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Analysis of physico-chemical characters and heavy metal distribution along the Murna river, Shahdol, Madhya Pradesh

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Abstract
The Analysis of physico-chemical characters and heavy metal distribution along the Murna River, Shahdol, Madhya Pradesh during the period of 2020-2021 was carried out by selecting four sites namely, Kalyanpur (S-1), near to Koni Amrita Hospital (S-2), MPEB Colony (S-3) and near to Akashwani Sohagpur (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 2020-21. 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 Murna River is under threat of heavy metal pollution.

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

1. Introduction

The entry of contaminants into the environment due to human and natural activities is one of the most important issues facing today's communities. Due to the industrial and economic growth and the production of a variety of compounds and chemicals followed by increased consumption man makes some unwanted pollutants, many of which cause serious problems and risks for the environment and for man himself. The most important natural resources of environmental pollution are soil and rock weathering and natural events such as earthquakes and floods (Espinoza-Quiñones, *et al.* 2005) [1]. The entry of municipal, industrial, and agricultural waste into the environment is another way of the environment pollution by human. Water resources are among the most critical resources. The importance of water resources, particularly surface waters (rivers), in meeting the water needs of humans, animals and industries indicates the essential need to protect them against contamination. As municipal, industrial, and agricultural waste enters the water, biological and chemical contaminants including heavy metals also enter water resources. Although some of these metals are essential as micronutrients, their high concentration in the food chain can cause toxicity and environmental impacts and endanger aquatic ecosystems and their users (Prabu, 2009 and Pandey & Pandey, 2009) [2, 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 Study area

District Shahdol lies between 23°15' N latitude to 24° N Latitude and 81°E longitude to 81°45' Longitude. The xpanse of the district is 110 km N-S and 30 km E-W thus comparising an area of about 5642 sq. km. which is 1.83% of the total area of the M.P. Shahdol lies on Katni-Bilaspur railway line and is approachable by road from Jabalpur, Shahdol, Bilaspur, Mandla, Sidhi and Koria district (C.G.). The roads are motorable in all weather. District Shahdol lies in the heart of the country. The district is surrounded by Sone river and Satna and Sidhi district in north, Dindauri in South, Koria (Sarguja), Anuppur in east and Jabalpur and Umaria in the West. It is situated 489 mts. above the sea surface.

According to the 2011 census Shahdol District has a population of 1,064,989, roughly equal to the nation of Cyprus or the US state of Rhode Island. This gives it a ranking of 427th in India (out of a total of 640). The district has a population density of 172 inhabitants per square kilometre (450/sq mi). Its population growth rate over the decade 2001-2011 was 17.27%. Shahdol has a sex ratio of 968 females for every 1000 males, and a literacy rate of 68.36% [7].

In Shahdol town, eastern Madhya Pradesh state, central India. It lies along the Murna River (a tributary of the Son River) about 110 miles (177 km) northwest of Bilaspur. Murna river flows from south to north-east. Murna river also provides the necessary water requirements for few villages of Shahdol city. During the survey it was found that forest cover in the bank of Murna river has almost nonexistent. In addition to there was a large and small slum encroachments along the bank of the river. This encroachment of bank of the river has a resulted into a drastic situation where the river Munra (now becomes as a drainage) has slowly dried up.

2.2 Climate

It is Hot in summer. Shahdol District summer highest day temperature is in between 29 °C to 45 °C.

Average temperatures of January is 16 °C, February is 21 °C, March is 26 °C, April is 32°C, May is 36 °C .

2.3 Site description

Site description

S. No.	Site code	Sites	Description
1.	S1	Near to Kalyanpur	Where the river Murna enters the city
2.	S2	Near to Koni, Amrita hospital	Located in the middle of the course of the River Murna through the city.
2.	S3	Near to MPEB colony	Located in the middle of the course of the River Murna through the city.
3.	S4	Near to Akashwnai, Sohagpur	Where the River Murna just leaves the city

