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Analysis of Physico-Chemical Parameters and Heavy Metals from Surface Water and Sediments of Ujani Backwaters

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A B S T R A C T

The concentration of four eco-toxic heavy metals such as Hg, Pb, Cu, and Zn have been analysed from two sampling sites of Ujani backwaters for three seasons by atomic absorption spectrometer. The concentrations of these heavy metals have been found to be 0.0025±0.005, 0.029±0.056, 1.58±0.313, 4.39±1.17 & 0.00240±0.005, 0.047±0.067, 2.043±0.309, 6.09±1.281 respectively. These values are found to be slightly above the permissible limit of drinking water quality standards. The data has been used for the calculation of Heavy-metal Pollution Index (HPI) and Metal Index (MI). The mean HPI values of ground water in Site-I and Site-II are 244.45 and 229.93 respectively. The results indicated that mean HPI values were found to be above the critical pollution index value of 100. The mean MI values of ground water at Site-I & Site-II are 6.047 and 6.147 respectively. These results of MI indicate the strong heavy metal pollution at both sites. Same metals were analysed from sediments of same sites. Average values found are 0.033±0.009, 0.17±0.077, 19.45±4.64, 17.48±2.8 & 0.036±0.005, 0.225±0.06, 20.77±4.82, 21.01±5.33 respectively. Physicochemical parameters like temperature, pH, total hardness, & dissolved oxygen were also evaluated for two years. Average values of these parameters for site-I & site-II were 26.7°C, 8.00, 318.71mg/L, 4.63mg/L & 26.59°C, 7.9, 357.7mg/L, 4.12mg/L respectively.

Keywords

Ujani backwaters, Sediment, Heavy metals, Physico-chemical parameters

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Introduction

Water is characteristic feature of planet Earth and is component of both organic and inorganic substances. Its role as solvent, medium for reaction and transport, it is essential for all abiotic and biotic processes on Earth. Its ability of forming intermolecular hydrogen bonds, it has an array of unique physicochemical properties which form fundamental relevance for the matter and energy budgets of ecosystems (Gordalla *et al.*, 2007). About 70% of total freshwater is present in the form of glaciers and icecaps which is not available for human use. Remaining 30% of freshwater is present as either water running through riverine system, natural and artificial lakes, or ground water. Only about 0.3% of fresh water is running through rivers and lakes (Bhattacharya *et al.,* 2015).

Good-quality water is essential aspect of water and living system and it helps in environmental and spiritual rejuvenation whereas polluted water is a curse for ecosystem.

Dumping of untreated or partially treated wastes from municipal & industrial areas as well as pesticide-loaded return flow from agricultural areas, orchards, and plantations in many of our natural water bodies such as rivers, lakes and ponds is causing serious pollution of water.

Some surveys indicate that over 50% of urban India's sewage enters the water bodies untreated. Dumping of untreated industrial and other wastes in underground pits causes the contamination of the ground water of top 10–20 m subsurface zone (Jain, 2019).

The Bhima is a major River of Western Maharashtra and a tributary of Krishna River. It originates in the holy place of Bhimashankar in Ambegaon tehsil of Pune district. It flows in South-East direction for approximately 861 kilometres through the states like Maharashtra, Karnataka, and Telangana. It has many tributaries like Mula-Mutha, Kukadi, Meena, Chandani, etc. (MPCB, 2018-19). The environmental impacts at Ujani are indications of the increasing water pollution in Pune and the cities upstream of the dam.

Its tributaries like Mula-Mutha, Indrayani, Ghod, Pavana flow through the metropolitan cities like Pune, Pimpri-Chinchwad. There are many industrial areas nearby the course of the Bhima & its tributaries. (Shinde *et al.,* 2020; Kalekar *et al.,* 2022). Major source of water pollution in Bhima river is domestic and industrial sewage from Municipal areas of Pune, Pimpri-Chinchwad Cantonment settlements like Dehu, Pune and Khadki. Sewage disposal system of municipal and cantonment boards are not satisfactory (Dighavkar, 2016). Heavy metal pollution due to anthropogenic activities since the last few decades, has led to new pattern of metal distribution as compared to natural distribution.

Many heavy metals are used in large scale in automobiles, mining industries, pesticides, house-holds appliances, dental amalgams, paints, photographic papers, photo chemicals, etc. (Kumar *et al.,* 2012).

Assessment of physicochemical properties of water is one of the main methods of measurement of extent of water pollution. Such assessment gives idea about the quality of water for its utilization like drinking, irrigation, fisheries, and industrial purpose (Das and Acharya, 2003; Dighavkar, 2016; Pardeshi *et al.,* 2019). It is also helpful in understanding the complex interactions between the climatic and biological processes in the water. (Sevarkodiyone, 2018). Objective of the present study is to assess some of the important physicochemical aspects along with evaluation of levels of some heavy metals from the water and sediment collected from selected locations of Ujani backwaters to find the extent of suitability of Ujani (Bhima River) water for anthropogenic uses. Physicochemical properties like temperature, pH, hardness affect the metal concentration in water and thereby sediment and biotic component of water body (Gorakhe and Chandanshive, 2020).

