ponds and lakes have been a natural water source which is exploited by human beings at different times to meet their different needs; for example domestic or agricultural purpose, for transport, ritual or industrial use, swimming and fish farming (Narayan et al., 2007).

The need of water to all the living organisms, from microorganisms to man is a serious challenge because all the water sources are polluted due to unplanned industrialization and urbanization. The deteriorating water quality seriously minimizes the use and importance for human consumption also for aquatic life, among that dumping various type of solid waste became major threat to the aquatic system. Therefore, the periodical analysis of water quality testing is necessary to take preventive measures. Due to lack of awareness of the people living around water bodies, the ponds and lakes are getting contaminated day by day. Untreated water effluents from various industries, agricultural, sewage and residential waste water, human and animal faeces are disposed directly in the nearby water bodies causing serious environmental problems.

The aim of the study was to analyze the environmental status by physicochemical and heavy metal properties of the Hosakote Lake, Bengaluru, Karnataka, India.

Material and Methods

Hosakote Lake water samples were collected and analysis done from November, 2017 to March, 2018. The present findings of research work clear the environmental status by collection of data for various evaluations like physiochemical properties and detection of heavy metals.

Study Area and Topography

The study has been carried out in Hosakote Lake, Bengaluru, Karnataka, India. Bengaluru is the capital and metropolitan city of Karnataka in the Southern part of India. It lies in the Deccan plateau at 2953 feet above the sea level. Bengaluru covers an area of 741 sq km^2 in the latitude and longitude were 12.97°N and 77.56°E respectively. It is one of the fundamental urban areas in South India having a population of 12.476 million according to a report in 2018.
The Hosakote Lake receives waste water from nearby industries, farming activities, domestic crop cultivation as the water containing fertilizers seep through the soil contaminating the lake. Moreover, domestic wastes and various day to day activities like washing clothes, utensils, cattle grazing, etc has added to its deterioration.

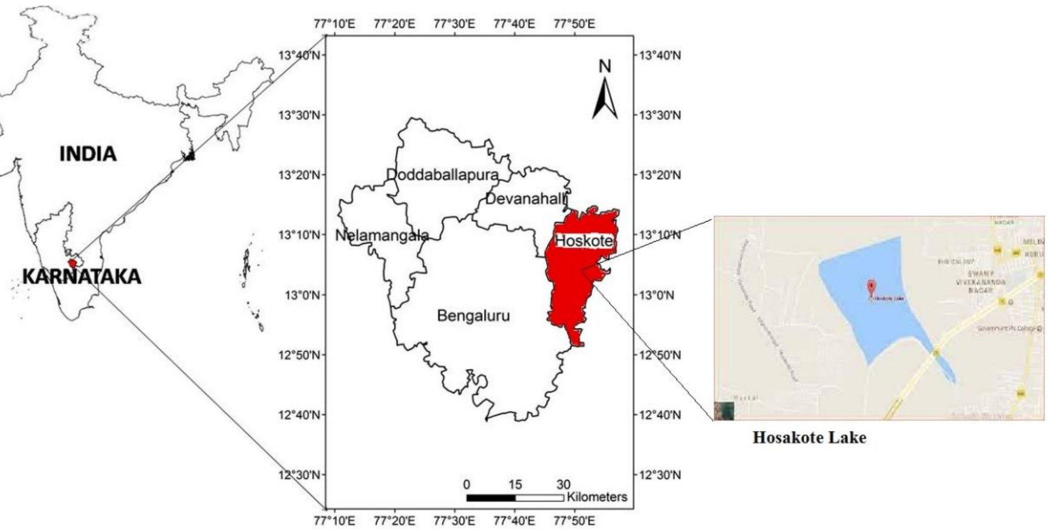

Figure 1. Map of India showing location of Karnataka state and the metropolitan city, Bengaluru and their representation of sampling Hosakote Lake location

Climate

Bengaluru has a tropical Savanna climate with distinct wet and dry season. It has a moderate climate throughout the year, the coolest month being January (15.1°C) and the hottest month April (35°). The highest ever recorded temperature is 39.2°C (2016) and the lowest is 7.8°C (1884).
The annual rainfall is 859mm. The primary rainy season is from June to September and the secondary rainy season is from November to December. The heaviest rainfall ever recorded lasted for 24hours and was 179mm.

