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Trophic status of Kolar reservoir based on trace and Heavy metals

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Abstract
Kolar reservoir is used for drinking purpose since 1989 in Bhopal and is the second largest drinking water resource in Bhopal. The present study was conducted to detect the contamination of Kolar reservoir due to trace elements. The various trace elements viz., As, Cu, Fe, Ni, Pb and Zn were analyzed to evaluate the contamination of reservoir by using flame atomization technique of atomic absorption spectrophotometer (AAS-4141). During present investigation the values for various trace elements ranged from 0.001-0.004 for As; 0.022-0.099 for Cu; 0.81-1.87 for Fe; 0.009-0.036 for Ni; 0.001-0.041 for Pb and 0.01-0.05 ppm for Zn. As per WHO (2011) all the elements fall within the safe limits. Though the composition of elements falls within the safe limits yet their presence no longer makes the water body safe. Looking to accumulation rate of the elements the water body has been assigned the mesotropic status.

Keywords: Kolar reservoir, drinking water resource, Bhopal

Introduction
Aquatic systems receive vast input of water from surface run off. This run off contains many harmful elements and heavy metals which contaminate these aquatic systems. Contamination of heavy metals in the aquatic environment has gained a global attention towards its abundance, persistence and environmental toxicity (Ahmed *et al.*, 2015) [1]. The contamination on account of these heavy metals results from both natural and anthropogenic in the environment (Wilson and Pyatt, 2007; Khan *et al*., 2008) [21, 13]. The metal pollution of aquatic ecosystems is increasing due to the effects from urbanization and industrialization (Sekabira *et al*., 2010; Zhang *et al*., 2011) [15, 22]. The investigation of heavy metals in water and sediments could be used to assess the anthropogenic and industrial impacts and risks posed by waste discharges on the aquatic ecosystems (Zheng *et al*., 2008) [13]. Some of the metals get easily dissolved in water and are subsequently absorbed by aquatic organisms such as fish and invertebrates. Some of the metals are essential at low concentrations for living organisms while their higher concentration induces toxic effects. The increasing pollution by heavy metals have a significant adverse health effects for invertebrates, fish, and humans (Ahmed *et al*., 2015) [1]. Therefore, it is important to measure the concentrations of heavy metals in water and sediments of any contaminated aquatic ecosystem.

Study area
Kolar dam is one of the Tourist spots around Bhopal city. It is located nearly 35 kms to the south-west of Bhopal city and is built on Kolar River a tributary of Narmada River. This dam is constructed near Lawakhedi village in Sehore district. This dam mainly provides the drinking water to Bhopal city and for irrigation purpose in surrounding areas. The Height of Kolar dam is 45 meters and its water storage capacity is 265 MCM (millions cubic meters).

