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Occurrence of Heavy Metal Toxicity in Water Bodies of Ahmedabad Especially around the Industries

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Abstract: ***Due to increased industrial expansion and urbanisation, anthropogenic activities in the Ahmedabad watershed have lowered water quality over the past few years. Land use patterns in the Ahmedabad watershed drastically changed. To examine the effects of change in land use, urbanisation, and industrialization on water quality for Environmental Impact Assessment (EIA), baseline data were collected during the post - monsoon season (October - November) of 2019 in the Ahmedabad watershed. The total concentrations of 18 heavy metals (Ca, Cu, Cd, Mg, Mo, Mn, Sb, Sr, Cr, As, Fe, Ni, Tl, Ti, V, Zn, Li) in surface water bodies were estimated in this study using historical sample data. For this investigation, samples were taken at four separate Sabarmati River sites, four different lakes, and eleven different industrial dumping sites where treated water was dumped into canals. Using ICP - OES (Inductive Coupled Plasma Mass Spectrometry), the number of heavy metals in water samples was examined. To evaluate the water's quality, the physicochemical characteristics of the samples were also assessed. This revealed that the level of heavy metals in the water was below the hazardous level as per the international recommendations. According to the findings, the effluent was cleaned by the industries before being released into the environment.***

Keywords: Heavy metals pollution, surface water contamination, industrial toxicity, physio - chemical parameters, ICPOES

1. Introduction

Pollutants entering the environment because of both natural and human activities are one of the most important issues that modern society must deal with. Humans have produced several poisonous compounds, many of which have serious negative effects on both the environment and humans. These compounds were produced because of the growth of industry and the economy, the manufacture of a broad variety of compounds and chemicals, and the consequent rise in their use. The major natural resources that cause environmental pollution are the weathering of rocks and soil as well as weather - related events like earthquakes and floods. In addition, another way that people harm the environment is through the discharge of municipal, industrial, and agricultural trash (Manisalidis et al., 2020) .

The quality of water is impacted by physical, chemical, and microbial factors. Based on the findings, it was decided that it was imperative to assess the water's appropriateness for drinking, which will provide crucial information for managing water resources. We shall assess the degree to which the parameters' connection with the chosen dependent and independent variables is significant (Ramakrishnaiah et al., 2009) . According to Kumar and co - workers, a wide range of biological and chemical contaminants, including heavy metals, are introduced into water supplies whenever municipal, industrial, or agricultural waste is discharged into them (Kumar et al., 2011) . Heavy metals are defined as metals with a relatively high density compared to water (Chaney, 1991) **.** Heavy metals including chromium (Cr), cadmium (Cd), mercury (Hg), lead (Pb), nickel (Ni), and thorium (Tl) may be harmful in their mixed or elemental forms. Due to how easily heavy metals dissolve in water, living organisms may easily absorb them. Heavy metals have been discovered in the gills, liver, and muscle tissues of many fish species in contaminated coastal locations (Sobhanardakani et al., 2011) **.** One of the severe issues that the many developing countries, including India, face is the discharge of treated or partially treated industrial effluent into pristine ecosystems. The composition of industrial wastewater varies greatly, but many hazardous heavy metals, including cadmium, nickel, lead, chromium, thallium, and mercury, are present. These metals are known to have significant negative impacts on both the environment and humans (Collivignarelli et al., 2019) (Oruko et al., 2020) .

Gujarat is one of India's most industrialised states, having a variety of manufacturing industries, including those for

chemicals, pharmaceuticals, textiles, cars, and energy. Ahmedabad is considered as having the greatest degree of industrialisation and population among the Gujarati districts. To conduct a surveillance study of the distribution of heavy metals, water samples were collected from industrial sites, lakes, and residential areas in Ahmedabad, as well as from the Sabarmati River, which has been receiving domestic and industrial wastewater discharges for decades. ICP - OES (Inductive coupled plasma optical emission spectrometry) was used to examine the number of heavy metals in the collected water samples to determine their toxicity.

