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ASSESSMENT OF TRACE AND TOXIC METALS IN CHHOTI MAHANADI RIVER BASIN

Chandra Bhan Lohar,
Research Scholar, Dept. of Chemistry,
Kalinga University

Dr. Anil Sharma,
Professor, Dept. of Chemistry,
Kalinga University

ABSTRACT

The quality of water plays an important role in environmental monitoring. In present days, it is a matter of serious concern for the health of both human and animals. It measures the condition of water relative to the requirements of one or more biotic species and human need or purpose. The quality of river water depends on a number of interrelated factors such as geology, climate, topography, biological processes, and land use. Trace metals are tenacious environmental pollutants which enter in the river from a variety of natural as well as anthropogenic sources. Usually, trace metals are derived from point sources, such as smelting and mining, disposal of partially treated and completely untreated effluents, discharged metal chelates from different industries, and indiscriminate use of heavy metal-containing fertilizer and unutilized pesticides from agricultural fields. The practice of discharging of untreated domestic and small-scale industries into the water bodies leads to the increased level of concentration of the metals in the rivers passing through urban areas. The present study, before using water for drinking purposes, it must be treated since at some stations, the water quality index is dangerously close to the point where it could be contaminated by both organic and inorganic debris.

Keywords: *Environmental, water, anthropogenic*

INTRODUCTION

The inhabitants of these places rely on the Chhoti Mahanadi riverbeds for their very existence. A number of drains conveying sewage from cities, mine waste, and industrial effluents are connected to the Chhoti Mahanadi River through the Katni River/Kathina. Water is one of the most fundamental necessities of the population, hence its safety needs to be considered before use. The goal of this paper is to find both dangerous and trace amounts of heavy metals. Heavy metals are metallic elements with high atomic weights and densities that are at least five times greater than those of water. They are bio-accumulative, or transferred up the food chain to humans, and stable, meaning they cannot be digested by the body. They are extremely poisonous and even in very small doses they can be harmful. The concentrations of trace metals, particularly heavy metals, in waterways have increased as a result of growing urbanisation and industrialization. There are about 50 elements that can be categorised as heavy metals, but only 17 that are regarded to be both exceedingly hazardous and relatively accessible. Regarding water contamination, special consideration should be paid to mercury, lead, arsenic, cadmium, selenium, copper, zinc, nickel, and chromium. The effects of heavy metal toxicity on our brain system, kidney, lungs, and other organ functioning are severe. Urban sewage discharge pollutes surface water bodies. The current study's main objective is to quantitatively analyse the heavy metals in the Chhoti Mahanadi River.

The purpose of the current study is to evaluate the concentration of heavy metal ions along the Chhoti Mahanadi river basin's sections. In the Chhoti Mahanadi basin, nine samples were taken during the course of the months of September 2020. Nine heavy metals (Cu, Zn, Cd, Pb, Hg, Fe, As, Ni, and Cr) in the surface water of the Chhoti Mahanadi River, one of the most significant rivers in Madhya Pradesh, India, were estimated as part of this study. The Chhoti Mahanadi River is receiving home, industrial, and municipal waste streams and effluents all along its course in the chosen research region. Overall, the heavy metals found in the surface water of Chhoti Mahanadi river in the following order: Cu>Ni>Pb>Cr>As>Fe>Zn>Hg>Cd. My research demonstrated how industrialization, mining, and human activity have all contributed to the decline in river water quality.

MATERIALS AND METHODS

In clean and dry polythene bottles, water samples were taken in September 2020, November 2020 from nine different stations as listed below. Throughout the course of the chemical study, water samples were taken and stored at 10^{o}C for testing of various parameters. By incorporating 5 mL of 1N HNO_3 into a litre of sample to keep the pH below 4.0, the heavy metals were protected. Following a filtering step using Whatman filter paper No. 40, the filtrate was immediately employed in the Atomic Absorption Spectrophotometer for analysis. The samples are acidified at the time of sampling in accordance with the standard, global method reference provided by APHA.

RESULTS AND DISCUSSION

Heavy metals such as Cu, Cr, Fe, As, Zn, As, Cd, Hg, and Pb were analysed for in the Chhoti Mahanadi River water quality examination. Tables 1.1, 1.2, and 1.3 contain all the parameters' maximum, minimum, and average values. The units are as follows: gm/L (ppb).

Table-1.1

Measurements of maximum, minimum and average values of Heavy Metals in Chhoti Mahanadi River at 1st, 2nd and 3rd stations.