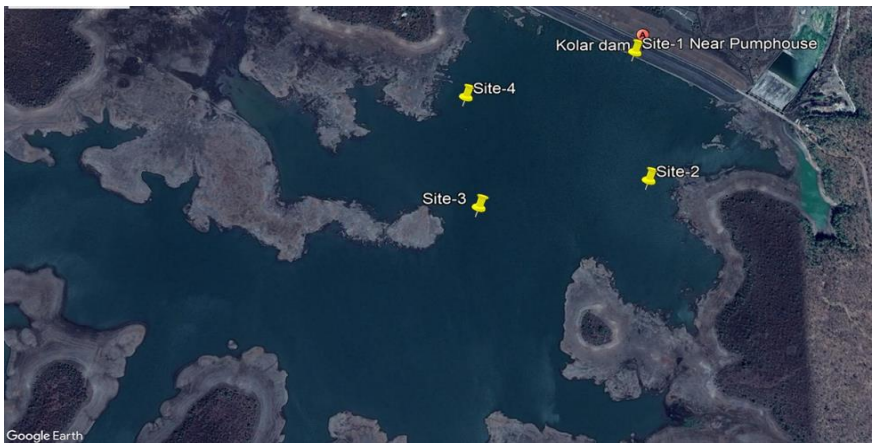

Fig 1: Sampling sites selected in Kolar dam

Methodology

Water samples were analyzed for 17 parameters such as water temperature, pH, conductivity, TDS, total alkalinity, total hardness, chloride, dissolved oxygen, sodium, potassium, calcium, arsenic, copper, iron, nickel, lead and zinc. Sampling and physico-chemical investigation was carried out according to standard methods (Adoni 1985 and APHA 2005) [2]. The water quality parameters such as water temperature, pH, total dissolved solids, electric conductivity, and dissolved oxygen were measured on the field. However the parameters like chloride, sodium, potassium, calcium, total alkalinity and total hardness were measured in the laboratory. The samples for heavy metals were preserved by adding 5ml of 1N HNO_3. The detection of heavy metals was done at the laboratory by AAS.

Results and Discussion

Water Temperature (˚C) - The water temperature ranged from 18.4˚C to 26.8˚C minimum temperature was recorded at site 1 during the winter season (Table 1 & Fig. 2) and the maximum temperature at site 2 during the monsoon season (Table 2 & Fig. 4).

pH (Units) – In the present study the pH ranged from 7.2 to 8.7 Units. Minimum pH was recorded at site 4 during the summer season (Table 4 & Fig. 8) and the maximum pH was observed at site 1 during the monsoon season (Table 1 & Fig. 2).

Conductivity (µS/cm) – In the present study conductivity ranged from 100 µS/cm to 210 µS/cm. Minimum conductivity was recorded at sites 1,2 & 4 during the monsoon (Table 1,2,4 & Fig. 2,4,8) and at site 3 during post monsoon season (Table 3 & Fig. 6). The maximum conductivity was recorded at site1, 2 & 4 during the winter season (Table 1, 2, 4 & Fig. 2, 4, 8) and at site 3 during summer season (Table 3 & Fig. 6).

TDS (ppm) – The TDS ranged from 63 to 137 ppm**.** Minimum TDS was recorded at site 2, during the monsoon (Table 2 & Fig. 4) and the maximum TDS was recorded at site 3 in summer season (Table 3 & Fig. 6).

Total Alkalinity (mg/l) – The alkalinity ranged from 100 to 188 mg/l. Minimum alkalinity was found at site 1 & 4 during monsoon (Table 1, 4 & Fig. 2, 8) while maximum alkalinity was recorded at site 4 during the summer season (Table 4 & Fig. 8).

Total Hardness (mg/l) – The total hardness ranged from 41 to 84 mg/l. Minimum total hardness was recorded at site 3 during the winter season (Table 3 & Fig. 6) and the maximum total hardness was observed at site 1, during the summer season (Table 1 & Fig. 2).

Chloride (mg/l) – The chloride ranged from 6.99 to 28.98 mg/l. Minimum chloride was recorded at site 3 during the post monsoon (Table 3 & Fig. 5) and the maximum chloride was recorded at site 4, during the winter season (Table 4 & Fig. 8).

Dissolved Oxygen (mg/l.) — The DO ranged from 4.2 to 8.7 mg/l. Minimum DO was recorded at site 4 during the post monsoon (Table 4 & Fig. 8) and the maximum DO was recorded at site 3 during the summer season (Table 3 & Fig. 6).

Sodium (mg/l) – In the present study the sodium ranged from 4.28 to 7.42 mg/l**.** Minimum sodium was recorded at site 2 during the post monsoon (Table 2 & Fig. 4) and the maximum sodium was recorded at site 3, during the summer (Table 3 & Fig. 6).

Potassium (mg/l) – In the present study the potassium ranged from 0.17 to 2.23 mg/l. Minimum potassium was recorded at site 1 during the post monsoon season (Table 1 & Fig. 2) and the maximum potassium was recorded at site 1, during the winter season (Table 1 & Fig. 2).

Calcium (mg/l) – During the present study the calcium ranged from 26.11 to 28.76 mg/l. Minimum calcium was recorded at site 2 during the post monsoon season (Table 2 & Fig. 4) and the maximum calcium was recorded at site 2, during the summer season (Table 2 & Fig. 4).