Materials and Methods

Study Area

Study area selected for the present study is backwaters of Ujani dam constructed on River Bhima. Ujani dam is built on a comparatively flat land. Its submergence area stretches nearly 40 kilometers from the dam wall. The environmental impacts at Ujani backwater are an indication of the increasing water pollution in Pune and the cities upstream of the dam. (MPCB, 2018) Samples were collected from two sites as Site-I & Site-II.

Collection of water sample

Water and sediment samples were collected from the selected sites in three seasons as pre-monsoon (February – May), Monsoon (June – September) & Post-monsoon (October to January) seasons. For laboratory analysis, water samples were collected in pre-acid washed dry polyethylene bottles. Parameters like temperature, pH, and dissolved oxygen were measured at the collection sites.

Temperature

Temperature was measured with the help of mercury thermometer having accuracy of 0.1°C. (Gorakhe and Chandanshive, 2020) Readings were recorded at the collection sites in early morning.

pH

pH was recorded with the help of Blue pH02 Digital LCD pH Meter.

Dissolved Oxygen

Dissolved oxygen was measured by Winkler's method (Carpenter, 1965; APHA, 2005; Dhawde *et al.*, 2018).

Total Hardness

Total hardness was determined by EDTA titrimetric method (APHA, 2005).

Heavy metal

Concentrations of Heavy metals were determined by Atomic Absorption Spectrophotometer; LABINDIA AA8000 as per the protocols recommended by APHA (2005).

HMI Index and MI

Heavy metal pollution index and metal index was calculated by the method proposed by Venkata Mohan *et al.,* (1996).

Results and Discussion

Physical Parameters

Temperature

Average temperature of the water at site-I & site-II was found to be 26.95 °C&27.2°Crespectively. At site-I, minimum temperature was 25.1°C, in the month of October and maximum was 29.5°C in the month of March. Maximum temperature at site-II was recorded as 29.1°C in the month of May & July. Approximately similar readings are recorded by Gorkhe and Chandanshive (2020) for Mula-Mutha rivers, main tributaries of Bhima.

pH

pH is one of the important indicators of water quality. Ideal value of pH for the water fit for agricultural usage (A-IV category) is 6.5 to 9.0 & for public water supply system (A-II category) is 6.0 to 8.5 (MPCB, 2016). In the present study, the average pH of water at site-I and site-II was found to be 7.8. Minimum pH during the study period was recorded to be 7.4 & 7.2 for site-I & site-II respectively. Similarly, maximum pH was found to be 8.4 & 8.6 respectively. Annual reports of MPCB also reported pH values in similar range for the Ujani backwaters of Bhima river (MPCB, 2017-18; MPCB, 2018-19). Pattern of seasonal variation in pH value is found to be like Monsoon > Pre-monsoon = Post-monsoon Gorkhe and Chandanshive, 2020 also reported that pH values for pre- & post-monsoon seasons were almost same for the river Mula-Mutha in Pune.

Total Hardness

Total hardness is the sum of the concentrations of calcium and magnesium, both expressed as calcium carbonate, in mg/L. (APHA, 1999). In present study, average value of total hardness at site-I was found to be 319.08 mg/L and at site-II, it was 339.83 mg/L. Minimum values at both sites were 238 mg/L & 279 mg/L respectively whereas maximum values were

465 mg/L & 414 mg/L respectively. Highest total hardness was found to be during summer (pre-monsoon) season. Similar results were reported by Pardeshi *et al.,* (2019) for same river but at different location.

Dissolved Oxygen

Average value of dissolved oxygen at site-I was 4.96 mg/L and at site-II was 4.04 mg/L. Minimum and maximum values at site-I & II were 3.21 mg/L, 3.11 mg/L and 6.37 mg/L, 5.27 mg/L respectively. Maharashtra Pollution Control Board (2018-19) has also reported similar range of dissolved oxygen at Paragaon near Vasant Bandhara. Decreased levels of dissolved oxygen is an indication of polluted water (MPCB, 2019); Depleted level of dissolved oxygen may be due to the presence of high quantity of organic material (Das and Acharya, 2003).

Heavy Metals

Water

Samples of water & sediments from site-I & II were analysed for detection of presence of four heavy metals as mercury (Hg), lead (Pb), copper (Cu) & zinc (Zn).

Average concentration of Hg, Pb, Cu & Zn for water were 0.0025±0.005 & 0.0024±0.005, 0.029±0.056 & 0.047±0.067, 1.58±0.31 & 2.043±0.309, 4.39±1.17 & 6.09±1.28 respectively. These average concentrations for all metals except lead (Pb) are found to be slightly higher than the EPA recommended standards for drinking water. Concentration of lead (Pb) is considerably higher than the EPA & WHO standards (Fewtrell, 2001).

Comparatively higher concentrations of Pb, Cu & Zn are reported by Gorakhe (2020) for the water samples collected from different locations of Mula-Mutha rivers in Pune city. These rivers are main tributaries of Bhima River. As far as seasonal variation is considered, it is evident from the obtained results that concentration of heavy metals shows the pattern like Rainy (Monsoon) > Summer season (Pre-monsoon) > Winter (Post-monsoon). Higher concentrations of heavy metals in monsoon may be due to the river runoff after the heavy rainfall and thereby bringing much industrial sewage derived materials along with domestic, municipal, and agricultural wastes, which include residues of heavy metal containing pesticides (Jayasingam *et al.,* 2017; Senthilnathan and Balasubramanian, 1997; Ananthan *et al.,* 2006; Bragatheeswaran *et al.,* 2007).