Parameters	S_1(Deeghee)			S_2(Kudari)			S_3(Loolee)		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
	µgm/L(ppb)			µgm/L(ppb)			µgm/L(ppb)		
Iron(Fe)	0.071	2.503	0.100	0.01	1.269	0.567	0.042	3.299	1.105
Arsenic(As)	0.33	2.89	1.107	0.06	1.92	0.853	0.52	3.95	2.087
Cadmium(Cd)	0.02	0.51	0.203	0.02	0.32	0.164	0.00	0.42	0.107
Chromium(Cr)	0.02	11.28	2.022	0.01	8.56	0.660	0.18	13.20	1.090
Copper(Cu)	1.63	39.29	10.73	1.65	20.81	11.845	1.68	19.67	10.750
Nickel(Ni)	0.00	22.49	10.260	0.00	24.50	10.179	0.00	24.70	14.940
Lead(Pb)	0.62	8.20	4.567	0.23	8.13	4.023	3.08	14.41	7.695
Zinc(Zn)	0.005	1.850	0.371	0.006	1.355	0.197	0.004	1.835	0.390
Mercury(Hg)	0.000	0.63	0.310	0.00	0.610	0.480	0.00	0.55	0.233

Table-1.2

Measurements of maximum, minimum and average values of Heavy Metals in Chhoti Mahanadi River at 4th, 5th and 6th stations

Parameters	S_4 (Hinauta)			S_5 (Basadi)			S_6 (Konia)		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
	µgm/L(ppb)			µgm/L(ppb)			µgm/L(ppb)		
Iron(Fe)	0.283	1.248	1.786	0.049	1.164	0.509	0.030	2.30	0.748
Arsenic (As)	0.68	4.62	2.412	0.18	3.18	1.084	0.12	2.54	1.350
Cadmium(Cd)	0.08	0.620	0.280	0.01	0.43	0.257	0.02	1.19	0.276
Chromium(Cr)	0.26	11.20	3.264	0.06	10.00	0.740	1.95	9.08	4.945
Copper(Cu)	7.62	22.63	12.34	1.66	24.92	11.840	3.26	38.81	7.380
Nickel(Ni)	0.02	11.210	11.260	0.00	12.75	9.349	0.00	12.10	10.325
Lead(Pb)	4.62	18.32	8.92	0.19	13.69	1.064	0.04	17.49	7.567
Zinc(Zn)	0.008	2.320	0.484	0.005	0.860	0.234	0.028	1.853	0.366
Mercury(Hg)	0.000	0.68	0.316	0.00	0.610	0.480	0.00	0.57	0.315

Table-1.3

Measurements of maximum, minimum and average values of Heavy Metals in Chhoti Mahanadi River at 7th, 8th and 9th stations

Parameters	S_7(Manghata)			S_8(Gairtalai)			S_9(Bakeli)		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
	µgm/L(ppb)			µgm/L(ppb)			µgm/L(ppb)		
Iron(Fe)	0.080	3.20	0.848	0.064	2.94	0.764	0.031	2.366	0.849
Arsenic(As)	0.18	3.28	1.620	0.12	2.92	1.240	0.61	9.24	2.437
Cadmium(Cd)	0.08	1.32	0.321	0.06	1.06	0.282	0.00	0.86	0.186
Chromium(Cr)	2.24	11.24	4.21	1.68	10.24	3.64	0.60	22.79	1.180
Copper(Cu)	4.32	31.42	8.62	3.84	28.41	7.64	1.45	39.70	8.525
Nickel(Ni)	0.08	12.14	8.46	0.04	10.26	1.49	0.00	14.39	9.703
Lead(Pb)	0.08	18.62	8.238	0.06	11.62	7.143	0.89	17.24	7.813
Zinc(Zn)	0.042	1.928	0.462	0.036	1.828	0.392	0.000	1.635	0.311
Mercury(Hg)	0.000	0.610	0.332	0.00	0.425	0.218	0.000	059	0.253

Below is a discussion of these parameters' variants. Figures 1.1 to 1.9 illustrate parameter-wise the variation in concentrations of each parameter along the river basin at each sampling point.

Iron (Fe): In surface water, iron concentrations can range from 0.5 parts per billion to 100 parts per billion. The range of iron concentrations, from 0.019 parts per billion to 1.248 parts per billion, is substantially within the permitted limits set by the ICMR, WHO, and BIS guidelines. Consuming little amounts of iron is both absolutely necessary and typically healthful. Anaemia is brought on by an iron deficiency in the body.

Arsenic (As): The average concentration of arsenic in drinking water is 0.002 ppm. Arsenic was discovered in the current investigation to be well under BIS's permitted level, nonetheless. From 0.06 ppb at Kudari to 9.24 ppb at Bakeli, the range is. Arsenic exposure of any kind can harm the kidneys and liver, and the most serious exposures can result in hemolysis of the erythrocytes. "Garlic breath," skin sensitivity, dermatitis, and keratitis are all highly common during chronic intoxication.

Arsenic poisoning through oral consumption causes significant stomach pain, nausea, vomiting, and diarrhoea due to damage to the gastrointestinal tract, all of which lead to coma and death.

Cadmium (Cd):- Because cadmium is not under homeostatic control in the human body, it is extremely poisonous. When too much cadmium is consumed, it causes a metabolic problem by replacing zinc at important locations. The Chhoti Mahanadi River's water contained safe levels of cadmium. At Loolee and Bakeli, the range is 0.00 ppb, and at Manghata, it is 1.32 ppb.