2. Material and methods

2.1 Study area

Geographically, Ahmedabad is located at 23.03° N and 72.58° E, with an average elevation of 53m above sea level in an area of 310 km2. The Sabarmati River enters Ahmedabad close to Hansol area and then flows around 20 - 25 km from north to south through the city's central area. In total, 19 samples were taken from various locations in the city of Ahmedabad, including Sabarmati River, industrial sites, lakes, and residential areas (see table).

2.2 Collection and characterization of water

Water samples from the Sabarmati River, industrial sites, lakes, and residential areas of Ahmedabad, Gujarat, were gathered in October and November of 2019. The water was collected in clear, sterile polyvinyl chloride (PVC) bottles, and samples were filtered via 0.22 m pore size filters before being stored at 20 °C.

2.3 Determination of physiochemical parameter and heavy metals in collected water samples.

The pH and EC were measured on - site by using OCEAN STAR EC Meter and pH Meter. Other physicochemical parameters such as total dissolved solids (TDS), biochemical oxygen demand (BOD), chemical oxygen demand (COD), dissolved oxygen (DO), alkalinity, chloride, nitrate, and sulphate were determined by using the methods as described in APHA (2005). Heavy metals present in collected water samples were determined using inductively coupled plasma Optical emission spectrometry (ICP - OES) (Perkin - Elmer Optima 7300). After collecting the water samples, one set of each sample was acidified with 65% (v/v) HNO_3 to pH 2 to dissolve all heavy metals and to prevent crystallization, precipitation, and adsorption of trace metals to the container surfaces. The samples were then transported to the laboratory in an ice container.

3. Results

3.1 Standard limits of Physicochemical parameters and heavy metals in drinking water.

The recommended limits of selected heavy metals according to USEPA, WHO, ICMR, and CPCB. Permissible limit considered as published/recommended by either USEPA, WHO, ICMR, or CPCB.

3.2 Determination of physiochemical parameters of collected water samples

The pH range of the water samples collected from the four different regions of the Sabarmati River (A1 to A4) ranged between 8.32 and 7.34 (Table 8.1.2). As depicted in Table 2, the TDS value was found to be between the range of 145 to 3466 mg/L across the samples. The BOD was determined as 32.2, 64, 73 and 35.8 mg/L in A1, A2, A3 and A4 samples respectively. Similarly, the COD of samples A1, A2, A3 and A4 were determined as 56, 226, 262 and 52 mg/L respectively. At A1, A2, A3 and A4 the DO was 7.32, 8.93, 8.74, and 7.29 mg/L respectively. The alkalinity, chloride, nitrate and sulphate of sample A1 were 116, 101, 6.2, and 34 mg/L. Similarly, sample A2 has 436, 103, 7.3 and 231 mg/L of alkalinity, chloride, nitrate and sulphate. Sample A3 has alkalinity, chloride, nitrate and sulphate of 453, 346, 7.2, and 246 mg/L respectively. Sample A4 has 98, 43, 6.1, and 24 mg/L of alkalinity, chloride, nitrate and sulphate respectively A1 and A4 area which located in less industrialization shows low physiochemical parameter and A2 and A3 which is located on or near industrial area are show high physiochemical parameter.

The pH range of the water samples collected from the four different lakes of Ahmedabad (A14 to A17) (Table 8.1.3) ranged between 7.6 to 8.3. The TDS value was found as 4180, 1489, 262 and 149 mg/L in samples A14, A15, A16 and A17 respectively. The BOD values were 18, 14, 13 and 9 mg/L in A14, A15, A16 and A17 samples respectively. Similarly, the COD of samples A14, A15, A16 and A17 were 326.8, 321, 175 and 138 mg/L respectively. The DO values of A14, A15, A16 and A17 samples were 3.29, 4.6, 6.32 and 6.21 mg/L respectively. The alkalinity, chloride, nitrate and sulphate of sample A14 were 823, 498, 6.37 and 269 mg/L. Similarly, sample A15 has 179, 49, 8.22 and 796 mg/L of alkalinity, chloride, nitrate and sulphate respectively. Sample A16 has alkalinity, chloride, nitrate and sulphate of 102, 32, 6.2 and 36 mg/L respectively. Sample A4 has 99, 43, 6.3 and 31 mg/L of alkalinity, chloride, nitrate and sulphate respectively. A14, 15 and A17 area which located in less industrialization shows low physiochemical parameters and A16 which is located in industrial areas are shows high physiochemical parameters.