Heavy metal pollution index (Venkata Mohan *et al.,* 1996) were found to be 224.40 & 207.14 for Hg, 19.99 & 22.71 for Pb, 0.00037 & 0.00055 for Zn and 0.06391 & 0.07644 for Cu. Thus, heavy metal pollution for Hg at both sites is higher than 100 indicating mercury pollution. Individual index for rest of the metals is far below to the 100. However, overall HPI for both sites is 244.45 & 229.93 respectively.

Sediments

In case of sediments, same heavy metals were analysed from the samples collected at both sites. Concentration of mercury, lead, copper & zinc was found to be 0.033±0.009, 0.17±0.077, 19.45±4.64, 17.48±2.8 and 0.036±0.005, 0.225±0.06, 20.77±4.82, 21.01±5.33 respectively at site-I & II. All values are quite less than the standards recommended for sediments by EPA, 2013.

As per the results obtained for the physicochemical parameters like temperature, pH, total hardness & dissolve oxygen in the present study, it can be concluded that the water at both the sites is polluted and not suitable for human consumption.

Similar report has been declared by MPCB, 2018-19. Low levels of dissolved oxygen may be due to heavy load of organic matter drained in from the industrial and domestic sewage. Heavy metals like Hg & Pb were found to be just above the standard levels recommended for drinking water & ground water by the agencies like EPA and FSSAI.

Table.1 Physicochemical Parameters of Site-I

Period	Month	Temperature (°C)	pH	Total Hardness mg/L	DO mg/L
Pre-monsoon	February	29.4	7.8	257	3.21
	March	29.5	7.4	348	3.52
	April	28.7	7.6	421	4.18
	May	28.2	7.9	465	5.21
Monsoon	June	27.7	8.1	310	5.28
	July	26.4	8.4	378	6.18
	August	26.2	8.1	257	6.12
	September	25.3	8.2	244	4.21
Post-monsoon	October	25.1	7.9	238	5.17
	November	25.3	7.8	321	6.37
	December	25.2	7.6	278	5.78
	January	26.4	7.8	312	4.26
	Minimum	25.1	7.4	238	3.21
	Maximum	29.5	8.4	465	6.37
	Average	26.95	7.88	319.08	4.96

Table.2 Physicochemical Parameters: Temperature:°C, Total Hardness: mg/L, DO: mg/L of Site-II

Period	Month	Temperature (°C)	pH	Total Hardness mg/L	DO mg/L
Pre-monsoon	February	24.8	8.1	284	4.31
	March	26.7	8.4	305	3.11
	April	28.7	7.2	358	4.42
	May	29.1	7.7	389	3.78
Monsoon	June	28.1	7.4	367	3.21
	July	29.1	8.2	405	3.65
	August	28.1	7.8	414	4.12
	September	26.8	7.4	327	3.47
Post-monsoon	October	25.8	7.5	321	4.58
	November	26.6	8.5	279	5.27
	December	26.2	8.6	341	4.21
	January	26.4	7.2	288	4.36
	Minimum	24.8	7.2	279	3.11
	Maximum	29.1	8.6	414	5.27
	Average	27.2	7.83	339.83	4.04

Table.3 Heavy Metal Concentration in Surface Water (mg/L) at Site-I. Values are Average±S.D. (n=3), BDL: Below Detectible Limit

Period	Month	Hg	Pb	Cu	Zn
Pre-monsoon	February	BDL	BDL	1.55±0.4	4.41±0.81
	March	BDL	BDL	1.39±0.077	4.08±1.80
	April	0.004±0.007	0.043±0.075	1.37±0.11	4.61±1.27
	May	0.0073±0.006	0.093±0.083	1.98±0.34	5.58±0.39
Monsoon	June	0.004±0.007	0.043±0.075	1.52±0.16	4.28±1.63
	July	0.004±0.007	0.037±0.064	1.41±0.18	3.99±0.35
	August	0.0033±0.006	BDL	1.51±0.15	4.17±0.85
	September	0.007±0.006	0.093±0.083	2.15±0.49	5.90±0.88
Post-monsoon	October	BDL	0.043±0.075	1.67±0.25	4.16±1.19
	November	BDL	BDL	1.51±0.07	4.08±1.87
	December	BDL	BDL	1.52±0.17	3.69±1.13
	January	BDL	BDL	1.4±0.043	3.76±0.43
	Minimum	BDL	BDL	1.3260	3.69
	Maximum	0.0113	0.130	2.1523	5.92
	Average	0.0025±0.005	0.029±0.056	1.58±0.313	4.39±1.17
EPA Standards (mg/L)		0.002	0.015	1.3	5

Table.4 Heavy Metal Concentration in Surface Water (mg/L) at Site-II. Values are Average±S.D. (n=3), BDL: Below Detectible Limit