Field Studies

Water Sample Collection

Water samples were collected on particular dates of every month from the Hosakote Lake to know the environmental status study. Water from the surface was collected using clean and sanitized BOD bottles and filled upto its neck. Collection was done from the four different lakes around Bangalore city during morning at around 9-11am for the months of November 2017 to March 2018.

Physicochemical properties

Temperature of the water samples was recorded at the sampling point. Analytical Grade (AR) grade chemicals and glass distilled water was used for the preparation of the reagents. Electrical conductivity and pH was determined using Systronics - Conductometer and Digital Systronics pH – meter respectively. The water quality parameters like mean pH, Total Dissolved Solids, Electrical Conductivity, Turbidity, Alkalinity, Hardness, Calcium, Magnesium, Nitrate, Phosphate, Fluoride, Sulphide, Chloride, Sulphate, Sodium, Potassium and TSS were studied using standard procedures (APHA, 2012).

Heavy metal status

Atomic absorption spectrometry (AAS)

The elements like Chromium, Iron, Copper, Lead, Nickel and Zinc were analyzed by using AAS technique. AAS is a quantitative method of metal analysis suitable for the determination of approximately 70 elements. This method measures the concentration of the element by passing light in specific wave length emitted by a radiation source of a particular element through cloud of atoms from a sample. Atoms will absorb light from an energy source known as hollow cathode lamp (HCL). The reduction in the amount of light intensity reaching the detector is seen as a measure for the concentration of particular element in the original sample.

A typical AA spectrometer consists of energy (light) source, sample compartment (atomizer). The radiation source is usually a hollow cathode lamp (HCL) or electrodeless discharge lamp (EDL), while different atomizers are used in various AAS techniques such as flame, a graphite furnace, or a quartz tube. The Monochromator is eliminating scattered light of other wavelengths by a number of lenses and mirrors to focus the radiation and the detector is typically a photomultiplier tube that converts the light signal to an electrical signal proportional to the light intensity (Beaty and Kerber, 1993).

Results and Discussion

The quality of the water samples were analyzed by collecting samples from the Hosakote Lake of Eastern Bengaluru from November 2017 to March 2018. The results obtained by the analysis of the water samples are listed as physicochemical parameters and heavy metal analysis during the experimental studies.

Status of Physicochemical Properties and Heavy Metal Status of Hosakote Lake

The sampling was done for 5 months and covered two seasons (post-winter and pre-summer). Sampling and analysis was carried out on the selected lake water for eight times in the whole study period.

Physicochemical properties and heavy metal status were analyzed such as pH, TDS, electric conductivity, turbidity, alkalinity, hardness, calcium, magnesium, nitrate, phosphate, fluoride, sulphide, sulphate, chloride, sodium, potassium, TSS, boron, chromium, lead, copper, iron, nickel and zinc (Table 1 and 2).

pH

Variation of pH was seen between 7.33 and 8.95 in Hosakote Lake in post monsoon months of 2017. But in most of the samples, pH was maintained at an average of 7.5. On an average, the pH was high in winter and pre-monsoon (Table 1). The pH of the studied samples was within the maximum permissible limits given by WHO and BIS during both the pre- and post-monsoon season (Kamble and Saxena 2016). Most of the studies reported higher pH was usually observed in post-monsoon and winter in the first sampling period and in winter and pre-monsoon in the second sampling period in most of the samples (Satyanarayana and Krishna 2017; Singh et al., 2022).