The pH of the wastewater samples collected from the industrially polluted zones of Ahmedabad was highly varied between the samples A5, A6, A7, A8, A9, A10, A11, A12, A13, A18 and A19) (Table 8.1.4) were 7.62, 8.02, 7.72, 5.82, 8.63, 7.21, 8.72, 8.52, 7.23, 8.32 and 7.72 respectively. The TDS value was found 10.46, 1.16, 0.56, 453, 894, 3218, 1962, 1621, 862, 1789 and 896 mg/L in sample A5, A6, A7, A8, A9, A10, A11, A12, A13, A18 and A19 respectively. The BOD values were 1240, 320, 281, 7628, 328.5, 279, 295.6, 274.8, 326.8, 11.5 and 12.1 mg/L in A5, A6, A7, A8, A9, A10, A11, A12, A13, A18 and A19 samples respectively. Similarly, the COD of samples A5, A6, A7, A8, A9, A10, A11, A12, A13, A18 and A19 were 1240, 320, 281, 7628, 328.5, 279, 295.6, 274.8, 326.8, 11.5 and 12.1 mg/L respectively. The DO values of A5, A6, A7, A8, A9, A10, A11, A12, A13, A18 and A19 samples were 6.31, 6.23, 6.18, 9.3, 8.6, 7.21, 7.28, 6.32, 8.3, 8.72 and 7.62 mg/L respectively. The alkalinity, chloride, nitrate and sulphate of

sample A5 were 521, 372, 7.3 and 296 mg/L respectively. Sample A6 has 104, 293, 6.3 and 236 mg/L of alkalinity, chloride, nitrate and sulphate respectively. Sample A7 has alkalinity, chloride, nitrate and sulphate of 102, 201, 7.1 and 228 mg/L respectively. Sample A8 has 2700, 6342, 6.2 and 283 mg/L of alkalinity, chloride, nitrate and sulphate respectively. Sample A9 has alkalinity, chloride, nitrate and sulphate of 623, 829, 6.2 and 231 mg/L respectively. Sample A10 has 526, 203, 6.28 and 263 mg/L of alkalinity, chloride, nitrate and sulphate respectively. The alkalinity, chloride, nitrate and sulphate of sample A11 were 721, 376, 7.3 and 244 mg/L respectively. Sample A12 has alkalinity, chloride, nitrate and sulphate of 686, 321, 7.36 and 223 mg/L respectively. Sample A13 has 763, 426, 6.2 and 228 mg/L of alkalinity, chloride, nitrate and sulphate respectively. The alkalinity, chloride, nitrate and sulphate of sample A18 were 648, 892, 6.9 and 261 mg/L respectively. Sample A12 has alkalinity, chloride, nitrate and sulphate of 529, 723, 7.1 and 246 mg/L respectively. so, A5, A6, A9 - A13 and A19 - 20 areas located near the industrial area show high physiochemical parameters A6 - A7 are treated water of pirana sewage treatment, so it shows very much low parameters**.**

3.3 Determination of heavy metal concentration of collected water samples.

Regarding calcium (Ca) abundance, all other metal ions fell within the CPCB's allowed range. However, Cadmium (cd), was found in high concentrations. InA2 - A3 OF Arsenic (As) (Ca) found higher concentrations in A2 - A3 of four samples (Table - 8.1.5)

In a manner comparable to that of the water in the Sabarmati River, freshwater lakes in Ahmedabad revealed the presence of heavy metals yet remained within the CBCP's permitted limits. However, calcium (Ca) was found in high concentrations in all four lake samples, and magnesium (Mg) was found in high concentrations in lake samples A15 (19.95 ppm), A16 (47.63 ppm), and A17 (43.3 ppm). These elements must be removed before the water can be used to meet the daily needs of animals and humans (Table - 8.1.6). In industrial zone dumping chanals water samplesA2 (Vasna barrage), A3 (Narol), A14 (chandlodia lake), A11 (Bavla), A19 (Odhav) are shows high concentration. of As. Most of the samples show high Ca and Cd contamination. Cr concentration of A19 (Odhav industrial area) shows high. A10 (Sanand GIDC) And A18 (Narol industrial area) show high concentrations of Cu. A5 (Pirana dump site) shows a high Li concentration. Mg level of most samples show high. A12 (Changodar) shows high Mo and Se concentration. A10 (Sanand) showed High Ni concentration. (Table - 8.1.7). The concentration of each heavy metal in the water samples varies depending on the pollution level in the Ahmedabad region.

