Effects of heavy metal contaminations in water from anthropogenic sources on lakes of Bangalore Rural, India

Shiva Kumar Lakshmipurada, K. Ramakrishna Reddy* and Durgesh R

Research & Development Centre, Bharathiar University, Coimbatore- 641046, India.
P G Department & Research Studies in Chemistry, Government Science College (autonomous), Bangalore-560001.
****E-mail ID**: rkrchem@gmail.com*

Abstract: Lakes are the heart and soul of our ecosystem. The aim of the study to effects of physico-chemical and heavy metal contamination from the anthropogenic sources in Bangalore Rural lakes. The field survey was conducted and also to investigate the present situation and health risk of due to heavy metal contamination of Lead , Chromium, Cadmium , Arsenic, Mercury and Copper in Bangalore Rural lake water. The lake water samples were subjected to comprehensive Physico-chemical analysis such as colour, odour, turbidity, temperature, pH and conductivity, TDS, total hardness, chloride, sulphate, nitrate, Dissolved Oxygen, Chemical Oxygen Demand and Biological Oxygen Demand are analysed through wet analysis and heavy metals analysis of the elements namely Lead, Chromium, Cadmium, Arsenic, Mercury and Copper were carried out by standard methods, such as ICP-MS.

Results of physico-chemical parameters and heavy metals shows that, conductivity, TDS, total hardness, DO, BOD and COD were above the APHA limits and the concentration of heavy metals such as Lead Cadmium and Arsenic in the surface water of the lakes exceed the threshold level of human consumption, whereas Chromium, Mercury and Copper below the permissible limit of human consumption

Further , it is apparent from CCME WQI values that, Bangalore rural lakes such as Bashettyhalli lake –Doddaballapura, Bharathipura Lake –Nelamangala and Pillagumpe area Lake-Hosakote WQI values range from (37.45-44.71),(37.45-44.71) and (27.21-33.58) respectively and water categorised as poor quality and KIADB industrial area Lake Devanahalli WQI value range from (52.47-58.37),water quality categorised as marginal.

MI index shows that, Bangalore rural lakes such as Bashettyhalli(3.18), KIADB industrial area Devanahalli(3.78) and Pillagumpe area Hosakote (3.79)are seriously affected and Bharathipura Lake (0.44)slightly affected.

KEY WORDS: Anthropogenic sources, APHA, heavy metals, DO and ICP-MS

INTRODUCTION

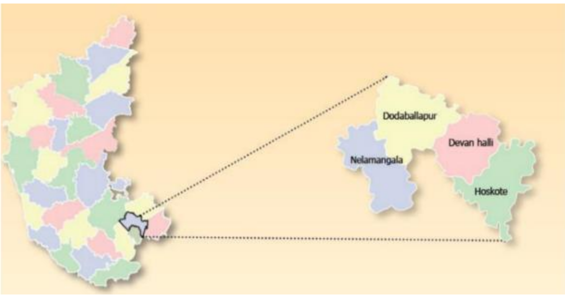
Today we are facing ecological threat due to water pollution. Environment with its water quality is considered the main factor controlling the state of health and diseases, and also a serious threat to the survival of aquatic organisms. The environmental conditions of any lake system depend upon the nature of that lake and its exposure to various environmental factors (P.Ravikumar, 2013). Although heavy metals are natural elements that are found throughout the earth's crust, the environmental pollution is due to anthropogenic activities such as mining and smelting operation, use of fertilizers and pesticides in agriculture (Serrano et al., 2012). The industrial and agricultural drainage water containing pesticides, fertilizers, effluents from industries and runoff in addition to sewage effluents supply the water bodies and sediment with huge quantities of inorganic anions and heavy metals (ECDG, 2002).

Industrial, sewage and municpal wastes are being continuously added to water reserviors, affect physico-chemical quality of water making them unfit for use of livestock and other organisms (Dwivedi and Pandey,2002)The most anthropogenic sources of metals are industrial, petroleum contamination and sewage disposal. In this study, heavy metals such as Lead, Cadmium, Copper, Mercury, Arsenic and Chromium were analyzed in the samples collected from the different lakes which are connected to the Industrial areas of Nelamangala, Doddaballapura, Devanahalli and Hosakote taluks of the Bangalore rural district. This study provides data on the levels of heavy metals and physico-chemical parameters in lake waters of the Bangalore rural district, which would be a baseline data for further studies.