Total dissolved solids (TDS)

TDS varied from 221ppm to 509ppm in Hosakote Lake, lowest in winter 2017 and highest in early summer of 2018 (Table 1). TDS was high in pre-monsoon and monsoon and low in post-monsoon and winter. Increase in monsoon was due to run off from the surrounding catchment, which was observed due to increased agricultural activities (Manohar et al., 2017). TDS in mg/L of all the samples was observed to be less than the permissible limits set by WHO (2011) and BIS (2012) with average value of 316.09 (pre-monsoon) and 406.18 (post-monsoon). Higher values were due to the decrease of water level and disturbances by various activities. Similar opinion was expressed by Veena et al., (2020) on river Umschyripi at Shillong and by Kumar et al., (2017) on surface water of Dehradun.

Electrical conductivity (EC)

The variation was observed between 542µs/cm and 1201µs/cm, lowest in Hosakote Lake in late winter 2017 and highest in early summer 2018 (Table 1). EC was low in first sampling year and high in second sampling year in monsoon season, due to high variation in rainfall in these two sampling year. All samples have shown higher EC (µS/cm) values than permissible limits, i.e., 750.80 (pre-monsoon) and 891 (post-monsoon). The water level of these lakes was very low in monsoon and gradually increased in post monsoon. The presence of ionic solids and minerals in water increases conductivity. EC of water is proportional to the amount of dissolved solids. Presence of dissolved salts due to poor irrigation system, leaching of salts or nutrients, agriculture runoff containing more chlorine, phosphate and nitrate, anthropogenic discharges and minerals from rain water may enhance conductivity (Manohar et al., 2017). EC is affected by calcium, magnesium, ferrous or by anions and by the presence of inorganic dissolved solids like nitrate, phosphate, sulphate and chlorine (Kumar et al., 2017;Gaur et al., 2022).

Turbidity

Turbidity varied from 0.9 to 4.7NTU lowest in Hosakote Lake in early winter and it is highest in early summer. The turbidity was higher in post-monsoon and winter in the first sampling period and in monsoon and pre-monsoon in the second sampling period. Deforestation, poor agriculture practice and soil erosion contribute to increased turbidity (Table 1). Variation in the sampling year was seen because of drastic decrease in rainfall in the second sampling year (Ojok et al., 2017). The oxidation of ferrous in its lower oxidation state was responsible for high turbidity (Khadse et al., 2015). The presence of organic and inorganic elements such as mud, clay, silt, aquatic organisms cause turbidity in water (Kjelland et al., 2015; Pineda et al., 2022).

Alkalinity
It is the sum of carbonates, bicarbonates, calcium, magnesium, hydroxides and other compounds in water and it make the water resistant to changes in pH level. The values were varied between 200.6mg/L and 456 mg/L, it was observed lowest was present in early winter and highest in early summer (Table 1). Similar observations were made by Satyanarayana and Krishna (2017). In pre monsoon, alkalinity increases with increased decomposition of human and animal excreta and indicate severity of pollution (Singh 2015, Ojok et al., 2017). Increase in utilization of bicarbonates by phytoplankton and macrophytes decreases alkalinity (Pineda et al., 2022).

Hardness
Total hardness varied between 171.36 and 220.32mg/L, fluctuation is observed in both the season due to various anthropological activities near by the lake. Hardness was high in pre-monsoon and monsoon and low in winter and post-monsoon (Table 1). The increase in hardness in summer was due high photosynthetic activity, utilization of free carbon and conversion of bicarbonates to carbonate which precipitate as Ca salts (Riddhi et al., 2011; Dey et al., 2021). The overall range of hardness in sampling period was 108 mg l to 635 mg l. Hardness was -1 -1 usually higher in monsoon followed by pre monsoon in both the sampling year (Ojok et al., 2017). Temporary hardness is due to carbonates and bicarbonates and permanent hardness is due to bivalent cations of sulphate and chlorides and it indicates the regional variation of hydrosphere (Pineda et al., 2022).

Calcium (Ca)
Amount of calcium in the sampling period varied from 89.96 to 171.92mg/L, lowest in Hosakote Lake early summer of 2018 and highest in early winter of 2017 (Table 1). Similar observations were reported by Saad et al., (2017). Ca increases due to decomposition of biological matter, hydro-chemical process, dissolution of sedimentary rocks will increase and by anthropogenic activities and its utilization by aquatic organisms will decrease calcium content (Satyanarayana and Krishna, 2017;Saha et al., 2019).