4. Discussion

According to reports, factors affecting water quality such as DO, pH, temperature, COD, and BOD have a significant impact on how contaminants are distributed and change their course in riverine systems. The main variables affecting the solubility of trace metals in surface water are pH, temperature, river flow, and the redox environment of the river system (Kumar et al., 2011) . A drop in pH makes it more difficult for hydrogen ions and metal ions to compete for binding sites.

Sabarmati A1 and A2 are situated in a densely populated, high - traffic region, and people often throw offerings from religious ceremonies—such as kum - kum powder, coconuts, flowers, and other dewy objects—directly into the river. As a result, the river's pH, BOD, COD, and TDS levels are high. A3 is situated in the heart of a municipal and heavy industrial dumping zone, and the COD and TDS levels in this location are high. A4 is situated in a tidy, typical location like a village dew, and hence exhibits typical physiological and chemical properties. Only A2 - A3 regions, which are industries that employ heavy metals, exist in these four places. Regarding textiles. Cd and Mo employ pigments, papers, and metal adhesives in A2 regions for industries creating batteries and engines. For companies that use magnesium as a raw material in refineries, such as those that produce petrol, the A3 region shows significant Mg levels in the dew. As a result, it has been decided that the Sabarmati River A1 and A4 water may be used directly for household and agricultural uses. Samples of lakes in the Ahmedabad region Only A14 has high physicochemical characteristics and high heavy metal pollution since it is situated in the centre of an industrial district and demonstrates that people utilise lake water for household tasks like washing clothes.

Most samples taken from dumping canals, wastewater discharge, and floating river water in industrial zones indicate high physiochemical parameter and metal content. A5 region has high BOD, COD, and TDS values since it is close to an industrial zone and is also recognised as the centre of Ahmedabad's municipal landfill. Water samples from sewage - treated piranha water are used in the A6–A7 zones, and the dew in these places falls within the usual range. A8 is situated in an area where heavy machinery is produced, and the COD and chloride levels here are high. Heavy metal pollution of industrial regions samples of calcium concentration reveals high dew to heavy industrial load of production of certain metals as an allying agent used to create cement and glass, plastic material, and Ca usage in household activities. The high dew to heavy usage of the battery and electroplating production sectors is shown by the cadmium contamination of samples.

The places where drilling and stainless - steel manufacture are active are those where Cr levels are high. Where enterprises produce fungicides, fertilizers, ceramics, and glass disappearing, Mg pollution is very high. In the oil and gas, automobile, and electric power production industries, nickel contamination occurs often. In industrial areas that mostly employ grease lubricants, lithium concentrations were found in water samples. The results indicated that the industries have treated the wastewater before releasing into the environment. Industrial areas metal Concentration shows concentration range Ca >Cu>Cd>Mg>Mo>Mn> Sb>Sr>Cr>As>Fe>Ni>Tl>Ti>V>Zn>Li. However, metals such as Ca, Cd, Mg, Cd, Cr required to be removed.

5. Conclusions

The current research demonstrates that the physiochemical parameter and heavy metal content of unpolluted. In 19 sections of Ahmedabad, dirty areas near industrialization exhibit significant levels of metal pollution, whereas residential areas show lower levels of metal contamination. The degree of pollution in rivers that run near industrial regions is higher than in residential areas, and the same is true for lakes that are close to industrial districts. This study highlights the importance of more comprehensive research investigations to examine groundwater and wastewater abstractions, as well as the rate of recharge, trace heavy metal levels, and assessment of the volume of water removed daily.