MATERIALS AND METHODS

Study area: Bangalore Rural district covers Taluks of Nelamangala, Doddaballapura, Devanahalli and Hosakote which are located at 12°15’ and 13°35’ North latitude 77°05’ and 78°0’ East and Longitude spread over 2259 sq. km. The average annual rain-fall is about 859.6 mm and temperature min 15°C and maximum of 34°C. Due to proximity to Bangalore city, there are lots of industrial developments. (Source: MSME development institute).

Figure 1: Map showing the study area, illustrating the Bangalore rural district and its taluks.



Sampling

Water samples were collected for this study in Summer and Winter from different locations of Bashettyhalli Lake of Doddaballapura Taluk (Lake A), Bharathipura Lake of Nelamangala Taluk (Lake B), Lake connected to KIADB industrial area of Devanahalli Taluk (Lake C) and Lake connected to KIADB industrial area, Pillagumpe village Hosakote, Bangalore Rural District (Lake D).

Samples were collected from each lake in plastic containers which were thoroughly cleaned several times with distilled water. About 500ml of water sample filtered through Whatmann filter paper number 41(0.45µm pore size) and added 2mL of conc. Nitric acid to avoid precipitation of metals and samples were stored at 4°C (H. Lokeshwari and G. T. Chandrappa, 2007).

The parameters namely colour, odour, turbidity, pH, Electrical Conductivity and Temperature are recorded in single point of time, however, all other parameters are analysed in triplicates by standard methods (APHA, AWWA) and the mean values are reported.

Analysis of the elements namely, Lead, Chromium, Cadmium, Arsenic, Mercury and Copper were carried out by standard methods, such as ICPMS. {(ICPMS method: IS3025 (part 2), 2004 RA-2014 & part 48 for Mercury)}.

Water Quality Index (WQI):

Water quality analysed using CCME WQI method. Although there have been a variety of attempts to create such a water quality index, the most successful attempt to date appears to be the index developed by the British Columbia Ministry of Environment, Lands and Parks (Rocchini and Swain 1995).

Table 1: The physico- chemical parameters of water samples

Water quality	Parameter	Unit	BIS Standard (Desirable)	Bashettyhalli (Lake-A) Doddaballapura		Bharathipura (Lake-B) Nelamangala taluk		KIADB-Devanahalli (Lake-C) Devenahalli taluk		Pillagumpe village (Lake-D) Hosakote taluk	
				Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
General Parameter	Odour	-	Agreeable	Unpleasant	Unpleasant	Unpleasant	Unpleasant	Unpleasant	Unpleasant	Unpleasant	Unpleasant
	Turbidity	NTU	10	10	12	6	8	7	5	8	12
	Temperature	°C	-	30	23	29	23	31	26	31	24
	pH	-	6.5-8.5	6.2	6.8	6.5	6.7	6.5	6.5	5.8	6.4
	Conductivity	mho/cm	300	1350	1256	885	505	672	478	1123	1016
Conservative Parameter	TDS	mg/L	500	915	840	587	500	428	435	745	760
	Total hardness	mg/L	200	445	495	430	444	410	435	348	360
	Chloride	mg/L	250	126	156	150	163	125	129	79	95
	Sulphate	mg/L	200	55	65	69	79	85	94	48	68
	Nitrate	mg/L	45	59	68	52	62	25	35	25	20
Non-conservative parameter	DO	mg/L	4	8	11	7	12	4	6	7	10
	BOD	mg/L	2	21	16	9	6	11	8	40	33
	COD	mg/L	10	58	66	21	27	23	30	109	123
CCMEWQI				**30.69**	**31.02**	**37.55**	**44.71**	**58.37**	**52.49**	**27.21**	**33.58**

Calculation of Water Quality Index

Thus, in the CCME WQI a value of 100 is the best possible index score and a value of 0 is the worst possible. Once the CCME WQI value has been determined, water quality is ranked by relating it to one of the following categories:

$$CCMEWQI = 100 - \left(\frac{\sqrt{F_1^{\,2} + F_2^{\,2} + F_3^{\,2}}}{1.732} \right)$$