Arsenic (mg/l) – During the present study Arsenic ranged from 0.001 to 0.004 mg/l**.** Minimum value of arsenic was recorded at site 1,2 & 3 during the summer season (Table 1, 2, 3 & Fig. 3, 5, 7) and the maximum value of arsenic was recorded at site 4 during the monsoon season (Table 4 & Fig. 9).

Copper (mg/l) – During the present study the copper ranged from 0.023 to 0.045 mg/l**.** Minimum value of copper was recorded at site 3 during the summer season (Table 3 & Fig. 7) and the maximum value of copper was recorded at site 3 during the monsoon season (Table 3 & Fig. 7).

Iron (mg/l) – During the present study the Iron ranged from 0.021 to 0.047 mg/l. Minimum value of iron was recorded at site 1 during the summer season (Table 1 & Fig. 3) and the maximum value of iron was recorded at site 4 during the monsoon season (Table 4 & Fig. 9).

Nickel (mg/l) – During the present study the nickel ranged from 0.001 to 0.008 mg/l. Minimum value of nickel was recorded at site 3 during the summer season (Table 3 & Fig. 7) and the maximum value of nickel was recorded at site 1 during the monsoon season (Table 1 & Fig. 3).

Lead (mg/l) - During the present study the lead ranged from 0.001 to 0.007 mg/l. Minimum value of lead were recorded at site 2 during the summer season (Table 2 & Fig. 5) and the maximum value of lead were observed at site 1 during the monsoon season (Table 1 & Fig. 3).

Zinc (mg/l) – During the present study zinc ranged from 0.011 to 0.047 mg/l. Minimum value of zinc was recorded at site 2 during the winter season (Table 2 & Fig. 5) and the maximum zinc was observed at site 4 during the monsoon season (Table 4 & Fig. 9).

Table 1: showing values of physic-chemical parameters and heavy metals at site-1 during 2016.

Parameters	Site 1				WHO standards (2011)	BIS standards (2016)
	Winter	Summer	Monsoon	Post Monsoon		
Water temp. °C	18.4	26.2	25.5	20.5	---	---
pH units	8.2	8.2	8.7	8.6	6.5-8.5	6.0-8.5
Conductivity µS/cm	210	200	100	200	750	---
TDS ppm	133	132	69	131	500-1000	500-2000
DO mg/l	7.3	7.4	7.6	5.4	---	---
Total alkalinity mg/l	137	157	100	134	---	200-500
Total hardness mg/l	68	84	56	84	100-500	200-600
Chlorides mg/l	24.98	19.98	21.99	9.99	250	250-1000
Sodium mg/l	5.13	7.01	5.37	5.17	200	20
Potassium mg/l	2.23	2.19	1.26	0.17	100	---
Calcium mg/l	27.11	28.21	26.66	26.18	75	75-200
Arsenic mg/l	0.002	0.001	0.002	0.002	0.01-0.05	0.01-0.05
Copper mg/l	0.031	0.026	0.033	0.041	1.0-2.0	0.05-1.5
Iron mg/l	0.026	0.021	0.046	0.037	0.3	0.1-0.3
Nickel mg/l	0.003	0.005	0.008	0.006	0.02-0.07	0.01-0.02
Lead mg/l	0.002	0.001	0.007	0.004	0.01-0.05	0.01
Zinc mg/l	0.023	0.026	0.044	0.031	3 – 5	5-15