Magnesium
The value of magnesium (Mg) in the sampling period varied from 32.64 to 81.6mg/L with fluctuation in all the season (Table 1). Many researchers reported their opinion that calcium concentration is usually higher than magnesium (Kumar et al., 2017; Pineda et al., 2022). According to Bureau of Indian Standard (BIS) 30 to 100mg/L is the acceptable limit and any excess in these indicate contamination and pollution (Satyanarayana and Krishna, 2017).

Nitrate
Nitrate content varied from 0.149 to 0.372mg/L, the nitrate content was high in pre-monsoon and also summer season during study (Table 1). The nitrate concentration was below 10 mg/L and it is below permissible limit as per BIS (2012) in all the samples. Nitrate is also an essential nutrient for plants and plankton, which converts it into cell protein, but higher concentration, may be harmful (Divahar et al., 2019). The concentration of nitrate was high during winter and pre monsoon in the first sampling period and the increase in dry seasons were attributed to domestic pollution (Chen et al., 2016). It was high in monsoon and pre-monsoon in the second sampling period. Nitrate was below detectable level in post monsoon 2017 and in early summer 2018 throughout the second sampling period. Decrease in rainfall was one of the reasons behind the low concentrations of nitrate in different samples (Manohar et al., 2017).

Phosphate
Phosphate content of water varied between 0.023 and 0.795mg/L and found highly fluctuations in all the seasons (Table 1). Higher concentration of phosphate in monsoon season was due to inflow of rainwater (Vajravelu et al., 2018). The aquatic systems whose terrains are made of agriculture and residential areas usually contain more phosphate in rain water runoff in the form of phosphate fertilizers, detergents, animal waste, septic tank effluent and industrial discharge (Manohar et al., 2017). Increase in phytoplankton population shows more utilization of more phosphate and thus its concentration decreases. Phosphorus concentration of 0.03mg/L is sufficient to cause algal bloom (Sheela et al., 2011; Widyarani et al., 2022).

Fluoride
The natural sources of fluoride in water are apatite, fluorite, rock phosphate and topaz in nature. It was found almost constant throughout the sampling time in almost all the samples and the value was around 0.797l to 1.079mg/L and observed highest in the both the season (Table 1). Its concentration increases by the entry of industrial effluent and hazardous contaminants (Vinothkanna et al., 2019). Fluoride content was comparatively higher in post-monsoon and winter in the first sampling year. Fluoride is ubiquitous and is present in rocks, soil, water, plants and even air (Dehabandi et al., 2017, Vinothkanna et al., 2019; Kumar et al., 2021).

Sulphide & Sulphate
The values of sulphide and sulphate varied between 0.25 to 0.84mg/L and 0.098 to 0.567mg/L, sulphide content lowest was observed Hosakote Lake in post-monsoon and highest in pre-monsoon 2018 and sulphate is fluctuation in both the seasons (Table 1). Sulphate was low in pre monsoon season. Increase in monsoon can be attributed to the surface runoff which contains organic fertilizers. Concentration of sulphate was higher in post monsoon and winter; lowest in monsoon

during the first sampling period (Dey et al., 2021; Nateshan et al., 2022). Low concentrations sulphate in monsoon and high in winter season was recorded by Pawar (2010) which correlate with the present studies.

Chloride (Cl)

Chloride content varied from 113.96 to 241.92mg/L observed fluctuation in all the seasons (Table 1). This was due to the entry of surface runoff containing organic waste of animal origin and pesticides used for the horticulture plants (Manohar et al., 2017). Indian Council of Medical Research (ICMR) and BIS have suggested 250mg/L as the maximum permissible value. Similar findings by Singh (2015) have justified this study. Cl concentration mainly depends on climatic variations, domestic wastes, run off during monsoon, humidity and evaporation. Increased temperature and evaporation of water bodies may increase Cl content (Mohamed et al., 2017; Gupta et al., 2021).