Where: F1is Scope, F2 is Frequency and F3 is amplitude

$$F_1 = \left(\frac{\text{Number of failed variables}}{\text{Total number of variables}} \right) \times 100$$

$$F_2 = \left(\frac{\text{Number of failed tests}}{\text{Total number of tests}} \right) \times 100$$

$$F_3 = \left(\frac{nse}{0.01nse + 0.01} \right)$$

$$nse = \frac{\sum_{i=1}^{n} excursion_i}{\#\ of\ tests}$$

$$excursion_i = \left(\frac{Objective_j}{FailedTestValue_i} \right) - 1$$

Thus, in the CCME WQI a value of 100 is the best possible index score and a value of 0 is the worst possible. Once the CCME WQI value has been determined, water quality is ranked by relating it to one of the following categories:

Excellent: (CCME WQI Value 95-100) – water quality is protected with a virtual absence of threat or impairment; conditions very close to natural or pristine levels.

Good: (CCME WQI Value 80-94) – water quality is protected with only a minor degree of threat or impairment; conditions rarely depart from natural or desirable levels.

Fair: (CCME WQI Value 65-79) – water quality is usually protected but occasionally threatened or impaired; conditions sometimes depart from natural or desirable levels.

Marginal: (CCME WQI Value 45-64) – water quality is frequently threatened or impaired; conditions often en depart from natural or desirable levels.

Poor: (CCME WQI Value 0-44) – water quality is almost always threatened or impaired; conditions usually depart from natural or desirable levels

The result of CCME WQI from Table1 shows that, for Lake A in the range of 30.69-31.02, Lake B in the range of 37.55-44.71, Lake D in the range of 27.21-33.58 are categorised as poor and Lake C in the range of 52.49-58.37 categorised as Marginal. Water quality is almost always threatened or impaired; conditions usually depart from natural or desirable levels.

Calculation of Metal Index (MI)

***Metal index* (*MI*):** Another index used is the general metal index (MI) which is based on a total trend evaluation of the present status. Takes into account possible additive effect of heavy metals on the human health that helps to quickly evaluate the overall quality of drinking waters. Metal pollution index is given by the following expression:

$$MI = \sum_{i}^{n} (c_i\,(MAC)$$

Where MAC is the maximum allowable concentration (μg/l) and c_i – the mean concentration of each metal (μg/l). The higher the concentration of a metal compared to its respective MAC value the worse the quality of water. MI value>1 is threshold of warning

Table 2: Heavy metal concentration in Bangalore rural lakes

Sl.No.	Parameter	Threshold Value	Bashettyhalli (Lake-A) Doddaballapura			Bharathipura (Lake-B) Nelamangala taluk			KIADB-Devanahalli (Lake-C)Devenahalli taluk			Pillagumpe village (Lake-D)Hosakote taluk		
			Summer	Winter	MI	Summer	Winter	MI	Summer	Winter	MI	Summer	Winter	MI
1	Lead as Pb	0.01	0.005	0.003	0.4	0.005	0.009	0.7	0.004	0.009	0.65	0.012	0.014	1.3
2	Chromium as Cr	0.05	0.008	0.006	0.14	0.007	0.008	0.16	0.006	0.009	0.15	0.013	0.021	0.34
3	Cadmium as Cd	0.003	0.010	0.014	2.4	BDL	BDL	BDL	0.004	0.009	1.3	0.005	0.008	1.3
4	Arsenic as As	0.01	0.007	0.009	0.8	0.005	0.009	0.7	0.009	0.011	1.0	0.002	0.005	0.35
5	Mercury as Hg	0.001	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
6	Copper as Cu	0.05	0.005	0.011	0.16	0.005	0.009	0.14	0.03	0.038	0.68	0.011	0.014	0.5
∑ MI =					3.18			0.44			3.78			3.79