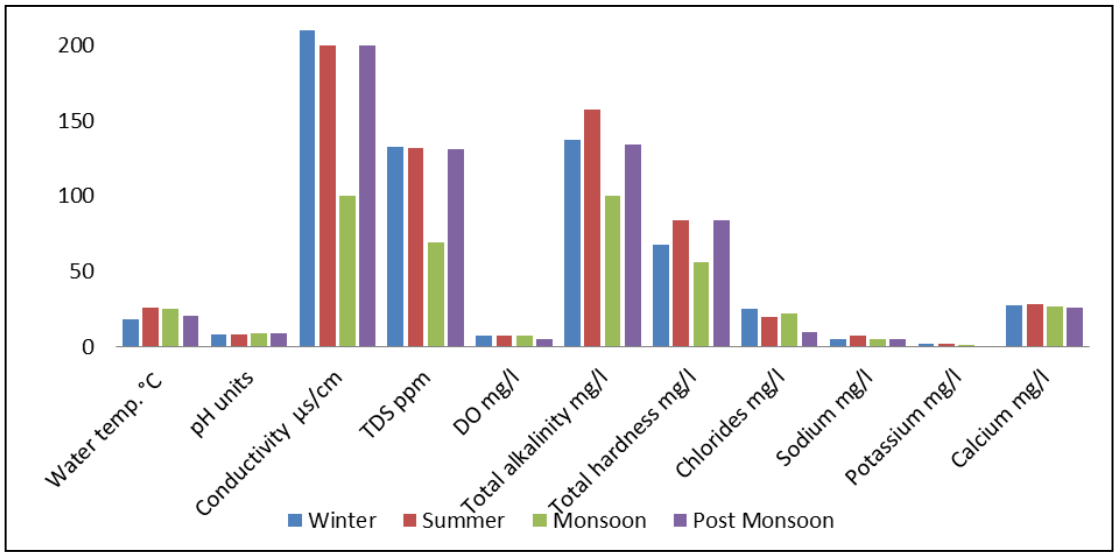

Fig 2: showing values of physic-chemical parameters at site-1 during 2016

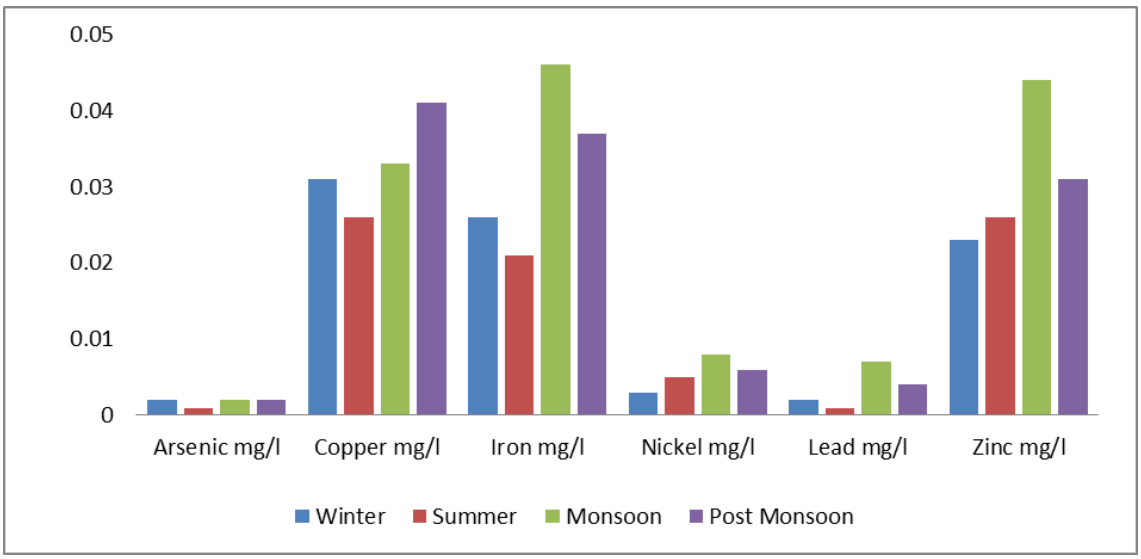

Fig 3: showing values of heavy metals at site-1 during 2016

Table 2: showing values of physic-chemical parameters and heavy metals at site-2 during 2016