Sodium (Na)

The sodium content varied from 21 to 33mg/L (Table 1). It was reported that sodium reduces the permeability of soil by reacting with the ions (Ca^{2+} and Mg^{2+}) present in the soil (Selvakumar et al., 2014). Na^+ ion was absorbed by the clay particles and destroyed the structure of the soil (Singh et al., 2015). The sodium values of Madivala and Begur lake at input and output are 303, 202 and 205mg/L respectively (Balachandran et al., 2012). Measurement of chloride content helps in detecting sewage contamination. It occurs in natural water in different forms like sodium chloride, potassium chloride, magnesium chloride and calcium chloride (Nandal et al., 2020; Singh et al., 2022).

Potassium (K)

The potassium content varied from 20 to 32mg/L and observed fluctuation in all the seasons (Table 1). Potassium deficiency in plants causes abnormal plant growth. Based on the results of potassium water can be categorized under class E . Presence of potassium in water is essential for plant nutrition in lower concentration. For good plant development it must be maintained in proper balance with other mineral requirement such as phosphorus (Thorne and Maathuis, 2022). The potassium values of Madivala and Begur lake at input and output are 45, 59 and 52, 48.2 mg l respectively (Balachandran et al., 2012).

Total suspended solids (TSS)

The wide variation between TSS concentrations for sampling site could be due to the presence of organic floatables observed during collection of the samples. The presence of these clumps of matter could significantly increase the TSS value for a sample in comparison to a similar sample without clumps. The overall range of TSS in sampling period was 0.68 to 13.24mg/L and was high when compare to the permissible limit (Table 1). Nandal (2020), solids refer to the matter that is suspended or dissolved in the water or waste water. The TSS, is a portion of total solids (TS) retained by a filter while the total dissolved solids (TDS) are the in filterable solids, mostly inorganic salts and small amount of organic matter dissolved in the water (Butler and Ford, 2018).

Boron

The boron concentration range from 21 to 0.258mg/L, the concentration seen in all the months of 2 seasons were fluctuation in condition (Table 1). Concentrations of boron in groundwater throughout the world range widely, from <0.3 to >100mg/L. High concentrations of boron can be found in many parts of the world, particularly in highly mineralized, naturally carbonated ground waters (Chruszcz-Lipska et al., 2021). Concentrations of boron in surface waters, except in areas of particularly high natural boron, are almost entirely less than about 0.5 mg/L (Parks and Edwards, 2007).

Table 1. Physicochemical properties of Hosakote Lake, Eastern Bengaluru, Karnataka, India

Months & Year	Physicochemical parameters																	
	pH	TDS (ppm)	Conductivity (μs/cm)	Turbidity (NTU)	Alkalinity (mg/L)	Hardness (mg/L)	Ca (mg/L)	Mg (mg/L)	Nit (mg/L)	K (mg/L)	F (mg/L)	S^{2-} (mg/L)	Cl- (mg/L)	SO_4^{2-} (mg/L)	Na (mg/L)	P(mg/L)	TSS (mg/L)	B (mg/L)
Nov 2017	7.33	221	542	1.1	220	195.64	163.2	32.64	0.149	0.002	1.055	0.375	113.9	0.151	23	20	13.24	0.333
Dec 2017	8.95	222	544	0.1	212	220.32	171.3	48.96	0.21	0.293	0.797	0.250	241.9	0.456	21	26	0.68	0.382
Jan 2018	7.80	278	696	0.9	456	204	163.2	40.8	0.311	0.795	1.066	0.630	193.9	0.078	26	30	1.2	0.422
Feb 2018	7.18	509	1201	4.7	200.0	171.36	97.92	73.44	0.372	0.311	0.892	0.412	Nil	0.567	33	28	10.05	0.413
Mar 2018	8.5	449	1176	1.8	203	185.5	89.76	81.6	0.323	0.301	1.079	0.840	Nil	0.089	21	32	11.7	0.431
Average	7.95	345.8	831.8	1.72	258.33	192.57	137.1	44.34	0.273	0.344	0.977	0.501	183.2	0.268	24.8	27.2	7.37	0.396