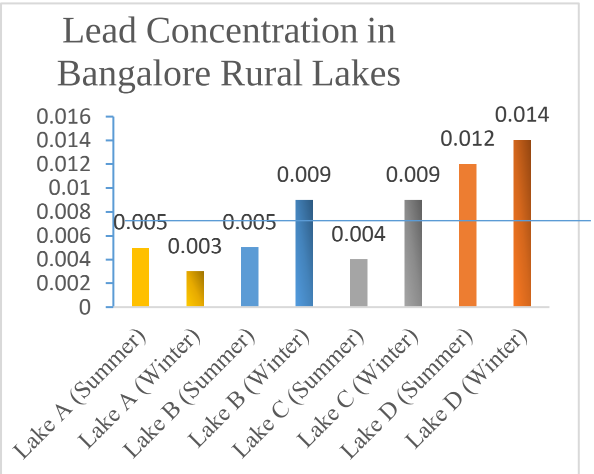
***Source: Prescribed by the Bureau of Indian Standards (IS-10500-2012), BDL: Below Detection Limit**

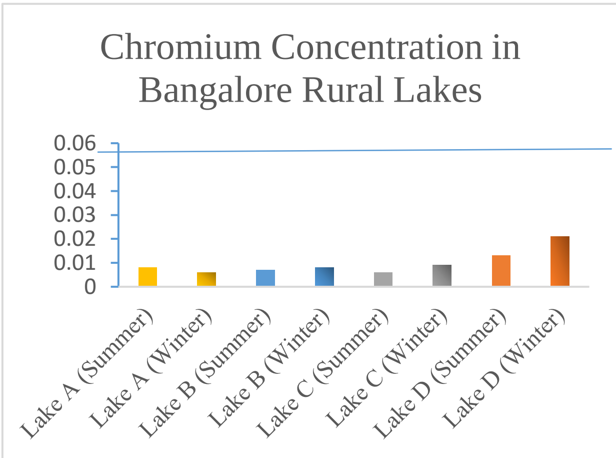
Table 3. Water quality classification using MI

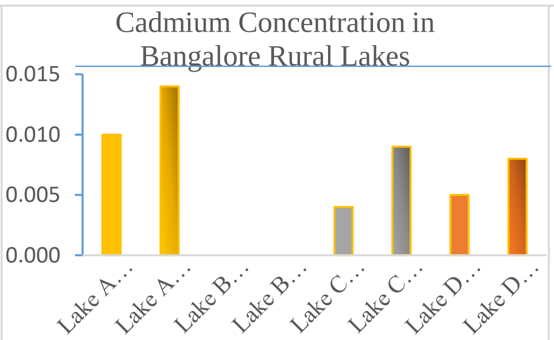
MI	Characteristic	class
<0.3	pure	I
0.3–1.0	slightly affected	II
1.0–2.0	moderately affected	III
2.0–4.0	strongly affected	IV
4.0–6.0	seriously affected	V
>6.0	seriously affected	VI

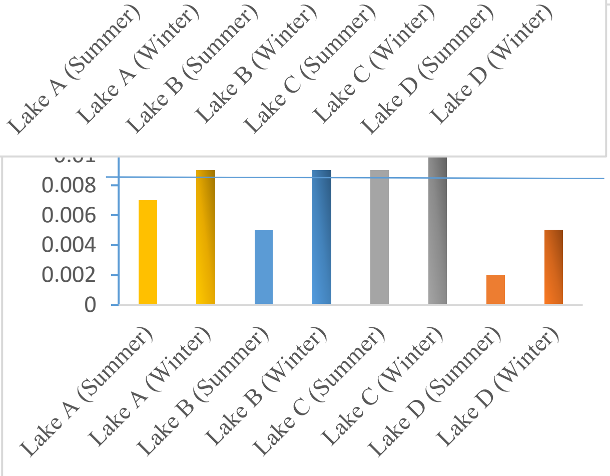
The result of MI from Table2 shows that, water quality and its suitability for drinking purpose Metal index for Lake-B slightly affected and Lake-A, Lake-C, and Lake-D found 3.18, 3.78 and 3.79 respectively, which shows that these lakes are strongly affected with respect to heavy metal pollution

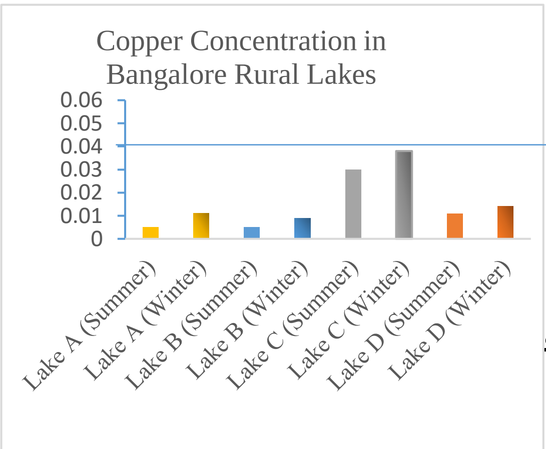
<u>Graphical representation of heavy metal concentration in Bangalore rural lake</u>