6. Figure

6.1 Figure 1

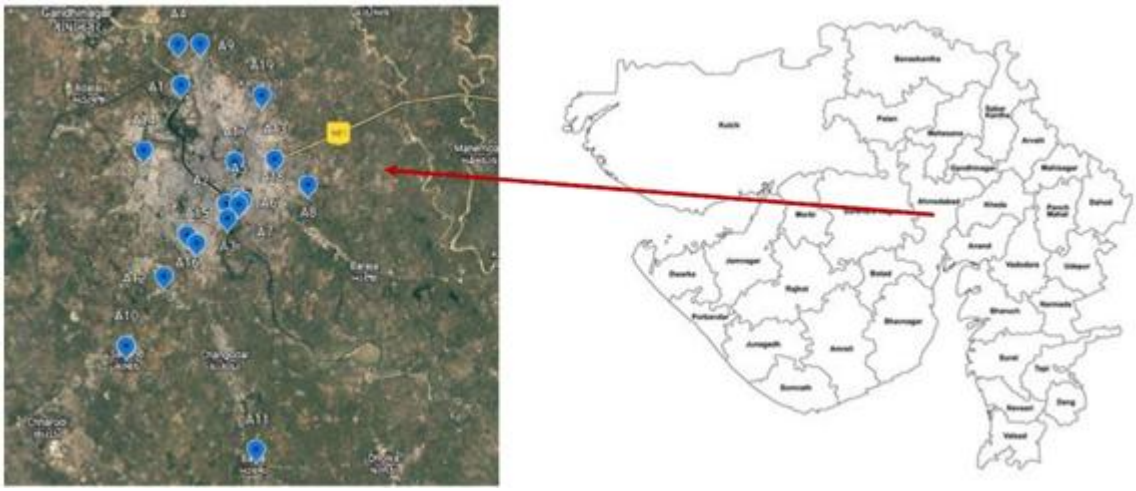

Figure 1: Map of sampling sites.

7. Tables

Table 8.1.1: Study areas have been selected for present work are as below

Regions	Geographical location
Sabarmati River (Indira Bridge) - A1	23°5′26″N 72°37′47″E
Sabarmati River (Vasna barrage) - A2	22°59′25″N 72°33′20″E
Sabarmati River (Narol - Vshala Bridge) - A3	22.9815°N 72.5436°E
Sabarmati River (Karai gam) - A4	23.1150°N 72.6628°E
Pirana Dump site Canal Water - A5	22.983811°N 72.567376°E
Pirana Ground water sample - A6	22.979305°N 72.567376°E
Pirana sewage treated water - A7	22.980368°N 72.56212°E
Vatva GIDC - A8	22°56′13″N 72°37′11″E
Naroda GIDC - A9	23.0980°N 72.6761°E
Sanand GIDC - A10	22.99129°N 72.375509°E
Bavla GIDC - A11	22.83351°N 72.36429°E
Changodar industrial area - A12	22.9995°N 72.4571°E
Vastral Industrial area - A13	22.9771°N 72.6217°E
Chandlodia Lake - A14	22.0839°N 72.5521°E
Sarkhej roja - A15	22.9936°N 72.5056°E
Prahlad nagar Lake - A16	23°0'15"N 72°30'21"E
Kakaria Lake - A17	23.0063°N, 72.6026°E
Narol industrial area water - A18	22.953326°N 72.573719°E
Odhav industrial area - A19	23.0319°N, 72.6831°E

Table 8.1.2: Physicochemical composition of water collected from Sabarmati River

Parameters	A1 - Indira Bridge	A2 - Vasna Barrage	A3 - Narol Bridge	A4 - Karai Gam
pH	8.32	7.48	7.59	7.34
TDS (mg/L)	262	3610	3466	145
BOD (mg/L)	32.2	64	73	35.8
COD (mg/L)	56	226	262	52
DO (mg/L)	7.32	8.93	8.74	7.29
Alkalinity (mg/L)	116	436	453	98
Chloride (mg/L)	101	103	346	43
Nitrate (mg/L)	6.2	7.3	7.2	6.1
Sulphate (mg/L)	34	231	246	24

Table 8.1.3: Physicochemical composition of water collected from lakes of residential areas.