Period	Month	Hg	Pb	Cu	Zn
Pre-monsoon	February	BDL	BDL	1.95±0.22	4.52±0.44
	March	BDL	BDL	2.26±0.10	5.39±0.54
	April	0.0037±0.006	0.047±0.081	2.1±0.48	5.53±1.01
	May	0.0080±0.007	0.147±0.025	2.7±0.28	6.84±1.52
Monsoon	June	0.0040±0.007	0.050±0.087	2.14±0.38	7.06±0.31
	July	BDL	BDL	1.93±0.26	5.79±1.07
	August	0.0037±0.006	0.040±0.069	1.99±0.36	6.85±1.10
	September	0.0080±0.007	0.167±0.015	2.42±0.50	7.46±0.07
Post-monsoon	October	BDL	0.037±0.064	2.16±0.15	5.20±0.59
	November	BDL	BDL	2.09±0.12	5.41±0.21
	December	BDL	0.047±0.081	1.79±0.36	5.50±1.95
	January	BDL	BDL	2.10±0.59	5.30±2.06
	Minimum	BDL	BDL	1.7270	4.52
	Maximum	0.0080	0.167	2.4417	8.47
	Average	0.00240±0.005	0.047±0.067	2.043±0.309	6.09±1.281
EPA Standards (mg/L)		0.002	0.015	1.3	5

Table.5 Heavy Metal Concentration in Sediment (mg/L) at Site-I. Values are Average±S.D. (n=3), BDL: Below Detectible Limit

Period	Month	Hg	Pb	Cu	Zn
Pre-monsoon	February	0.033±0.007	0.133±0.12	20.22±5.69	16.35±1.61
	March	0.035±0.010	0.210±0.03	20.56±4.51	17.09±1.08
	April	0.033±0.008	0.207±0.01	16.65±0.51	17.69±2.35
	May	0.027±0.004	0.213±0.04	23.67±5.30	20.25±2.63
Monsoon	June	0.045±0.005	0.190±0.02	20.87±4.94	18.39±1.32
	July	0.028±0.004	0.063±0.11	17.14±1.07	15.70±0.50
	August	0.042±0.008	0.157±0.07	19.28±6.15	17.33±3.15
	September	0.043±0.008	0.233±0.06	28.11±2.60	22.24±4.10
Post-monsoon	October	0.034±0.005	0.187±0.02	17.81±1.11	15.36±0.71
	November	0.026±0.003	0.203±0.05	16.14±0.73	17.17±3.26
	December	0.022±0.004	0.130±0.11	16.56±3.17	16.96±2.93
	January	0.025±0.004	0.123±0.11	16.40±1.67	15.19±1.70
	Minimum	0.022	0.06	16.14	15.19
	Maximum	0.045	0.23	28.11	22.24
	Average	0.033±0.009	0.17±0.077	19.45±4.64	17.48±2.8
EPA Standards (mg/L)		0.66	40	400	3200

Table.6 Heavy Metal Concentration in Sediment (mg/L) at Site-II. Values are Average±S.D. (n=3), BDL: Below Detectible Limit

Period	Month	Hg	Pb	Cu	Zn
Pre-monsoon	February	0.032±0.004	0.15±0.04	20.61±5.31	16.59±1.80
	March	0.038±0.003	0.19±0.03	19.89±5.14	17.77±1.08
	April	0.039±0.003	0.28±0.04	20.27±5.78	18.34±2.35
	May	0.041±0.004	0.31±0.04	21.81±5.39	28.32±1.95
Monsoon	June	0.038±0.004	0.24±0.02	22.52±6.79	18.78±0.51
	July	0.035±0.002	0.21±0.02	17.63±1.53	16.63±0.50
	August	0.040±0.005	0.26±0.02	24.96±2.84	22.46±5.04
	September	0.044±0.003	0.31±0.03	29.49±1.68	30.80±2.66
Post-monsoon	October	0.037±0.005	0.23±0.03	19.64±1.62	27.26±1.50
	November	0.032±0.003	0.20±0.02	16.82±0.73	21.17±3.55
	December	0.029±0.003	0.17±0.01	17.24±3.17	18.28±1.27
	January	0.030±0.002	0.15±0.02	18.31±0.54	15.74±1.70
	Minimum	0.029	0.147	16.82	15.74
	Maximum	0.044	0.313	29.49	30.8
	Average	0.036±0.005	0.225±0.06	20.77±4.82	21.01±5.33
EPA Standards (mg/L)		0.66	40	400	3200

Table.7 Heavy Metal Pollution Indices for water at Site (Values of Si, Ii, Mi are in PPB, value of K is unit constant = 1)

Site-I											
Site-I	Standard Permissible Limit (Si) (PPB)	Ideal Value (Ii) (PPB)	Monitored Value (Mi) PPB	Unit Weight Value (Wi)=K/Si	Mi - Ii	| Mi - Ii |	Si - Ii	Qi = | Mi - Ii |/(Si - Ii)*100	Wi*Qi	Σwi	Metal HPI = Wi*Qi/Σwi
Hg	1	0	2.47	1.000000	2.47	2.47	1	247.00	247	1.1007	224.40
Pb	10	0	22.00	0.100000	22.00	22	10	220.00	22	1.1007	19.99
Zn	15000	5000	4390.00	0.000067	-610.00	610	10000	6.10	0.0004	1.1007	0.00037
Cu	1500	50	1580.00	0.000667	1530.00	1530	1450	105.52	0.0703	1.1007	0.06391
				Σ 1.1007					Σ269.071		Σ244.45
Site-II											
Hg	1	0	2.28	1.000000	2.28	2.28	1	228	228	1.1007	207.14
Pb	10	0	25	0.100000	25	25	10	250	25	1.1007	22.71
Zn	15000	5000	5910	0.000067	910	910	10000	9.1	0.000607	1.1007	0.00055
Cu	1500	50	1880	0.000667	1830	1830	1450	126.21	0.084138	1.1007	0.07644
				Σ 1.1007					Σ253.09		Σ229.93
Values of standard permissible limit (Maximum Acceptable limit) (Si) & Ideal values (Minimum acceptable limit) (Ii) are as per BIS standards (IS 10500:2012) for drinking water.											
Permissible index value of HPI is 100; HPI > 100 indicates considerable Pollution.											