Lead (Pb) There is significant lead contamination in Chhoti Mahanadi water. Nearly all stations experienced it during its height in June, with Hinauta recording the greatest level. The lowest lead concentration was recorded during the monsoon season. From 0.08 ppb to 18.32 ppb was the range. The majority of people have a "lead balance," meaning they excrete as much as they take in. However, if the rate of intake rises, accumulation or a "positive lead balance" will occur. The body treats lead as if it were calcium because lead and calcium are chemically extremely similar. As a result, it is first delivered to the membrane sites and plasma in soft tissues. It is subsequently transferred to the other locations where calcium is necessary, most notably in growing children's teeth and bone throughout all ages. At concentrations of 0.1–10 mg/L, Pb has been found to be acutely hazardous to invertebrates.

Nickel (Ni):- One of the first metals is copper. The limit of copper is 0.05 parts per million, according to ISI. In the current analysis, the majority of the locations where copper was detected were within acceptable levels. At Deeghee, Konia, and the downstream Bakeli, high values were seen. This can be a result of the industrial activity nearby. Copper pollution levels in the Chhoti Mahanadi River ranged from 4.32 ppb at Manghata to 39.70 ppb at Bakeli during the research period. Copper is a vital component of several important metalloenzymes that keep the vascular and neurological systems functioning.

(Hg) Mercury- High mercury levels can have negative consequences on the nervous system, the brain, the kidneys, the lungs, the eyes, the skin, rashes, vomiting, and diarrhoea. The typical concentration of mercury in drinking water is 0.001 ppm. Mercury was, however, determined to be well within the BIS-acceptable level in the current investigation. The range is 0.000 parts per billion (ppb) in most regions to 0.680 ppb in Hinauta.

Chromium (Cr): Chromium can exist in the environment in oxidation levels ranging from +2 to +1. However, it is primarily found in a trivalent or hexavalent state in the environment. Health experts advise against using hexavalent chromium. Hexavalent chromium is a risk to anyone working in the steel and textile sectors. People who use tobacco are more likely to be poisonous to chromium. Chromium (VI) can harm the kidneys and liver in addition to causing allergic responses, skin rashes, irritations, nasal bleeding, stomach ulcers, respiratory issues, and lung cancer. Between 0.01 ppb and 22.79 ppb of chromium were discovered at Kudari and Bakeli, respectively.

The twenty-fifth most abundant element is zinc (Zn). Zinc is necessary for the operation of several enzymes in both plants and animals. A higher zinc dosage has harmful side effects include diarrhoea, diarrhoea, nausea, and vomiting. Zinc is permitted up to 15 mg/L. The concentration of zinc was at its lowest during the monsoon season.

The permitted range was 0.00 ppb to 2.320 ppb, which is comfortably inside it.

Nickel (Ni): The twenty-fourth most plentiful element is nickel (twice as copper). In the course of industrial operations, nickel is discharged into the environment. A small amount of nickel is required, but if the absorption is excessive, it can be hazardous. Headaches, motion sickness, nausea, light headache, vomiting, and epigastric pain are the main signs of nickel exposure. Chest tightness chills and sweating, shortness of breath, coughing, muscle pains, weariness, gastrointestinal discomfort, and in extreme instances convulsions and delirium are among the secondary symptoms. Nickel concentrations were high in Deeghee and Kudari. 0.000 ppb to 24.50 ppb is the range.

Iron (Fe): concentration is highest at Hinauta station and lowest at Deeghee station. Similar to that, Hinauta and Bakeli stations had the highest concentrations of arsenic (As), as seen in Fig. 1.1 below. According to Figure 1.2-1.4, there is a rise in the concentration of Cadium (Cd), Copper (Cu), Nickel (Ni), Lead (Pb), and Zinc (Zn) at numerous stations. According to the WHO standards listed in Table, there has been a significant increase in mercury (Hg) in the two stations Kudari and Basadi.