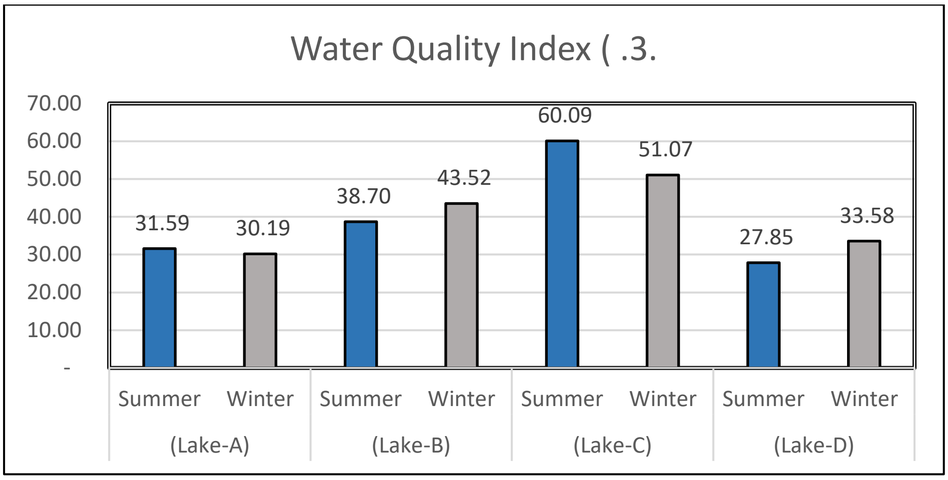






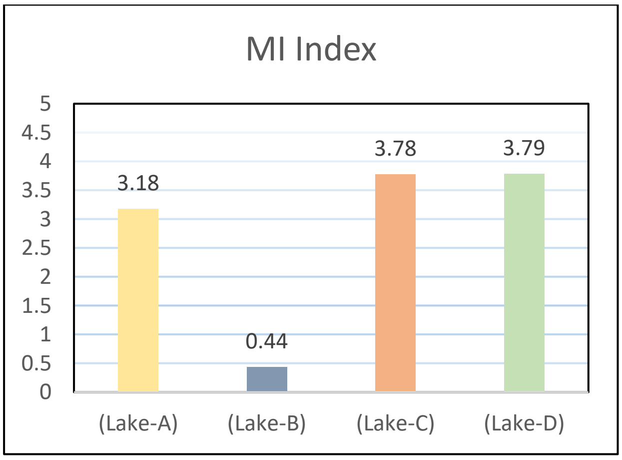
Note: Mercury concentration is not detectable, hence graphical representation is not shown.

<u>ality Index in Bangalore rural lake</u>



100-95	Excellent
94-80	Good
79-65	Fair
64-45	Marginal
44-0	Poor

Graphical representation of MI Index in Bangalore rural lake



MI	Characteristic	Class
<0.3	Pure	I
0.3–1.0	Slightly Affected	II
1.0–2.0	Moderately Affected	III
2.0–4.0	Strongly Affected	IV
4.0–6.0	Seriously Affected	V
>6.0	Seriously Affected	VI

RESULTS AND DISCUSSION

Water samples from Bangalore Rural lakes were analyzed in two seasons (Summer & Winter), for both physico-chemical and heavy metal contamination as given in Table 1 and the results are compared against BIS Standard. The physico-chemical properties of water sample categorized into three sections such as, general parameters, conservative and non-conservative parameters.

General Parameters

Colour: Colour of water samples were observed visually and colour of water almost clear in the Lake B and Lake C and the water samples of Lake A and Lake D are slightly brown colored in both seasons.

Odour: Water samples of all the lakes had an unpleasant odour in the both seasons. Water is unsuitable for domestic use.