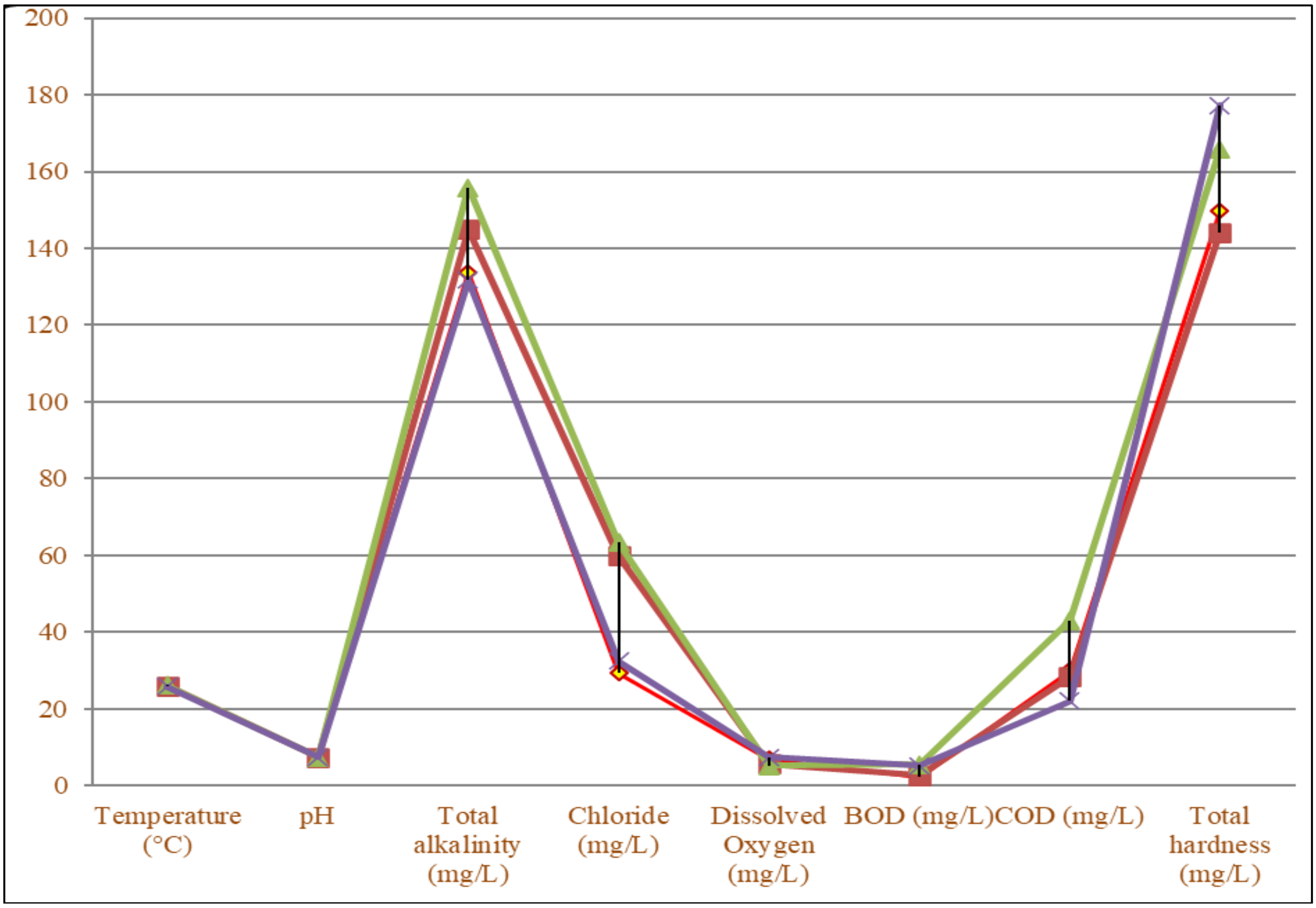
3. Results and Discussion

3.1 Study of Physico- chemical characteristics of the Murna River

The analysis of physico-chemical characters of the Murna River was carried out during Monsoon, winter and summer season during the period of 2020-2021. The average of these readings were calculated and represented in the Table 1.

Table 1: Average Physico-chemical characters during 2020-2021 year of the Murna 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



Graph 1: Graphics analysis of Average Physico-chemical characters during 2020-2021 year of the Murna 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 2020-2021were 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 Murna 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 Murna 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 Murna 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.