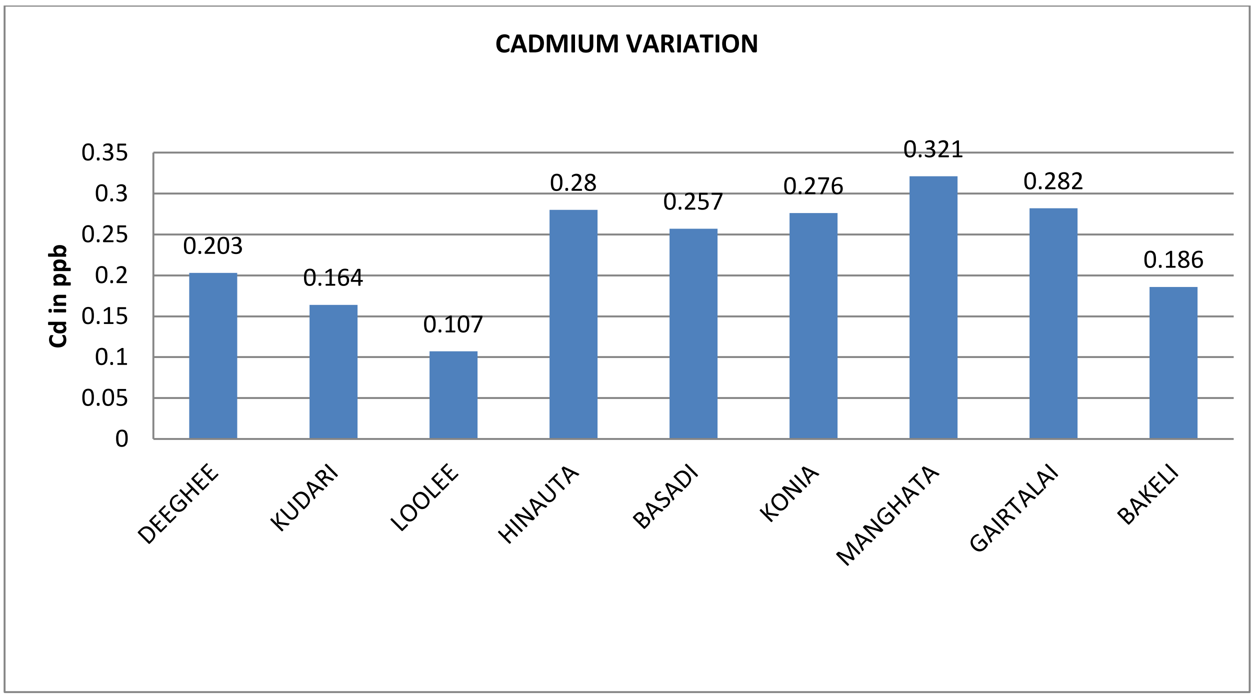

Figure-1.1 : Variation of the concentrations of Cadmium

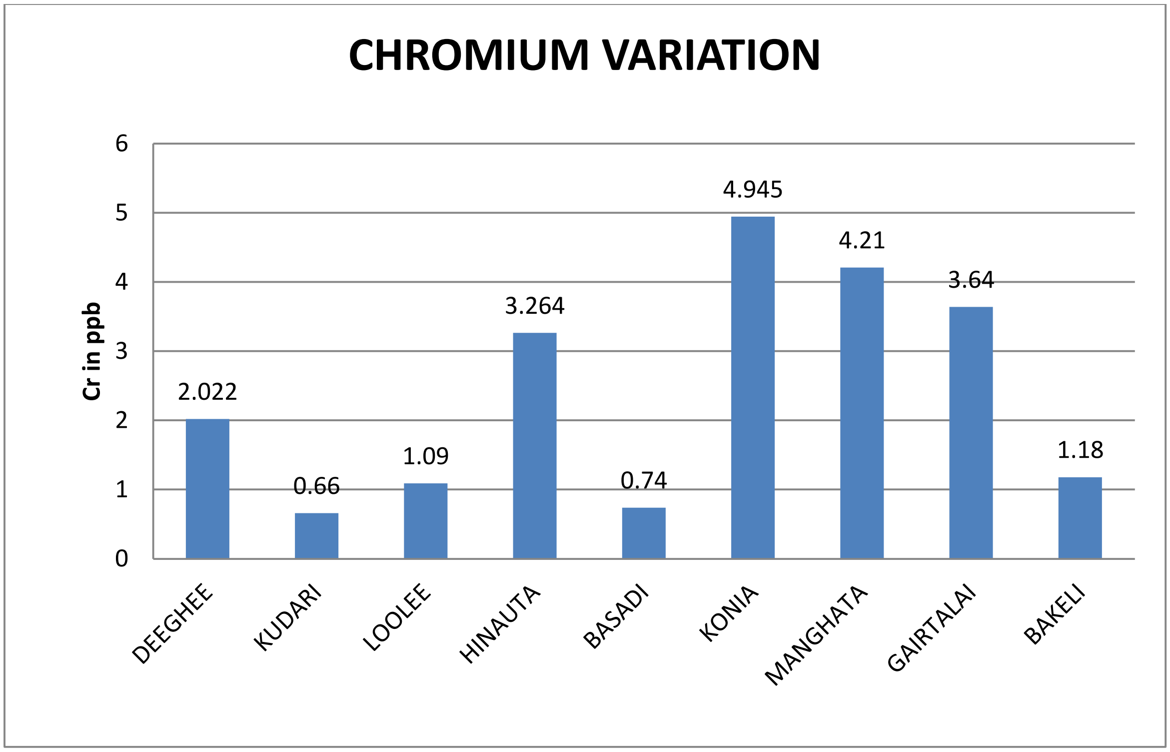

Figure 1.2 : Variation of the concentrations of Chromium.