Heavy metal analysis of Hosakote Lake by Atomic Absorption Spectroscopy (AAS)

Chromium (Cr)

In Hosakote Lake water, the range of Cr in all the lake was shown 0.041 to 0.057ppm and observed fluctuation in all the season (Table 2). In water, chromium ranged 0.57 – 4.07ppm (2.13 ppm) exceeding the drinking water standards stipulated by BIS, EPA, and irrigation standards limit by Food and Agriculture Organization (FAO). Moreover, Cr exceeded the tolerance limit for water bodies subjected to pollution which is 2.0ppm (Nithya et al., 2018). The critical level range is between 5.00 – 30.0ppm. Onchoke and Sasu (2016) put the critical range between 20 – 100 ppm. This was below the probable effect level (PEL) of 90.0 ppm and under the background value of 32.0 ppm reported by Elias et al., (2018).

Lead (Pb)

The Hosakote Lake water lead to range of Pb was 0.0126 to 0.4192ppm (Table 2). Lead concentration was very high in Feb 2018 in the lake compare to other months and very lowest in winter season 2017 in the lake. This range exceeded the drinking water standards and effluent discharge limits prescribed by Central Pollution Control Board (CPCB). Nevertheless, Pb has been known to accumulate in aquatic macrophytes in considerable levels based on the rooted and floating species. Critical range for Pb as described by Mohanakavitha et al., (2019) is 30-300ppm. However, Pb concentration in Vartur Lake exceeded the background value for uncontaminated sediments reported by Onchoke and Sasu (2016). Pb can exist in several valences and are of critical environmental importance. In urban areas, the principal source of Pb in wetlands comes from gasoline additives, metal plating, e-waste and battery cells, electrical equipment, textile mills, dye and pigments, paper mills, chemical and fertilizer industries, and ghee manufacturing industries (Jumbe and Nandini 2009; Jin and Zhang, 2020).

Copper (Cu)

The Hosakote Lake water copper in water was ranging between 0.0015 to 0.0959ppm. Cu was within drinking water standards stipulated by ICMR and Environmental Protection Agency (EPA), but exceeded BIS limits of 0.05ppm. The normal range of Cu in all the lakes shown in all the seasons was in the normal range should be 4 – 15ppm (Jumbe and Nandini, 2009). However, the mean exceeded the background value of 27.0ppm reported by Mohanakavitha et al., (2019). Cu reaches the aquatic environment through wet and dry depositions, mining activities and storm water runoffs, industrial, domestic, and agricultural waste disposal. Among industrial sources include copper plating, pulp and paper mills, e-waste, sewage and other forms of waste waters (Devda et al., 2020).

Iron (Fe)

The Hosakote Lake iron was usually below detectable level in the samples and in many seasons. The overall range of Fe in sampling period was 0.2965 to 1.1464mg/L and was high when compare to the permissible limit. It was high in pre winter and it was low in summer in study lake (month wise) (Table 2). In monsoon, the concentration of Fe was more due to the heavy runoff of water into lakes (Talwar et al., 2014). Similar variation of parameter was also observed by Mallampati and Osman (2015). Decomposition process is the source in dry seasons (Manohar et al., 2017).

Nickel (Ni)

The Hosakote Lake nickel range was 0.0172 to 0. 5245ppm and was highest in early summer months of 2018 in studied lake compare to winter season (Table 2). This was above drinking water standards stipulated for Ni. But the mean was within the tolerance limit for water bodies subjected to pollution discharge. Similarly, Ni has been found in a variety of plants and ranges up to 340 ppm have been recorded non-edible wild plants (Shreshta et al., 2021). The overall mean for Ni in macrophytes of Vartur lake was 47.91ppm. The range was 26.0 – 65.32ppm. This is in critical category of Ni contents in plants as described by Jumbe and Nandini (2009) which is between 10 – 50ppm.