Parameters	Site 2				WHO standards (2011)	BIS standards (2016)
	Winter	Summer	Monsoon	Post Monsoon		
Water temp. °C	18.6	25.4	26.8	20.8	---	---
pH units	7.5	7.4	8.3	8.4	6.5-8.5	6.0-8.5
Conductivity µS/cm	210	200	100	200	750	---
TDS ppm	129	131	63	129	500-1000	500-2000
DO mg/l	7.9	7.4	7.6	6.6	---	---
Total alkalinity mg/l	149	174	108	132	---	200-500
Total hardness mg/l	49	43	52	71	100-500	200-600
Chlorides mg/l	13.98	14.98	11.99	9.99	250	250-1000
Sodium mg/l	5.17	7.06	6.37	4.28	200	20
Potassium mg/l	1.19	2.05	1.28	0.28	100	---
Calcium mg/l	27.22	28.76	26.51	26.11	75	75-200
Arsenic mg/l	0.002	0.001	0.003	0.002	0.01-0.05	0.01-0.05
Copper mg/l	0.032	0.029	0.044	0.043	1.0-2.0	0.05-1.5
Iron mg/l	0.028	0.027	0.047	0.032	0.3	0.1-0.3
Nickel mg/l	0.004	0.003	0.006	0.005	0.02-0.07	0.01-0.02
Lead mg/l	0.002	0.001	0.006	0.004	0.01-0.05	0.01
Zinc mg/l	0.011	0.026	0.044	0.031	3 – 5	5-15

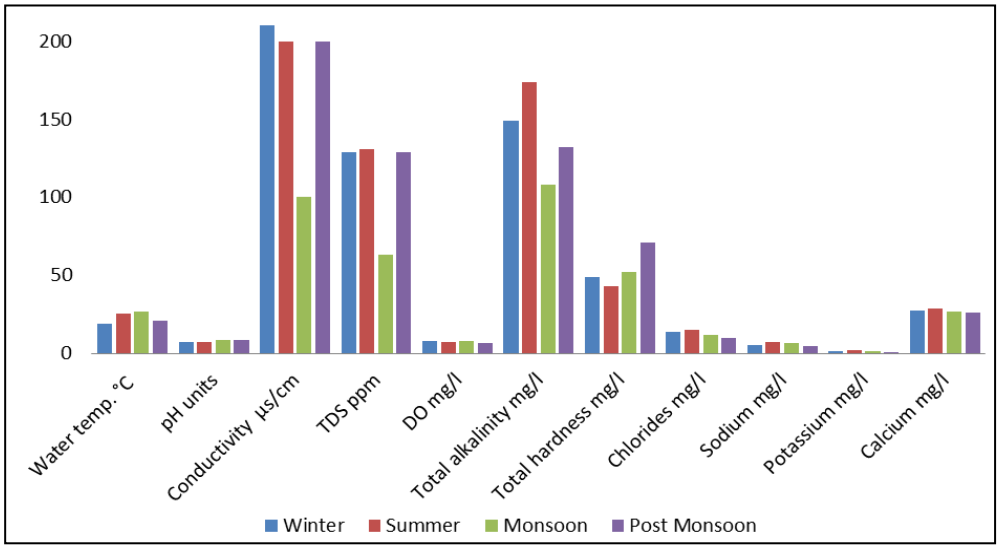

Fig 4: showing values of physic-chemical parameters at site-2 during 2016

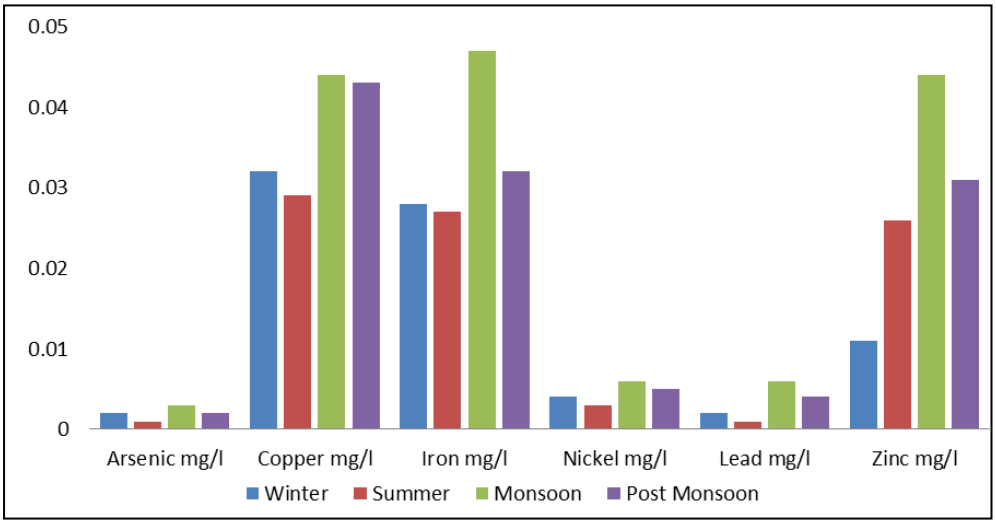

Fig 5: showing values of heavy metals at site-1 during 2016

Table 3: showing values of physic-chemical parameters and heavy metals at site-3 during 2016