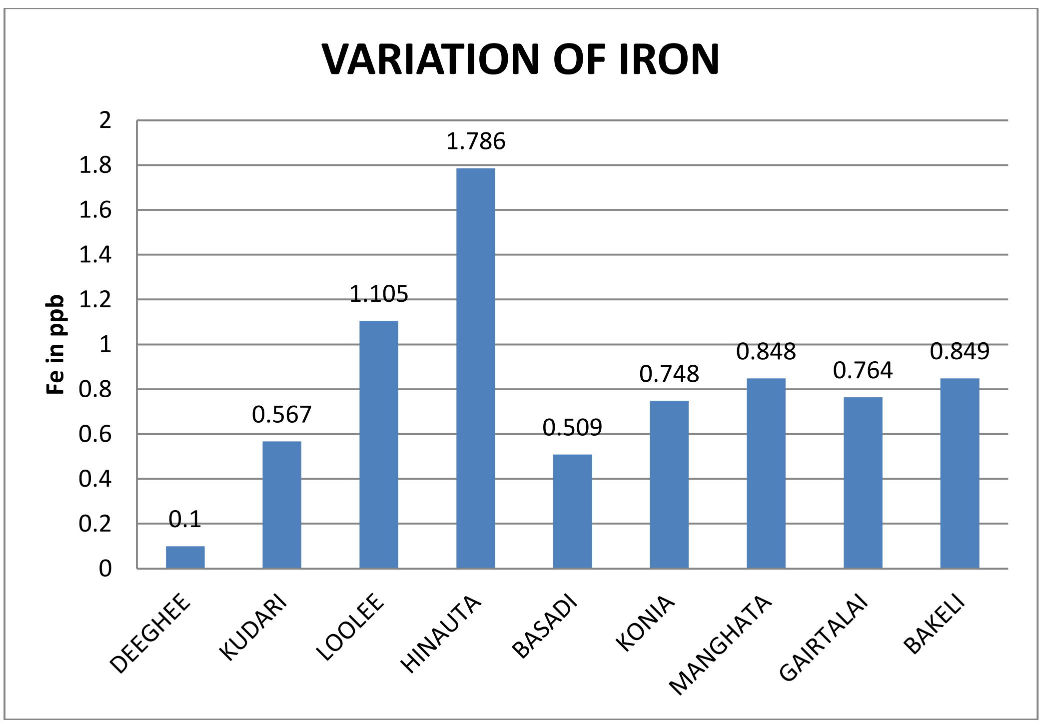

Figure1.3: Variation of the concentrations of Iron

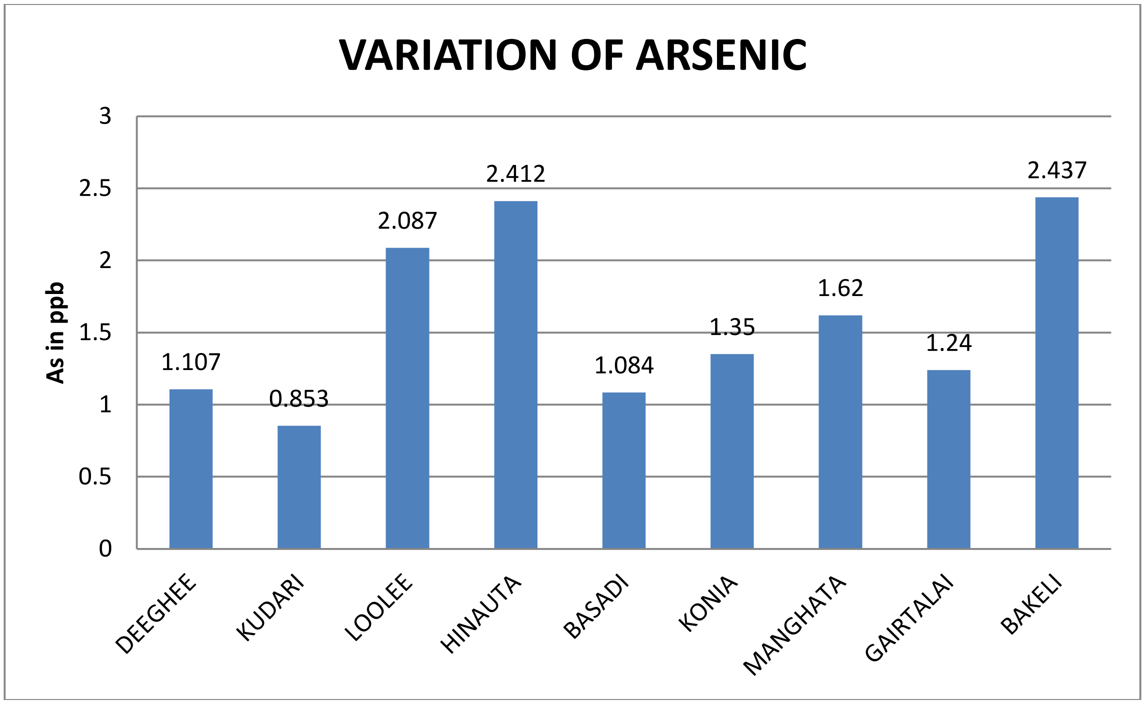

Figure1.4:Variation of the concentrations of Arsenic

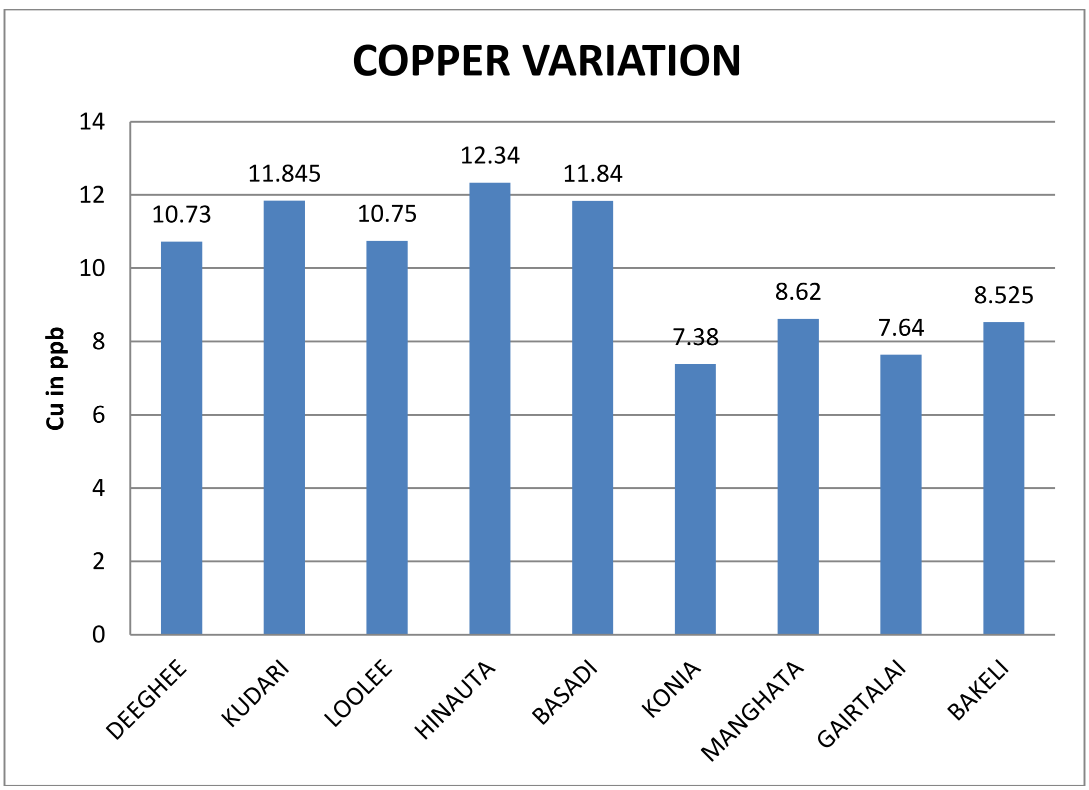

Figure 1.5:Variation of the concentrations of Copper

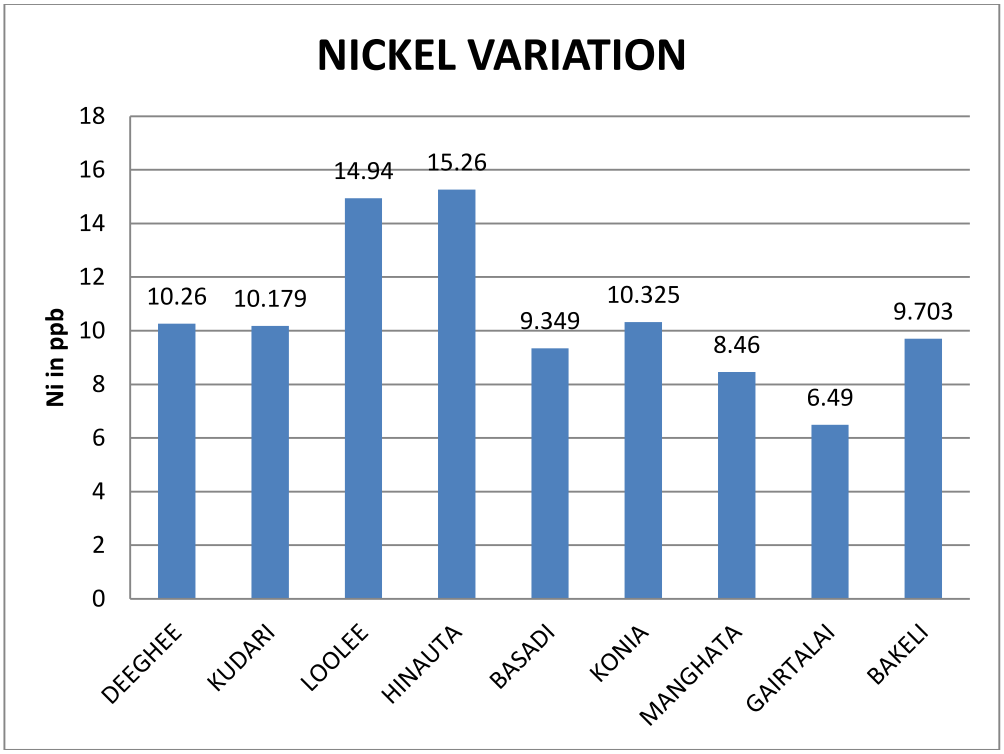

Figure 1.6:Variation of the concentrations of Nickel

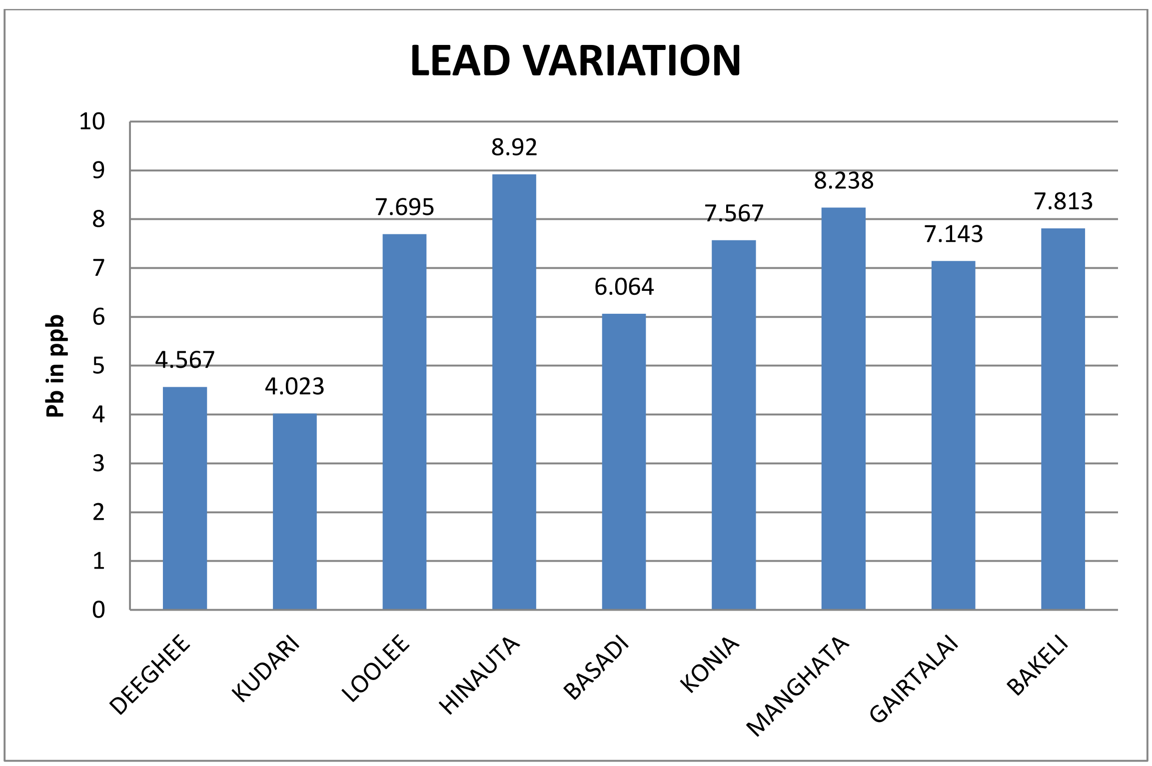

Figure 1.7 : Variation of the concentrations of Lead