Zinc (Zn)

The zinc concentration in Hosakote Lake water ranged -0.0019 to 0.1018ppm with mean average of Zn of 0.0470ppm. This was within the stipulated drinking water standards by BIS, ICMR, EPA and irrigation limits by FAO. This fluctuated range of Zn was seen in all the months of 2 seasons during the study (Table 2). Zn in urban lake water is caused by a variety of industrial effluents including phosphates fertilizers, ghee manufacturing, metal processing units, zinc plating Industries, silver plating industries, distillery units, landfill leachates, urban storm water, fly ashes of coal powered plants, poultry sewage and compost (Elias et al., 2018; Goswami et al., 2020). In Bangalore lakes, the range for Zn was 42.93ppm which was below the PEL limit reported by Jumbe and Nandini (2009).

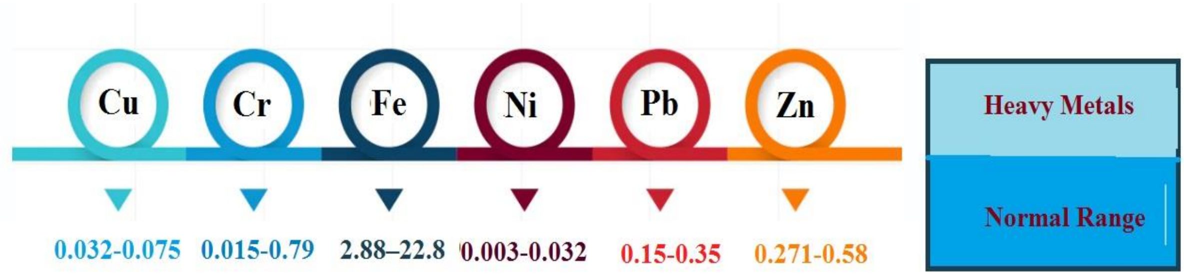

Figure 2. Normal range of heavy metals in fresh water ecosystem in ppm and iron (Fe) in mg/L

Table 2. Heavy metal status of Hosakote Lake, Eastern Bengaluru, Karnataka, India

Months & Year	Heavy metal parameters					
	Cr (ppm)	Pb (ppm)	Cu (ppm)	Fe (mg/L)	Ni (ppm)	Zn (ppm)
Nov 2017	0.052	0.0126	0.0949	1.1464	0.1285	0.0341
Dec 2017	0.048	0.0192	0.0055	0.7893	0.0183	0.0413
Jan 2018	0.048	0.0194	0.0133	0.5516	0.0172	0.0601
Feb 2018	0.041	0.4192	0.0804	0.2471	0.5245	0.1018
Mar 2018	0.057	0.0357	0.0015	0.3139	0.2141	-0.0019
Average	0.0492	0.1012	0.0393	0.2965	0.1805	0.0470

Conclusion

The Hosakote Lake shows the major source of contaminants during the study, it was due to sewage discharge, effluents and waste water from the surrounding places which entered directly to the lake without any treatment methods, also included anthropological activities like agricultural runoff, washing and cleaning activities by the dependent people. The experimental data exhibit that the lake was polluted moderately and requires serious attention in constructive approach to avoid further eutrophication of the lake. As a remedial measures lake would be rejuvenated by maintaining grass buffer strip around the lake, remediation against sewage discharge, domestic waste and sedimentation runoff of agricultural activities to minimize the particulate matter with the quality indicator to safeguard the lake before entering the pollutants. The entry of solid waste like pesticide containers, plastics, paper residues, liquid waste like thinners, lubricants, oils, paint residues and direct discharge of from drainage from various activities to the lake should be banned to reduce the water pollution. Community level awareness is most important, should educate the people with the importance of lakes or fresh water resources along with domestic water treatment, sanitary facility and various type of human waste disposal. This may change the structure of lake and also indirectly contribute by reducing activities to free from water pollution.

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