Turbidity: Turbidity observed more in the all the samples for both seasons and values were exceeded the BIS limit (1 NTU). Turbidity may be due to the presence of clay, silt, organic matter, algae and or micro-organisms. Turbidity directly affects the productivity of surface water because scattering and absorption of light depends upon the turbidity content in lake water.

Temperature: Temperature of all samples taken was lowest at 23°C to highest 31°C before 9 AM. The temperature plays crucial role in physico-chemical and biological behaviour of aquatic system (Dwivedi and Pandey,2002) In higher temperature water cannot hold enough oxygen for aquatic organisms to survive.

pH: pH is the most important factor that serves as an index for pollution (Thakur et al., 2011) and the pH value of water is an important indication of its quality and it is dependent on the carbon dioxide, carbonate–bicarbonate (Abida. B 2009). In present study pH values are lower in summer (5.8) and higher in winter (6.8).Lower pH of water attributed to discharge of acidic water by industrial, domestic and agricultural activities.

Conductivity: It is the capacity of water to conduct current and it indicates the pureness of the water. Agricultural runoff or a sewage leak may be the primary cause of the rise in the conductivity due to the additional chloride, phosphate and nitrate ions. Survival, growth and reproduction of any aquatic organisms is controlled by the dissolved ion concentration in lake water (Mihir Pal *et al.*, 2015). Electrical conductivity of water samples for all the lakes was found more than BIS limit(NMT 300mho/cm) in both season between values 478-1350 due to water predominated with sodium and chloride ions.

Conservative Parameters

Total Dissolved solids

The amount of dissolved or soluble materials in water is termed as total dissolved solids (TDS) and is generally measured in milligram per liter (mg/L). Different ions like sodium, potassium, chloride, carbonate, sulphate, calcium, magnesium, etc. contribute to the TDS of water. The total dissolved solids in the water samples ranged 840-915 mg/L in Lake A, 500-587 mg/L in Lake B, 428-435 mg/L in Lake Cand 745-760 mg/L in Lake D. Except for KIADB area Devanahalli Lake, other lakes are exceeding the BIS limit (500 mg/L). High concentration of TDS enriches the nutrient status of water body which were resulted into eutrophication of the aquatic ecosystem (Singh and Mathur, 2005; Swarnalatha and Rao 1998).

Total hardness

Total hardness is due to the presence of ions, especially Ca^{+2}, Mg^{+2}, Cl^{-}, SO_4^{-2}, CO_3^{-2}, HCO_3^{-2} and these ions impact hardness of water and causes distress in cattle and livestock and also produces scaling in boilers and corrosion of machinery. Total hardness of water samples is lower in summer and higher in winter season.

The total hardness in the water samples ranged 445-495mg/L in Lake A, 430-444 mg/L for Lake B, 410-435 mg/L for Lake C and 348-360 mg/L for Lake D. In all the Lakes sample the total hardness of water is exceeding the BIS limit (200 mg/L)

Chlorides and Sulphates

Chlorides and sulphates occur abundantly in water due domestic sewage and industrial waste

(PK Goel, 2008). The Chlorides in the water samples were in the range 126-156 mg/L in Lake A, 150-163 mg/L for Lake B, 125-129 mg/L for Lake C and 79-95 mg/L for Lake D.

The sulphates in the water samples ranged 55-65 mg/L in Lake A, 69-79 mg/L for Lake B, 85-94 mg/L for Lake C and 48-68 mg/L for Lake D. Chlorides and Sulphates in the water samples collected in both the seasons are within EPA limits (250 mg/L) for chloride & (200 mg/L) for sulphates.

Nitrate

The origin of nitrate in water can be from both natural and man-made sources such as plant debris, nitrogenous fertilizers, discharge of sewage and industrial wastes. It was found that in both the seasons nitrate values in water samples are more than EPA limits.

The nitrate in the water samples ranged 59-68 mg/L in Lake A, 52-62 mg/L for Lake B, 25-35 mg/L for Lake C and 25-20 mg/L for Lake D. The nitrate content in the water samples of Lake A and Lake B exceeds the limit recommended by the EPA and Lake C and Lake D the limits of 45 mg/L.

