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Analysis of physico-chemical characters and heavy metal distribution along the Beehar River, Rewa, Madhya Pradesh

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Abstract
The Analysis of physico-chemical characters and heavy metal distribution along the Beehar River, Rewa, Madhya Pradesh during the period of 2015-17 was carried out by selecting four sites namely, Rajghat Sangam (S-1), Nipania bridge (S-2), Vikram bridge (S-3) and Jayantikunj (S-4). The selected eight physico-chemical characters such as Temperature, pH, Total alkalinity, Chloride, Dissolved Oxygen, BOD, COD and Total hardness were found to be in an increasing trend from S-1 to S-4 as well as during the period of 2015-17. The average heavy metal distribution during the study period was found in the order of Iron>Manganese>Zinc>Arsenic>Copper>Chromium>Cadmium. Except Zinc and other metals have exceeded the acceptable limit for surface water as well as for drinking water which indicates that the Beehar River is under threat of heavy metal pollution.

Keywords: water, pollution, heavy metals, physico-chemical parametersx

1. Introduction
Water is one of the most common yet the most precious resources on earth without which there would be no life on Earth. Nowadays, water pollution is a major global problem. It is an acute problem almost in all major rivers and dams in India. Water pollution is increasing and becoming severe day-by-day and posing a great risk to human health and other living organisms. Water pollution can be defined as 'The contamination of water bodies by physicochemical and biological pollutants into the water making it unfit for drinking and use in other purposes'. Point source pollution refers to contaminants that enter a waterway from a single, identifiable source, such as a pipe or ditch while non-point source pollution refers to diffuse contamination that does not originate from a single discrete source. The change water quality also varies due to a change in chemical composition of the underlying sediments and aquifer (Jameel, 2002) [1]. About one third of the drinking water requirement of the world is obtained from surface sources like rivers, dams, lakes and canals (Jonnalagada and Mhere 2001) [2]. In urban areas, the careless disposal of industrial effluents and other wastes in rivers and lakes may contribute greatly to the poor quality of river water (Emongor *et al.* 2005) [3]. Pollution of river in India has now reached to a point of crisis due to unplanned urbanization and rapid growth of industrialization (Saksena *et al.* 2008) [4].

Heavy metals are known to have serious health implications including carcinogenesis induced tumor promotion (Schwartz, 1994) [5]. The growing consciousness about the health risks associated with environmental chemicals has brought a major shift in global concern towards prevention of heavy metal accumulation in soil, water and vegetables. Atmospherically driven heavy metals have been shown to significantly contaminate soil and vegetables causing a serious risk to human health when plant based foodstuffs are consumed (Pandey & Pandey 2009b, 2009c) [6, 7]. Dietary intake of trace elements depends also on irrigational water use. There may not always be a strong relationship between the concentrations of trace elements in soil and plants (Siegel, 2002) [8], but there always exists a strong relationship between their concentrations in irrigational water and plants (Ahmad & Goni 2009; Sharma *et al*. 2006) [9, 10]. Thus, the deposition of heavy metals in water bodies can doubly increase the human intake through food chain as well as through drinking water. Most of the surface discharge sources contaminate soil and water bodies under limited spatial range, aerial emissions being prone to long range transport, contaminate wider range of ecosystems especially downwind to emission sources. Furthermore, unlike surface discharge, where stream flow restricts midstream contamination, atmospheric deposition directly adds contaminants on water surfaces.

2. Material and Methods
2.1 Description of the study site
Rewa region has a saucer shaped structure. The flat central part is composed of sedimentary rocks derived from the denuded material of the hills surrounding the basin. The sloping margin of the saucer are composed of older rocks which contrastingly occupy a higher level than the younger. Sedimentary rocks of the central flat zone. The saucer was once a sea in which sediment from the coastal hills deposited during Precambrian period. Decapitation of the surrounding hills exposed the older rocks at the coast line of the original Synclinal tatnys. A profile of this vast hilly tract running south to north would clearly make out the physiographic feature of the Rewa, and its comparative position the elevation scale.

The physiography of Rewa is very rough and hilly. The area is cylinderical in share and the drainage pattern is of centripetal type. The rivers are mostly originating from the South and running towards north. Structure confirm earth surface behaviour and geodynamic process such as silting and erosion, consequently, tend to produce marked local climate or micro climate. The saucer shaped structure of this area clearly accounts for the scanty vegetation. Owing to its centripetal drainage pattern the area is subjected to quick and continuous.