Parameters	A14 - Chandlodia Lake	A15 - Sarkhej roja Lake	A16 - Prahlad nagar Lake	A17 - Kakaria Lake
pH	7.86	7.6	8.28	8.36
TDS (mg/L)	4180	1489	262	149
BOD (mg/L)	18	14	13	9
COD (mg/L)	326.8	321	175	138
DO (mg/L)	3.29	4.6	6.32	6.21
Alkalinity (mg/L)	823	179	102	99
Chloride (mg/L)	498	49	32	43
Nitrate (mg/L)	6.37	8.22	6.2	6.3
Sulphate (mg/L)	269	796	36	31

Table 8.1.4: Physicochemical composition of water collected from industrial areas.

Parameters	A5 - Pirana Dump site Canal Water	A6 - Pirana Ground water sample	A7 - Pirana sewage treated water	A8 - Vatva GIDC	A9 - Naroda GIDC	A10 - Sanand GIDC	A11 - Bavla GIDC	A12 - Changodar industrial area	A13 - Vastral Industrial area	A18 - Narol industrial area water	A19 - Odhav industrial area
pH	7.62	8.02	7.72	5.82	8.63	7.21	8.72	8.52	7.23	8.32	7.72
TDS (mg/L)	10.46	1.16	0.56	453	894	3218	1962	1621	862	1789	896
BOD (mg/L)	2932	1682	1420	1623	2.8	66	2.5	2.3	2.1	2.4	2.6
COD (mg/L)	1240	320	281	7628	328.5	279	295.6	274.8	326.8	11.5	12.1
DO (mg/L)	6.31	6.23	6.18	9.3	8.6	7.21	7.28	6.32	8.3	8.72	7.62
Alkalinity (mg/L)	521	104	102	2700	623	526	721	686	763	648	529
Chloride (mg/L)	372	293	201	6342	829	203	376	321	426	892	723
Nitrate (mg/L)	7.3	6.3	7.1	6.2	6.2	6.28	7.3	7.36	6.2	6.9	7.1
Sulphate (mg/L)	296	236	228	283	231	263	244	223	228	261	246

Table 8.1.5: Determination of heavy metals in Sabarmati water

Metals (PPM)	A1 – Indira Bridge	A2 - Vasna Barrage	A3 - Narol Bridge	A4 – Karai Gam
As	N. D.	0.025	0.12	0.01
Ca	74.2	24.85	69.41	35.62
Cd	0.105	0.985	1.7	0.107
Cr	0.019	0.09	0.05	0.09
Cu	N. D.	0.372	0.01	N. D.
Fe	0.021	0.05	0.73	0.417
Li	N. D.	0.015	0.142	0.003
Mg	33.28	0.05	22.68	20.7
Mn	N. D.	0.049	0.042	N. D.
Mo	N. D.	0.079	0.04	N. D.
Ni	0.009	0.01	0.07	0.01
Sb	N. D.	0.01	0.01	N. D.
Se	N. D.	0.055	0.327	N. D.
Sr	1.314	0.002	0.11	0.657
Ti	N. D.	0.04	N. D.	0.172
Tl	0.057	0.358	0.048	0.09
V	0.008	N. D.	N. D.	0.031
Zn	0.01	0.07	0.05	0.096

Table 8.1.6: Determination of heavy metals in lake water

Metals (ppm)	A14 - Chandlodia Lake	A15 - Sarkhej roja Lake	A16 - Prahlad nagar Lake	A17 - Kakaria Lake
As	0.235	N. D.	N. D.	0.007
Ca	13.41	46.42	72.4	64.9
Cd	2.93	0.017	0.009	0.023
Cr	2.598	0.027	0.016	0.013
Cu	2.209	N. D.	N. D.	N. D.
Fe	1.85	0.059	N. D.	N. D.
Li	N. D.	N. D.	0.025	N. D.
Mg	1.819	19.95	47.63	43.3
Mn	N. D.	0.006	N. D.	0.008
Ni	1.093	N. D.	N. D.	N. D.
Sb	1.515	N. D.	N. D.	0.027
Se	N. D.	0.05	N. D.	N. D.
Sr	N. D.	0.889	1.462	1.524
Ti	N. D.	0.005	N. D.	N. D.
Tl	0.092	0.024	N. D.	N. D.
V	N. D.	0.009	0.015	0.009
Zn	0.096	0.014	N. D.	N. D.