Table.8 Metal Index Site-I

Metal	Ci PPM	Ci PPB	MAC	MI=ΣCi/MAC
Hg	0.0025	2.5	1	2.5
Pb	0.0220	22.0	10	2.2
Zn	4.4000	4400.0	15000	0.29
Cu	1.5800	1580.0	1500	1.05
				Σ 6.047

Fig.1 Average temperature of water at site-I

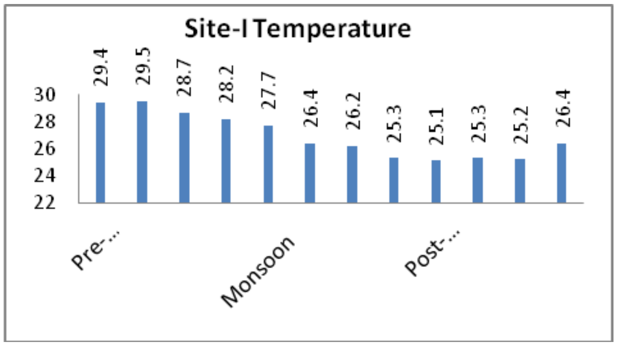

Fig.2 Average temperature of water at site-II

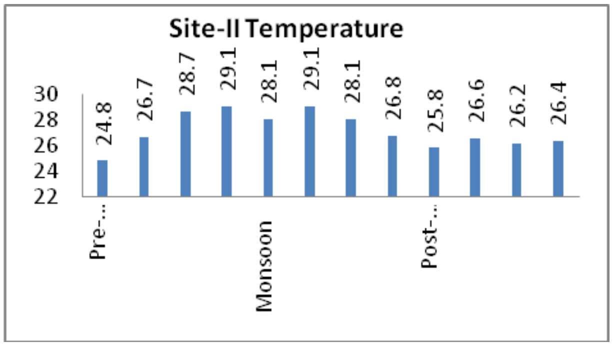

Fig.3 Average pH of water at site-I

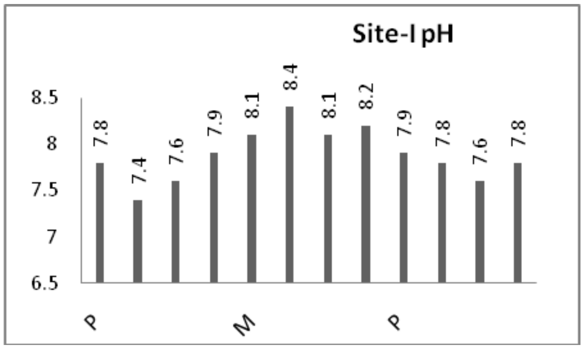

Fig.4 Average pH of water at site-II

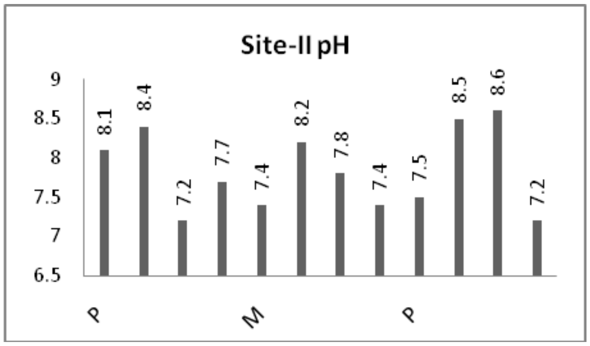

Fig.5 Average total hardness of water at site-I

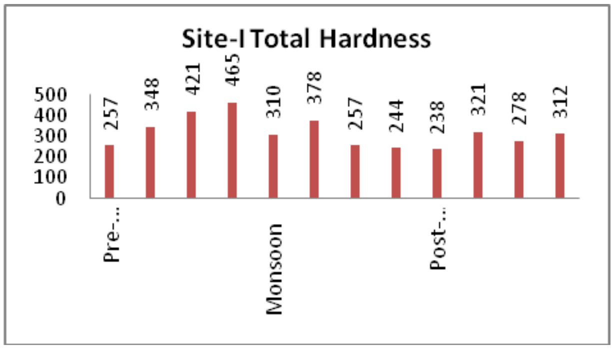

Fig.6 Average total hardness of water at site-II

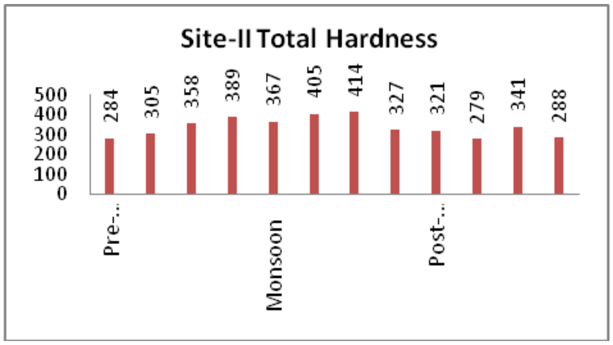

Fig.7 Average DO of water at site-I

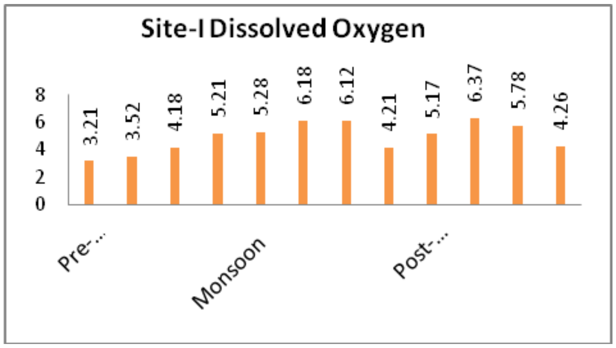

Fig.8 Average DO of water at site-II

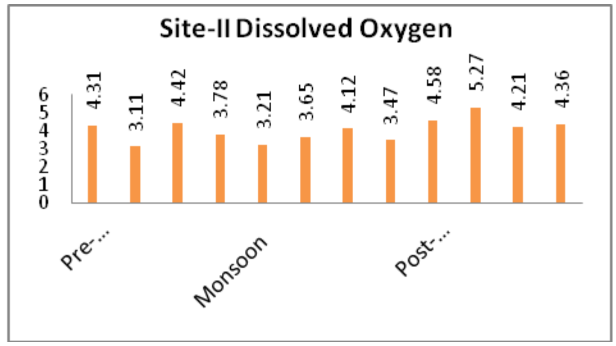

Fig.9 Average Hg in water at site-I

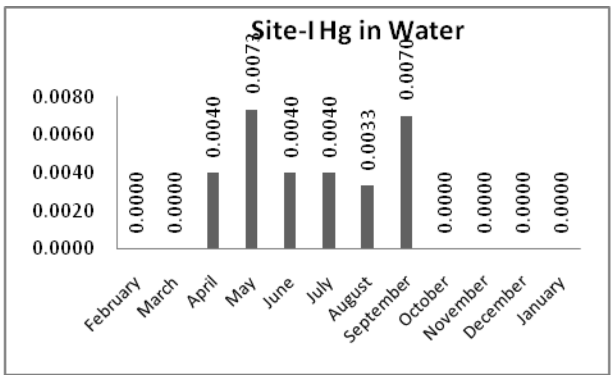

Fig.10 Average Hg in water at site-II

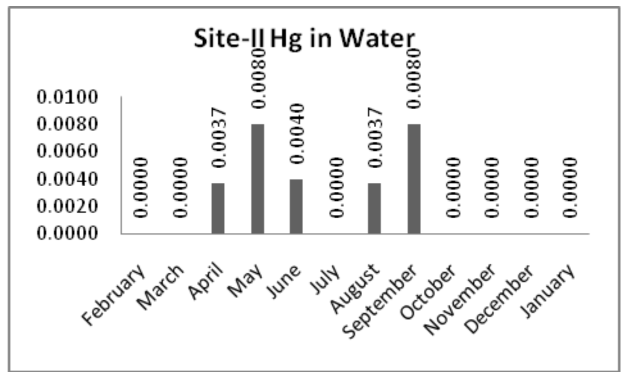

Fig.11 Average Pb in water at site-I