Site description

1. Rajghat Sangam (S-1): This sampling point was established near Rajghat Sangam. PHED pumping station is the characteristics of the site.
2. Nipania bridge (S-2): This sampling point was established near Nipania bridge intensive humann activities are the taking place at this site.
3. Vikram bridge (S-3): This sampling point was marked near Vikram bridge, a cloth washing by Dhobis and other human activities are the characteristics of the area.
4. Jayantikunj (S-4): This sampling station was established behind forest range office which characteristics the river moving out of the town.

3. Results and Discussion

3.1 Study of Physico-chemical characteristics of the Beehar River

The analysis of physico-chemical characters of the Beehar River was carried out during Monsoon, winter and summer season during the period of 2015-16. The average of these readings were calculated and represented in the Table 1.

Table 1: Average Physico-chemical characters during 2015-17 year of the Beehar River.

S. No	Parameters	Sampling sites			
		S-1	S-2	S-3	S-4
1.	Temperature (°C)	26.0	26.0	26.2	25.9
2.	pH	7.52	7.49	7.47	7.48
3.	Total alkalinity (mg/L)	133.7	145.0	155.9	131.7
4.	Chloride (mg/L)	29.4	59.9	63.3	32.5
5.	Dissolved Oxygen (mg/L)	6.97	5.75	5.24	7.51
6.	BOD (mg/L)	2.2	2.7	5.5	5.3
7.	COD (mg/L)	29.9	28.4	43.0	22.1
8.	Total hardness (mg/L)	149.91	144.24	165.91	177.18

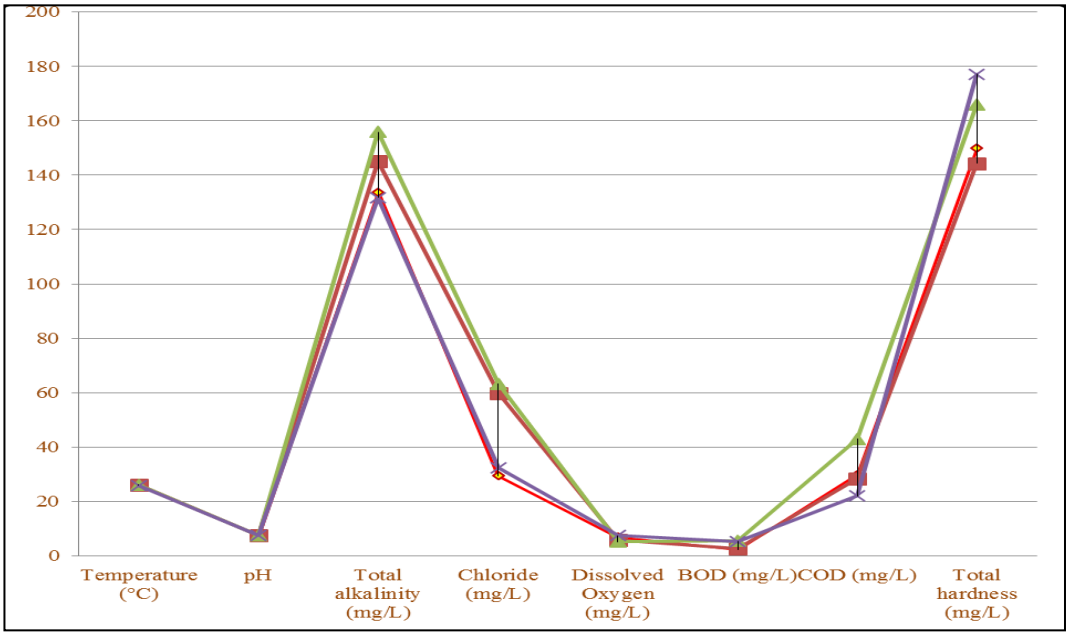

Fig 1: Graphics analysis of Average Physico-chemical characters during 2015-17 year of the Beehar River.