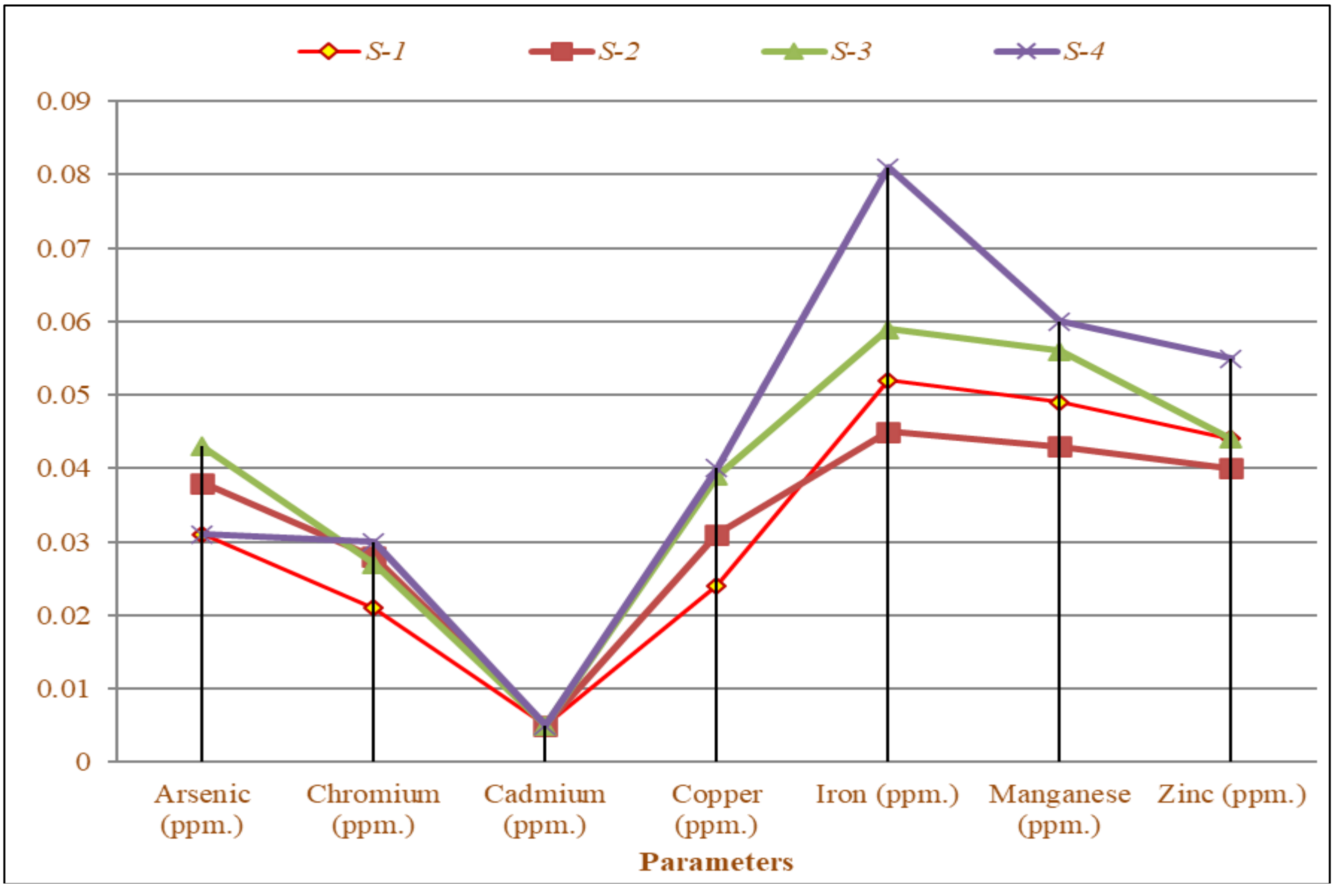
These values of total hardness recorded in the drinking water in the present investigation are much higher than the values reported by Olaniya *et al.* (1978) [21] in well waters of Jaipur.

3.2 Heavy Metals distribution along Murna 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 2020-21 is depicted in the Table 2.

Table 2: Average Heavy metal concentration during 2020-2021year of the Murna 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



Graph 2: Graphics analysis of Average Heavy metal concentration during 2020-2021year of the Murna River

The average heavy metal concentration during the period of 2020-21 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] while only the mean concentrations of Cd in marine sediments (Long, *et al.* 2013) [23]. The river basin of the Murna 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 Murna River from upstream to downstream. The physico-chemical characteristics of Murna 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 Murna River is under threat of heavy metal pollution. It is, thus, necessary to take serious and essential measures to control the entry of the sewage, treat it before entering the river, manage the quality of water and the sediments of the river, and utilize water for various purposes.

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