Parameters	Site 3				WHO standards (2011)	BIS standards (2016)
	Winter	Summer	Monsoon	Post Monsoon		
Water temp. °C	19.3	25.3	26.5	19.7	---	---
pH units	7.6	7.4	7.4	8.3	6.5-8.5	6.0-8.5
Conductivity µs/cm	210	210	100	100	750	---
TDS ppm	136	137	64	68	500-1000	500-2000
DO mg/l	8.6	8.7	6.4	5.3	---	---
Total alkalinity mg/l	119	141	100	136	---	200-500
Total hardness mg/l	41	59	64	58	100-500	200-600
Chlorides mg/l	15.98	12.98	12.99	6.99	250	250-1000
Sodium mg/l	5.47	7.42	6.53	5.27	200	20
Potassium mg/l	1.42	2.06	1.68	1.29	100	---
Calcium mg/l	27.34	28.61	27.42	27.02	75	75-200
Arsenic mg/l	0.002	0.001	0.003	0.002	0.01-0.05	0.01-0.05
Copper mg/l	0.032	0.023	0.045	0.037	1.0-2.0	0.05-1.5
Iron mg/l	0.029	0.036	0.043	0.032	0.3	0.1-0.3
Nickel mg/l	0.005	0.001	0.006	0.004	0.02-0.07	0.01-0.02
Lead mg/l	0.003	0.002	0.004	0.002	0.01-0.05	0.01
Zinc mg/l	0.023	0.031	0.054	0.031	3 - 5	5-15