From the Table 1, it is observed that the maximum Temperature was found to be at the S-3 site and the S-4 site. The maximum pH was noted at the S-1 site, similarly maximum Total alkalinity at the S-3 site, Chloride at the S-3, Dissolved oxygen at the S-4 was observed. The maximum BOD, COD at the S-3 and Total hardness at the S-4 during the period of 2015-17 were observed.

Temperature of surface water sources sampling stations varies with climatic conditions. Temperature values of the surface water ranged between a minimum of 25.9°C to a maximum of 26.2°C. Singh and Singh (1990) [11] have reported temperature variations of Subernarekha river in Ranchi from July 1985 to June 1986 to range from 19.2°C to 29.5°C.

Though, pH of all the sites varied from 7.47 to 7.52, pH ranging from 6.5 to 8.5 has been suggested as standards for drinking water. (ISI, 1982, WHO, 1988 and USEPA, 1989) [12-

[14].

Total Alkalinity in the surface water sources investigation has been observed to fluctuate in between 131.7 mg/l as minimum to a maximum of 155.9 mg/l which is towards higher side. Narmada river have reported that the maximum value of pre carbon dioxide was recorded during summer months may be because of decomposition of organic matter and a depletion in dissolved oxygen with low pH. Similar observations have also been made by Sreenivasan (1964) [15] and Welch (1935 & 1952) [16].

Chloride values of the surface water ranged between a minimum of 29.4 mg/l to a maximum of 63.3 mg/l.

The average DO for S-4 was found to be 7.51 which is good but S-1, S-2 and S-3 showed less DO i.e. 6.97, 5.75 and 5.24 mg/l than 4 mg/l (CPCB, 2016)[17] which may be due to domestic sewage and small industrial sewage discharge increased from upstream to downstream responsible for excessive pollution (Thorwat *et al.* 2012) [18] as micro-organisms consume large amount of oxygen from domestic sewage for their living.

In the present study, BOD is ranged from 2.2 to 5.5 from upstream site S-1 to Downstream site S-3. This indicated that the riverside stretch is free from organic pollution (Effendi *et al.* 2018) [19]. The BOD were found to be out of permissible limit of CPCB [17] which might be due to an increasing organic matter load from upstream to downstream ultimately the decomposition process of organic matter by microbes consume large amount of oxygen. The decreasing trend in DO and an increasing trend in BOD towards downstream show an increase in the load of pollution from upstream to downstream (Mulani *et al.* 2009) [20]. The COD is another important characteristics of water, which is the amount of chemical oxidant required for the oxidation of the organic matter present in the water. This is the reliable characteristics of water for judging the extent of pollution in water (Effendi *et al.* 2018) [19].

The COD of Beehar river water ranged from 22.1 to 43.0 mg/l, which is out of permissible limit designated by (World Health Organization) [13] WHO 1988. The Beehar river receives high amount of the organic matter which may be originated from domestic effluents on the bank of the river. This may be one of the reasons for increase in the organic pollution load in the Beehar River from upstream to downstream. The increased amounts of COD are undesirable for fisheries as well as for agriculture.

Total hardness values of the surface water ranged between a minimum of 144.24 mg/l to a maximum of 177.18 mg/l. These values of total hardness recorded in the drinking water in the present investigation are much higher than the values reported by Olaniya *et al.* (1978) [21] in well waters of Jaipur.

3.2 Heavy Metals distribution along Beehar River

Heavy metals are found to be environmentally stable and non-biodegradable, toxic to the living beings and tend to accumulate in plants and animals causing adverse effects on human health. The average heavy metal concentration during the period of 2015-2017 is depicted in the Table 2.

Table 2: Average Heavy metal concentration during 2015-17 year of the Beehar River.

S. No	Parameters	Sampling sites			
		S-1	S-2	S-3	S-4
1.	Arsenic (ppm.)	0.031	0.038	0.043	0.031
2.	Chromium (ppm.)	0.021	0.028	0.027	0.030
3.	Cadmium (ppm.)	0.005	0.005	0.005	0.005
4.	Copper (ppm.)	0.024	0.031	0.039	0.040
5.	Iron (ppm.)	0.052	0.045	0.059	0.081
6.	Manganese (ppm.)	0.049	0.043	0.056	0.060
7.	Zinc (ppm.)	0.044	0.040	0.044	0.055