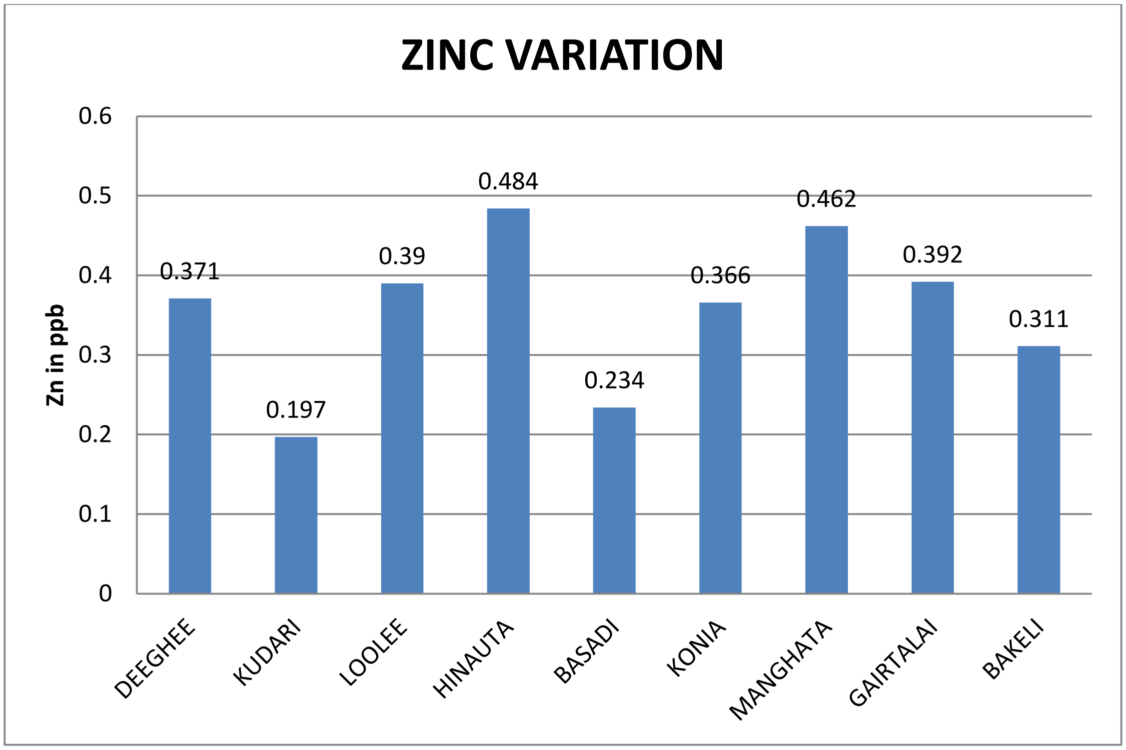

Figure 1.8: Variation of the concentrations of Zinc

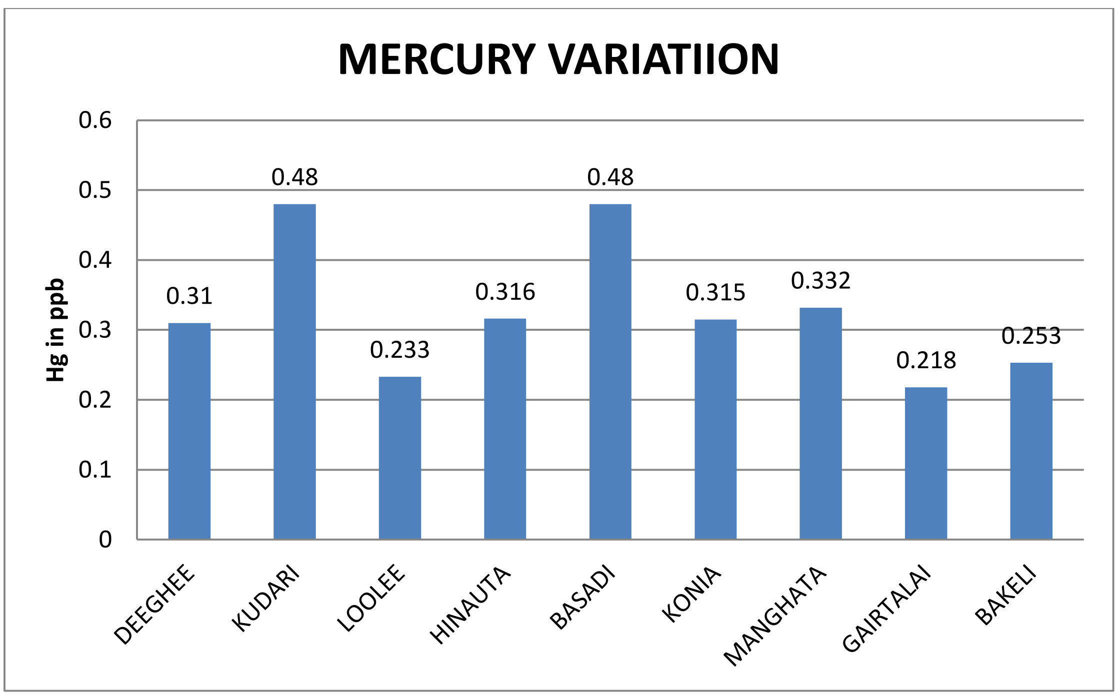

Figure 1.9 : Variation of the concentrations of Mercury

CONCLUSION

The iron levels in the current study were between 0.019 ppb and 1.24 ppb, which is well within the acceptable ranges set by WHO and BIS regulations. Even though there were comparatively higher results at Deeghee, Konia, and Bakeli, the concentration of Cu was within permissible bounds. Most of the time, the concentration of Hg was below the threshold for detection. Other metal concentrations like As, Cd, Ni, Zn, Pb, and Cr were within WHO and BIS-acceptable limits. In terms of heavy metal concentration, the Chhoti Mahanadi River's water is not appropriate for direct drinking but appropriate for irrigation because copper pollution has more positive health effects than negative ones.

Drinking water sources are susceptible to contamination due to both natural settings and human-made activities including mining, farming, and other construction projects. As a result, it is becoming increasingly challenging to guarantee the availability of drinking water. The drinking water quality index (WQI) was calculated using several chemical characteristics in drinking water samples collected from various Chhoti Mahanadi riverbeds in the following paper with the intention of advancing public health activities.

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