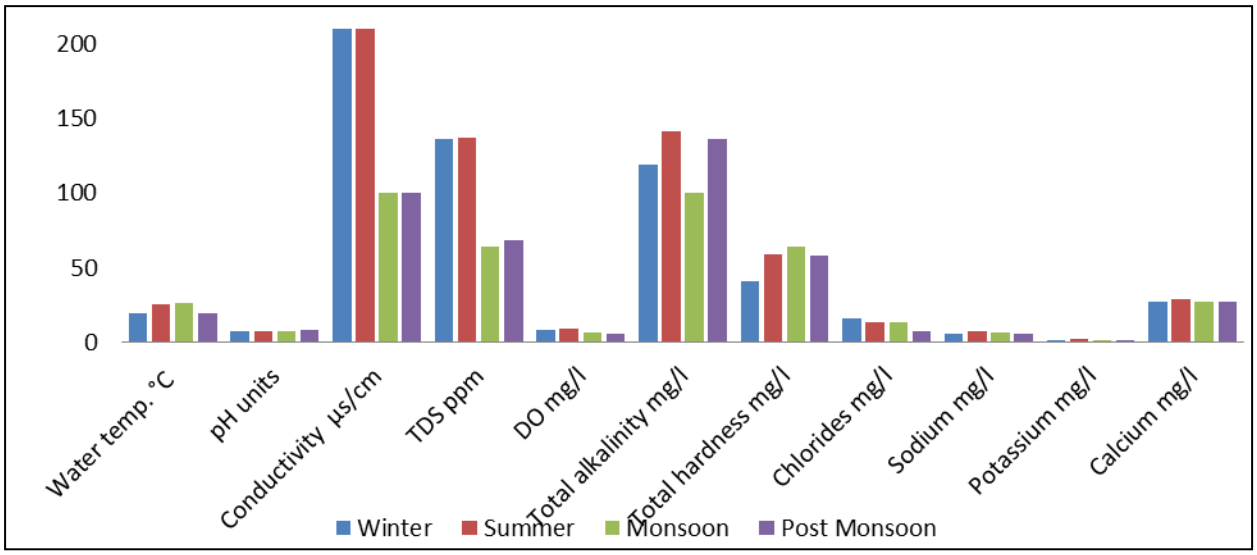

Fig 6: showing values of physic-chemical parameters at site-3 during 2016

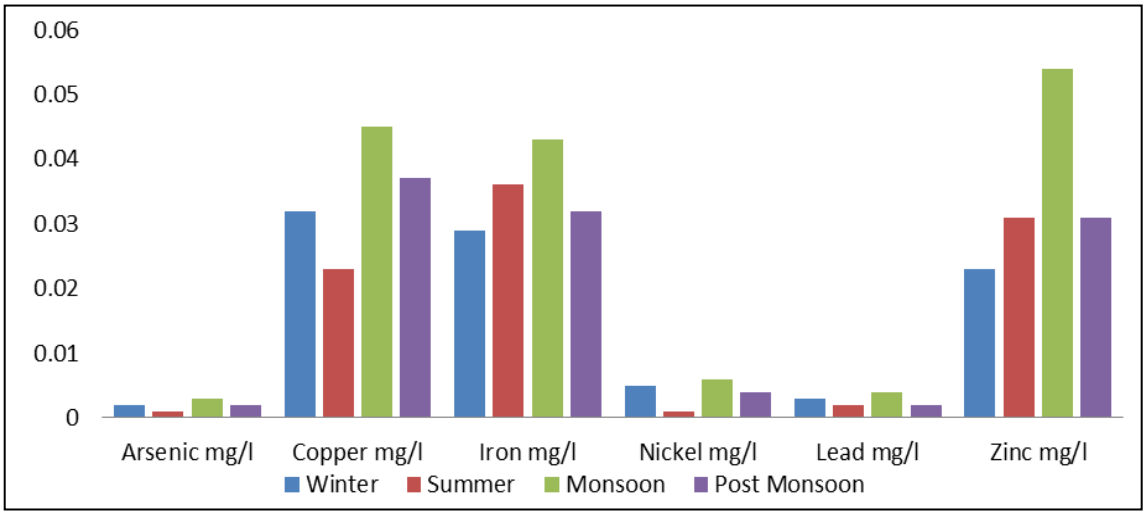

Fig 7: showing values of heavy metals at site-3 during 2016

Table 4: Showing values of physico chemical parameters and heavy metals at site-4 during 2016

Parameters	Site 4				WHO standards (2011)	BIS standards (2016)
	Winter	Summer	Monsoon	Post Monsoon		
Water temp. °C	20.4	24.4	26.4	20.9	---	---
pH units	7.3	7.2	7.3	8.2	6.5-8.5	6.0-8.5
Conductivity µs/cm	210	200	100	200	750	---
TDS ppm	137	133	68	132	500-1000	500-2000
DO mg/l	7.2	7.4	6	4.9	---	---
Total alkalinity mg/l	152	182	100	128	---	200-500
Total hardness mg/l	48	64	44	62	100-500	200-600
Chlorides mg/l	28.98	13.98	24.99	9.99	250	250-1000
Sodium mg/l	5.45	7.17	6.14	5.89	200	20
Potassium mg/l	1.26	2.14	1.45	1.02	100	---
Calcium mg/l	27.61	28.72	26.66	26.72	75	75-200
Arsenic mg/l	0.002	0.001	0.004	0.002	0.01-0.05	0.01-0.05
Copper mg/l	0.029	0.023	0.042	0.033	1.0-2.0	0.05-1.5
Iron mg/l	0.026	0.025	0.047	0.031	0.3	0.1-0.3
Nickel mg/l	0.004	0.003	0.007	0.004	0.02-0.07	0.01-0.02
Lead mg/l	0.002	0.002	0.005	0.004	0.01-0.05	0.01
Zinc mg/l	0.025	0.026	0.047	0.032	3 - 5	5-15