Non-Conservative parameters

Dissolved Oxygen

Dissolved oxygen is required for many physical and biological processes prevailing in water. It affects solubility and availability of many nutrients and therefore productivity of the ecosystem. The dissolved oxygen in the water samples ranged from 8-11 mg/L in Lake A, 7-12 mg/L for Lake B, 4-6 mg/L for Lake C and 7-10 mg/L for Lake D. The lower value of DO due to addition of organic content leading to oxygen depletion. The dissolved oxygen content of all the lakes samples exceeding EPA limit (4-6 mg/L).

Biological Oxygen Demand

Biochemical Oxygen Demand (BOD) depen ds on temperature, extent of biochemical ac tivities, concentration of organic matter and su ch other related factors(Muduli Bipra,2010)
It is the amount of oxygen needed by biological organisms to decompose the organic matter. The biological oxygen demand in the water samples was in the range 16-21 mg/L in Lake A, 6-9 mg/L for Lake B, 8-11mg/L for Lake C and 33-56 mg/L for Lake D. The BOD of all the lakes samples exceeds the BIS limit (2mg/L). Maximum value of BOD was observed in pre-monsoon period due to the maximum bi ological affinity at elevated temperature and l ow in winter (Ghavzan, e.t. 2006).

Chemical Oxygen Demand

It is the amount of oxygen required for the decomposition of organic matter and oxidation of inorganic chemicals such as ammonia and nitrate. The chemical oxygen demand in the water samples was in the range 58-66 mg/L in Lake A, 21-27 mg/L for Lake B, 23-30 mg/L for Lake C and 109-123 mg/L for Lake D. The COD value of the all the lakes sample exceeds the limit (10 mg/L).

Heavy metals

Metal pollution has harmful effect on biological systems, as it does not undergo bio-degradation. Toxic heavy metals such as Pb, Co, Cd, Hg, etc. can be differentiated from other pollutants, as these are not biodegradable, gets accumulated in living organisms, thus causing various diseases and disorders, even though it is in relatively lower concentrations (E.Pehlivan 2009) Details of heavy metal concentration are mentioned in table 2 and above graphical representations.

Lead

The results from the Table 2 and graphical representation shows that, the Pb content was within the range 0.003-0.005 mg/L for Lake A, 0.005-0.009 mg/L Lake B and 0.004-0.009 mg/L Lake C. On the other hand the lead content is in the range 0.012 to 0.014 mg/L in Lake D which has crossed the threshold limit of 0.01mg/L. The highest concentration was observed in winter and minimum was observed in summer and it may be due to paints, lead acid batteries ,E-waste ,smelting operation and an influx of storm water passing through the industrial areas predominantly responsible for Pb into lakes.

Absorption of Pb from the different sources depends on the amount of Pb present in portals per unit time, physical and chemical state. Since Pb has similar chemical property as calcium, it will distribute throughout bone, teeth, liver, lung, brain and spleen. The Bone being major accumulator, lead toxicity results in fatigue, irritability abdominal pain, tremor, headache, vomiting, weight loss, coma and renal failure.

Chromium

Chromium in water will be in trivalent or hexavalent state and it is potentially toxic in dissolved form (Venkatesha Raju *et al.*, 2010). The results from the Table 2 and graphical representation shows that, Chromium (Cr) content was within the range 0.006-0.008 mg/L for Lake A, 0.007-0.008 mg/L Lake B and 0.006-0.009 mg/L Lake C and 0.013 to 0.021 mg/L in Lake D and all the four lakes, which is lower than the threshold limit of 0.05mg/L. Chromium concentration is directly proportional to the hardness of water. Sources for chromium presence in water due to mining, industrial coolants, chromium salt manufacturing and leather tanning. A toxic level of chromium can affect lungs, kidneys, liver and skeletal system.

Cadmium

The results from Table 2 shows and graphical representation shows that, the cadmium content is below detection limit (BDL) in Lake B. The values are in the range 0.010 - 0.014 mg/L in Lake A, 0.004 to 0.009 mg/L in Lake C and 0.005-0.008 mg/L in Lake D which are higher than the threshold limit of 0.003 mg/L.