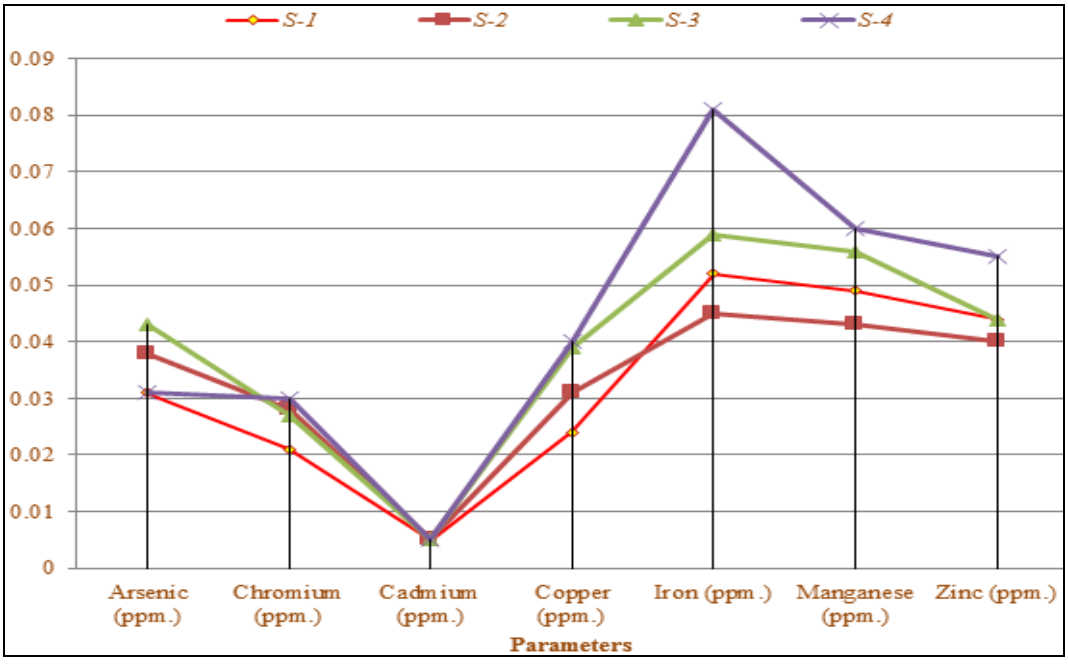

Fig 2: Graphics analysis of Average Heavy metal concentration during 2015-17 year of the Beehar River

The average heavy metal concentration during the period of 2015-2017 were found in the order of Iron>Manganese>Zinc>Arsenic>Copper>Chromium>Cadmium. The concentration of Iron ranged from 0.045 to 0.081 ppm. Manganese from 0.043 to 0.060 ppm., Zinc from 0.040 to 0.055 ppm, Arsenic from 0.031 to 0.043 ppm., Copper from 0.024 to 0.040 ppm., Chromium from 0.021 to 0.030 ppm. and Cadmium from 0.005 to 0.005 ppm. As the river flows from upstream to downstream there are many sources of pollution such as agricultural runoff, small scale industries waste water, domestic sewage which flows through different nullahs, waste water from industrial areas etc. Therefore, the increase in heavy metal content from upstream to downstream was observed from upstream to downstream during the study period.

In nature, the Cadmium is found in phosphate rocks and its natural background can be increased by atmospheric deposition, land application of sewage sludge and manure, and fertilizers (Roberts, 2014)[22]. The river basin of the Beehar river, is a rich agricultural area in which large amount of chemical fertilizers are used which may be one of the reasons for the occurrence of Cadmium content in river water sample.

4. Conclusions

The focus of the study was physico-chemical characters and heavy metal distribution along the Beehar River from upstream to downstream. The physico-chemical characteristics of Beehar River showed an increasing trend from upstream to downstream which indicates increasing anthropogenic activity in the corresponding area. The average heavy metal distribution during the study period was found in the order of Iron>Manganese>Zinc>Arsenic>Copper>Chromium>Cadmium. Except Zinc and other metals have exceeded the acceptable limit for surface water as well as for drinking water which indicates that the Beehar River is under threat of heavy metal pollution. As the river water is being used for drinking and agricultural purposes along the bank of river could exert an adverse effect on human health due heavy metals toxicity and increasing pollution load.

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