Table 8.1.7: Determination of heavy metals in Industrial areas Dumping water

Parameters	A5 - Pirana Dump site Canal Water	A6 - Pirana Ground water sample	A7 - Pirana sewage treated water	A8 - Vatva GIDC	A9 - Naroda GIDC	A10 - Sanand GIDC	A11 - Bavla GIDC	A12 - Changodar industrial area	A13 - Vastral Industrial area	A18 - Narol industrial area water	A19 - Odhav industrial area
As	0.005	N. D.	N. D.	0.05	0.04	0.004	0.025	0.01	0.86	0.007	0.721
Ca	51.2	77.85	30.65	0.65	51.85	34.81	47.93	0.25	40.21	26.2	10.07
Cd	4.2	0.085	0.022	7.6	2.1	6.42	4.32	4.2	1.52	3.8	5.21
Cr	0.21	0.016	0.012	0.05	0.03	0.006	0.004	0.005	0.01	0.01	0.095
Cu	0.061	N. D.	N. D.	0.077	2.097	3.96	0.007	0.004	0.003	3.008	0.081
Fe	0.05	0.06	N. D.	0.02	0.09	3.126	0.01	0.01	0.042	0.01	0.021
Li	0.032	N. D.	N. D.	0.031	N. D.	0.003	0.003	0.023	N. D.	0.016	N. D.
Mg	0.18	33.25	9.456	0.05	0.01	45.86	28.19	8.52	0.073	0.07	1.944
Mn	0.245	0.06	N. D.	0.051	0.028	N. D.	N. D.	N. D.	N. D.	N. D.	N. D.
Mo	N. D.	0.001	0.004	N. D.	N. D.	N. D.	N. D.	0.053	N. D.	0.034	N. D.
Ni	0.02	N. D.	N. D.	0.02	0.01	2.728	0.01	0.01	0.003	0.01	1.983
Sb	0.099	N. D.	N. D.	0.02	0.01	2.888	0.009	0.001	0.003	0.009	1.521
Se	N. D.	0.12	0.048	0.008	0.065	N. D.	N. D.	N. D.	N. D.	N. D.	N. D.
Sr	0.358	1.084	0.605	0.203	0.092	0.495	0.08	0.008	0.355	0.08	N. D.
Tl	0.022	0.139	0.046	0.144	0.08	0.049	0.125	0.191	0.285	0.125	N. D.
Ti	N. D	N. D	N. D	N. D	N. D	N. D	N. D	N. D	N. D	N. D	N. D
V	N. D.	N. D.	0.018	N. D.	N. D.	N. D.	N. D.	N. D.	N. D.	N. D.	N. D.
Zn	0.03	N. D.	N. D.	0.06	0.06	5.301	0.08	0.006	0.07	0.08	0.058

8. Abbreviations

ICP - OES : Inductive Coupled Plasma Mass Spectrometry
TDS : Total Dissolved Solids
BOD : Biochemical Oxygen Demand
COD : Chemical Oxygen Demand
DO : Dissolved Oxygen
USEPA : United State Environment Protection Agency
WHO : World Health Organization
ICMR : Indian Council of Medical Research
CPCB : Central Pollution Control Bord
ISI : Indian Standard Institute
mg/L : Mili Gram Per Litter
ml : Mili Litter
PPM : Parts Per Million
Cu : Copper
Cd : Cadmium
Mg : Magnesium
Mn : Manganese
Sb : Antimony
Sr : Strontium
Cr : Chromium
As : Arsenic
Fe : Iron
Ni : Nickel
Tl : Thallium
Ti : Titanium
V : Vanadium
Zn : Zinc
Li : Lithium
Mo : Molybdenum
N. D. : Not detected

9. Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and material

Not applicable.

Competing interests

All the authors declare that they have no competing interests.

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Authors contributions

BV, BP, and BG took part in the acquisition, analysis and interpretation, manuscript preparation and reviewing. HM, BG, and PS commented on the previous version of manuscript. All authors have read and approved the final manuscript.

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