Arsenic

The results from the Table 2 and graphical representation shows, the arsenic content in the water samples are in the range 0.007-0.009mg/L in Lake A and 0.005-0.009mg/L Lake B and 0.002-0.005 mg/L in Lake D. In Lake C the range is 0.009-0.011mg/L which is crossing the threshold limit of 0.01 mg/L. Environmental pollution by arsenic occurs as a result of natural phenomena such as volcanic eruptions and soil erosion, and anthropogenic activities (ATSDR 2000). Several arsenic containing compounds is produced industrially, and have been used to manufacture products with agricultural applications such as insecticides, herbicides, fungicides, algaecides, sheep dips, wood preservatives and dyestuffs etc. (Paul B *et al.*, 2014).

A toxic level of arsenic can affect pulmonary, kidneys, liver and gastrointestinal and symptoms are cough dyspnoea, chest pain, proteinuria, acute renal failure, jaundice, diarrhoea and abdominal pain.

Mercury

The results from the Table 2, it was observed that, mercury content is less than the threshold limit of 0.001mg/L. Mercury is less than the toxic limit and has no known function in human biochemistry and physiology. Inorganic forms of mercury cause spontaneous abortion, congenital malformation and GI disorders (Rashmi Verma *et al.*, 2013)

Copper

The amount of copper in the water samples in Lake A (0.005-0.011)mg/L, Lake B (0.005-0.009)mg/L and KIADB industrial Area Lake, (0.011-0.014)mg/L Hosakote are within the threshold limit of 0.05 mg/L. However, in the Lake connected to KIADB industrial area of Devanahalli, the observed values are reaching alarming value of 0.030 to 0.038 mg/L.

Although some of the elements like Cu, Fe, Zn, Co, Mn, Ni and Cr are needed in small quantities for the human metabolism but higher concentration of these metals causes the toxic signs (Blaylock *et al.*, 2000). Sources of copper in water due to mining, electroplating and smelting operations other metals like cadmium, mercury, arsenic and lead have no beneficial role and positively they are toxic. The aquatic ecosystem has been reported to be the ultimate recipient of heavy metals pollution.

SOURCES OF WATER POLLUTION IN BANGALORE RURAL LAKES.

	
Industrial treated water into Bhashettyhalli lake, KIADB Area, Doddaballapura(Lake-A)	Bhashettyhalli lake, KIADB Area, Doddaballapura (Lake-A)

	
Waste chemicals are burnt near Bharathipura lake, KIADB Area, Nelamangala(Lake-B)	Bharathipura lake, Nelamangala (Lake-B)
	
Industrial treated water into Devanahalli Lake, KIADB Area, Devanahalli (Lake-C)	KIADB Area, Devanahalli lake(Lake-C)
	
Industrial treated water into lake near KIADB area, Pillagumpe village, Hosakote(Lake-D)	KIADB area, Pillagumpe village, Hosakote (Lake-D)

CONCLUSIONS

A comprehensive analysis of published data indicates that heavy metals such as arsenic, cadmium, chromium, lead and mercury, occur naturally. However, anthropogenic activities contribute significantly to environmental contamination (Paul B, *et al.*, 2014).

Based on the results of this study, it was concluded that overall unplanned urban settlements and small scale industrial effluents in the lakes of Bangalore rural district, i.e. Nelamangala, Doddaballapura, Devanahalli and Hosakote area lead to more contamination of water with heavy metals and altering the physico-chemical properties. Industrialisation and exponential growth of human population has given rise to increase of metal content in the environment.

In a nutshell, with technology that currently exists, the years of global environmental mistreatment can begin to be reversed. The government has to take care by making preventive measures initiating the plan of diversion of nutrients from lakes, removal of nutrients from waster waters, zoning and watershed management awareness program on pollution control to small scale industries. Phytoremediation techniques may also be more publicity acceptable, aesthetically pleasing and less disruptive than the current technique of physical and chemical process (Bieby Voijant Tangahu *et al.,* 2011) or curative measures by dredging and covering of sediments, removal of lock-up nutrients, oxygenating and mixing of water before the release of water from industries and proper land management in the catchment area to control of eutrophication. It is imperative to conclude that, immediate policy goals needs to be implemented to save lakes.

ACKNOWLEDGEMENTS: The authors greatly acknowledge Vision group on Science and Technology (VGST), Government of Karnataka and UGC for providing K-FIST grants to the PG Department of Chemistry and UGC-CPE / MRP grants to Government Science College (autonomous), Bengaluru respectively.

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