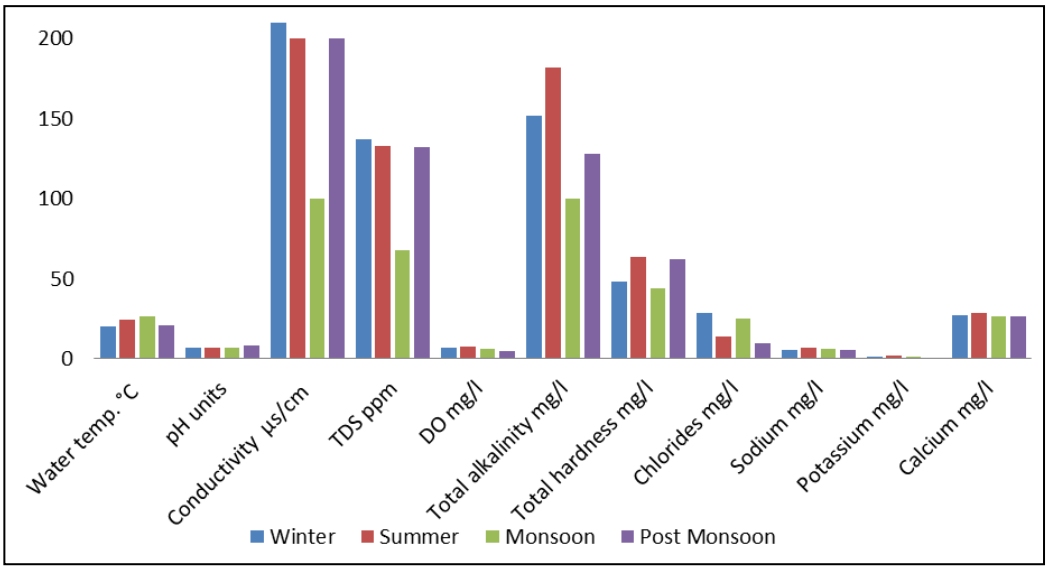

Fig 8: showing values of physic-chemical parameters at site-4 during 2016

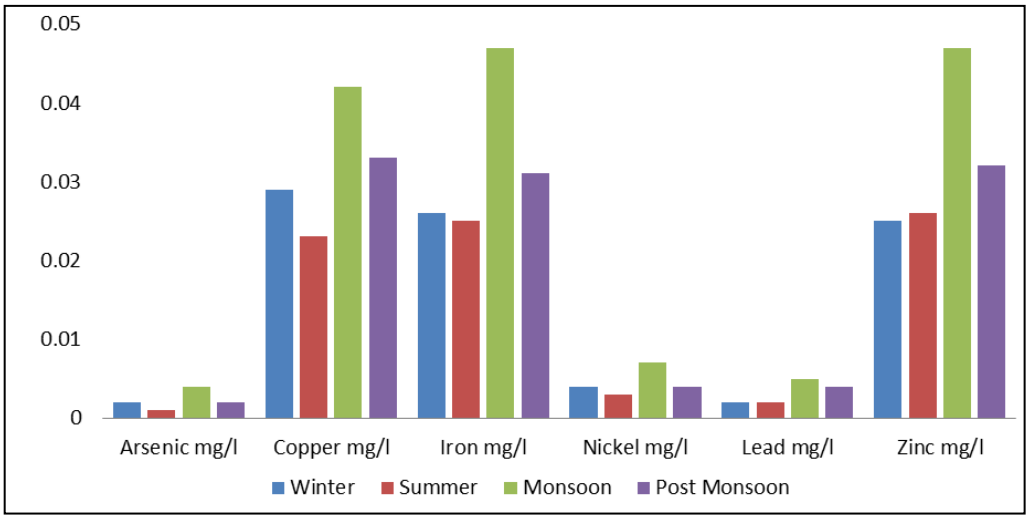

Fig 9: showing values of heavy metals at site-4 during 2016

Conclusion

The results indicate that the value of different parameters viz., water temperature, pH, conductivity, TDS, total alkalinity, total hardness, chloride, dissolved oxygen, sodium, potassium, calcium, arsenic, copper, iron, nickel, lead and zinc are found within the permissible limit as per WHO (2011) [20] standards & BIS (2016) [4] standards. The results indicate that the water of Kolar reservoir is relatively soft on account of moderate alkalinity. By observing the results in different seasons it can also be concluded that the parameters which were taken for the study of water quality are below the National standards of pollution level. The overall water quality of Kolar reservoir is much better as it is surrounded by thick forest.

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