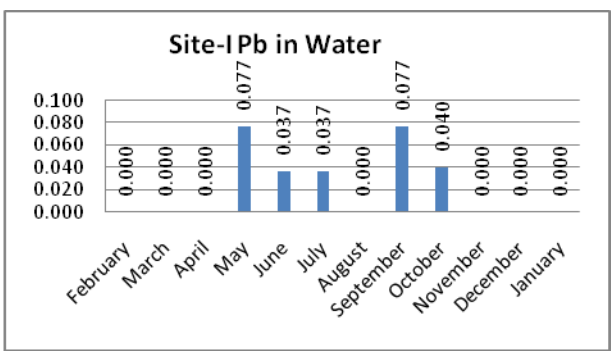

Fig.12 Average Pb in water at site-II

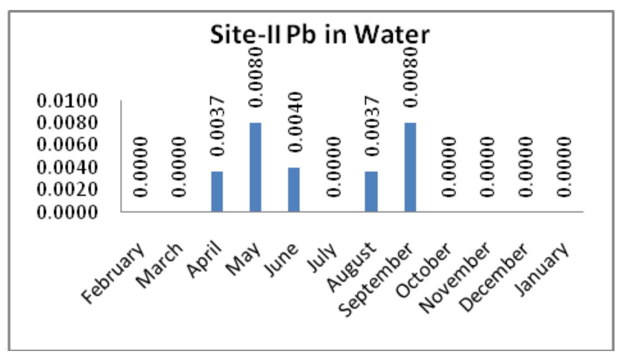

Fig.13 Average Cu in water at site-I

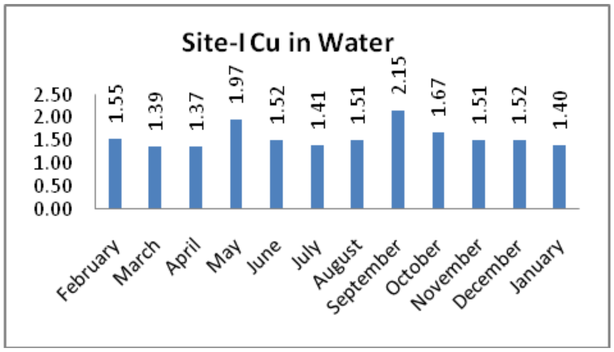

Fig.14 Average Cu in water at site-II

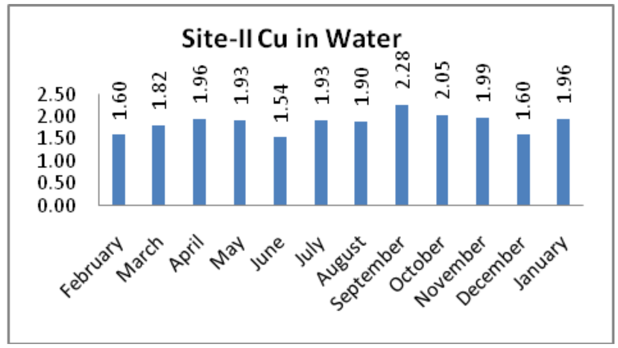

Fig.15 Average Zn in water at site-I

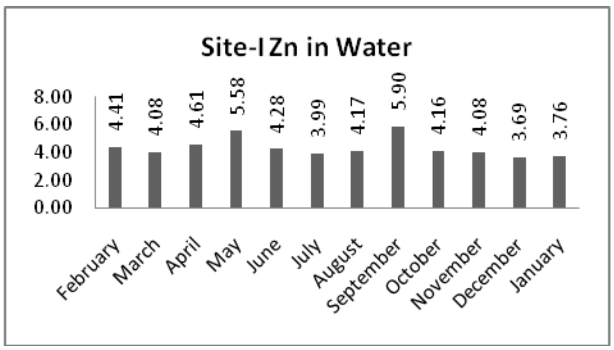

Fig.16 Average Zn in water at site-II

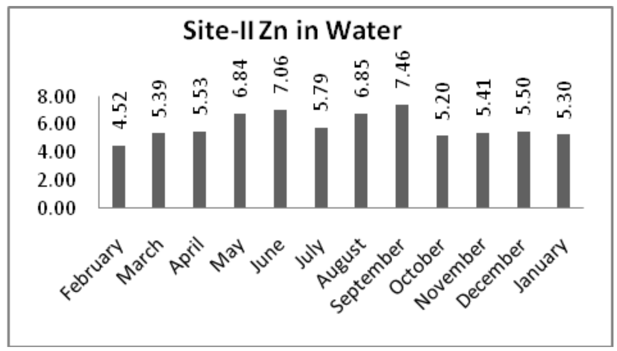

Fig.17 Average Hg in Sediment at site-I

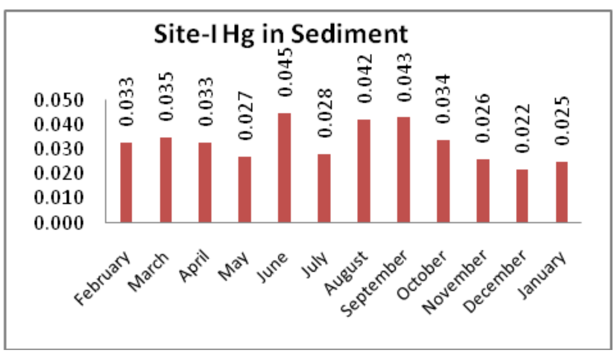

Fig.18 Average Hg in Sediment at site-II

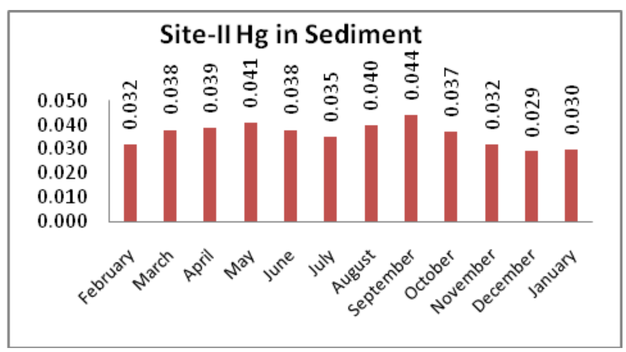

Fig.19 Average Pb in Sediment at site-I

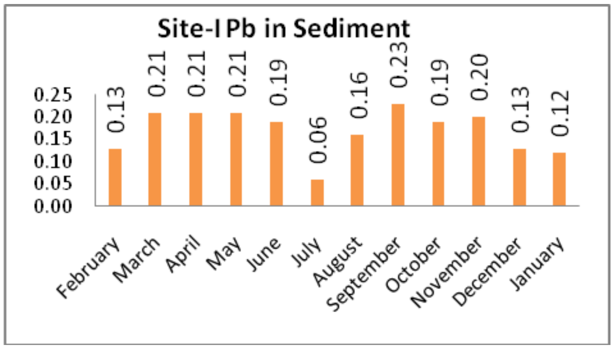

Fig.20 Average Pb in Sediment at site-II

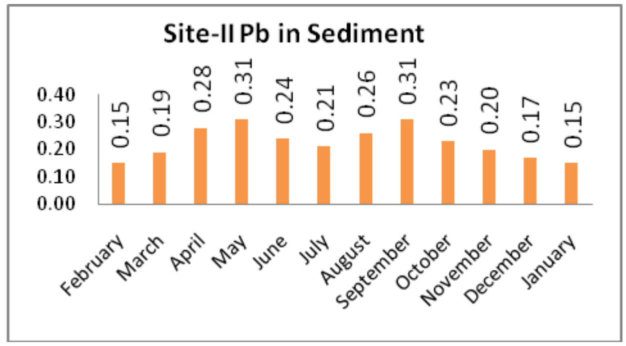

Fig.21 Average Cu in Sediment at site-I

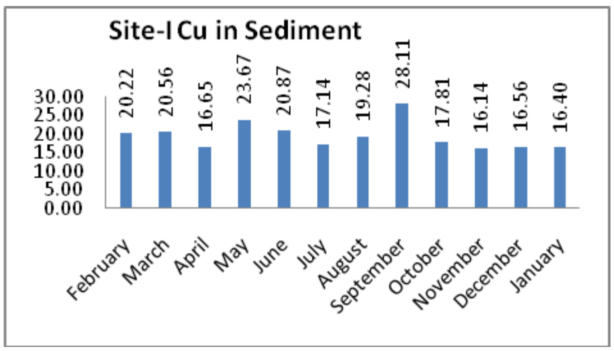

Fig.22 Average Cu in Sediment at site-II

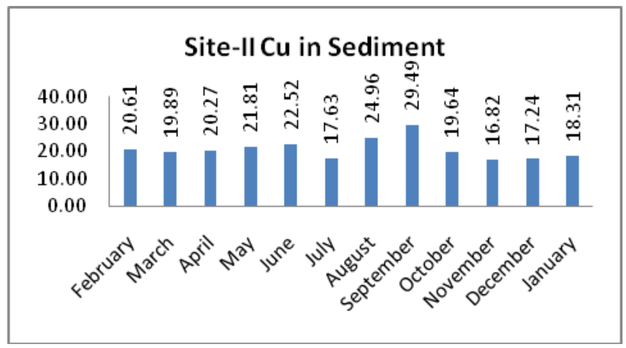

Fig.23 Average Zn in Sediment at site-I

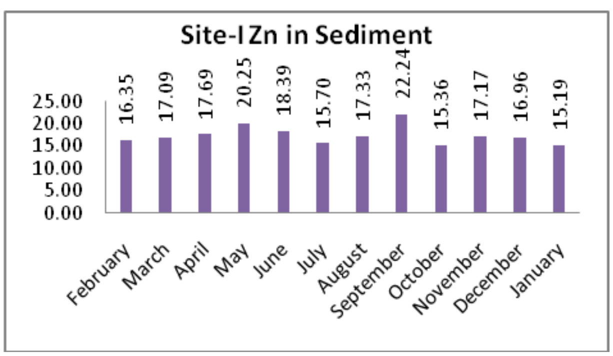

Fig.24 Average Zn in Sediment at site-II

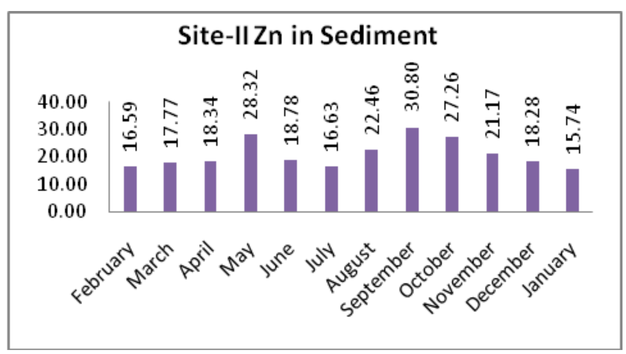

Table.9 Metal Index Site-II

Metal	Ci PPM	Ci PPB	MAC	MI= ΣCi/MAC
Hg	0.0023	2.3	1	2.3
Pb	0.0220	22.0	10	2.2
Zn	5.9100	5910.0	15000	0.394
Cu	1.8800	1880.0	1500	1.25
				Σ 6.147

Table.10

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

Metals like Cu & Zn are observed to be within permissible limits recommended by these agencies. Presence of heavy metals may be attributed to the pollution due to industrial sewage, idol immersion, paints, etc. As the sites selected for present studies are from Ujani backwaters, it is likely that there is no further flow of water and it remains stagnant for longer duration.

Thus, this area may act like a natural dumping place for pollutants being brought in with raining, agricultural run-off, industrial & domestic sewage. There is strong need of implementation of preventive measures at public & organizational level to stop the water pollution.

Local governing bodies & the residents living along the river bank, nearby the backwaters need to be made aware about the ways to minimise the pollution. Agriculturists need to be made aware about the judicious use of pesticides. Industries must be compelled to strictly adhere to the norms of pollution control board.

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Data availability

All data generated or analysed during this study is available with the corresponding author.

Declarations

Conflict of interest

The authors have no conflicts of interest to declare. Both authors have seen and agree with the contents of the manuscript and there is no financial interest to report. We certify that the submission is original work and is not under review at any other publication.

Ethical approval

There is no human participation or animal research involved in the study. Ethical approval is not applicable.

Informed consent

The manuscript in part or in full has not been submitted or published anywhere.

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