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Assessment and seasonal variations of heavy metal contamination of surface water in Murna river, Shahdol, Madhya Pradesh

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Abstract
The present work is assessment the seasonal variation in metal pollution and the ecological risk indices of surface water of the Murna River, Shahdol during summer, rainy and winter season during the year of 2019-20. The concentration of trace metals such as arsenic, chromium, cadmium, copper, iron, manganese and zinc were determined using atomic absorption spectrophotometer and the results were compared with the World Health Organization (WHO) and Bureau Indian standard (BIS) values. They are extremely dangerous for the health of fish. Most of these metals are characterized by being accumulated in tissues, and lead to the poisoning of fish. These metals can effectively influence the vital operations and reproduction of fish; weaken the immune system, and induce pathological changes. As such, fish are used as bio-indictors, playing an important role in monitoring heavy metals pollution. It is very important to assess and monitor the concentrations of potentially toxic heavy metals and metalloids in different environmental segments and in the resident biota.

Keywords: surface water, heavy metals, irrigation, WHO

1. Introduction
Environmental pollution is one of the major challenges in the modern human society (Ali and Khan, 2017) [1]. Environmental contamination and pollution by heavy metals is a threat to the environment and is of serious concern (Hashem, *et al.* 2017) [2]. Rapid industrialization and urbanization have caused contamination of the environment by heavy metals, and their rates of mobilization and transport in the environment have greatly accelerated since 1940s (Khan, *et al.* 2004 and Merian, 1984) [3, 4]. Their natural sources in the environment include weathering of metal-containing rocks and volcanic eruptions, while principal anthropogenic sources include industrial emissions, mining, smelting, and agricultural activities like application of pesticides and phosphate fertilizers. Combustion of fossil fuels also contributes to the release of heavy metals such as cadmium (Cd) to the environment (Spiegel, 2002) [5]. Heavy metals are persistent in the environment, contaminate the food chains, and cause different health problems due to their toxicity. Chronic exposure to heavy metals in the environment is a real threat to living organisms (Wieczorek-Dąbrowska, *et al.* 2013) [6].
Seasonal variations in quality of water generally refer to the change in components of water, which are to be present at the optimum level for suitable growth of plants and animals. These components play an important role for the growth of plants and animals in the water body. In natural aquatic system, various chemical parameters occur in low concentration.
Heavy metals in water refers to the heavy, dense, metallic elements that occur in trace levels, but are very toxic and tend to accumulate, hence are commonly referred to as trace metals. They are metallic elements with high atomic weight and density greater than that of water.
Sediments in untreated runoff from direct discharge storm water systems are one of the most important contributors to urban waterway pollution, and are considered to be a dominant stressor in urban aquatic ecosystems (Marshall *et al.* 2010) [7]. Excess suspended sediments can affect the aquatic ecosystem through depositional effects such as the reduction in the exchange capacity between benthic and water column zones, reduced food quality and smothering of biota, as well as through suspended effects such as respiratory damage, light attenuation and transport of other pollutants such as HM (Ryan 1991; Pekey 2006; Clapcott *et al.* 2011) [8-10].

This article comprehensively reviews the different aspects of heavy metals contamination of surface water. The article will serve as a valuable educational resource for both undergraduate and graduate students and for researchers in environmental sciences.

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, Rewa, 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 Murna (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

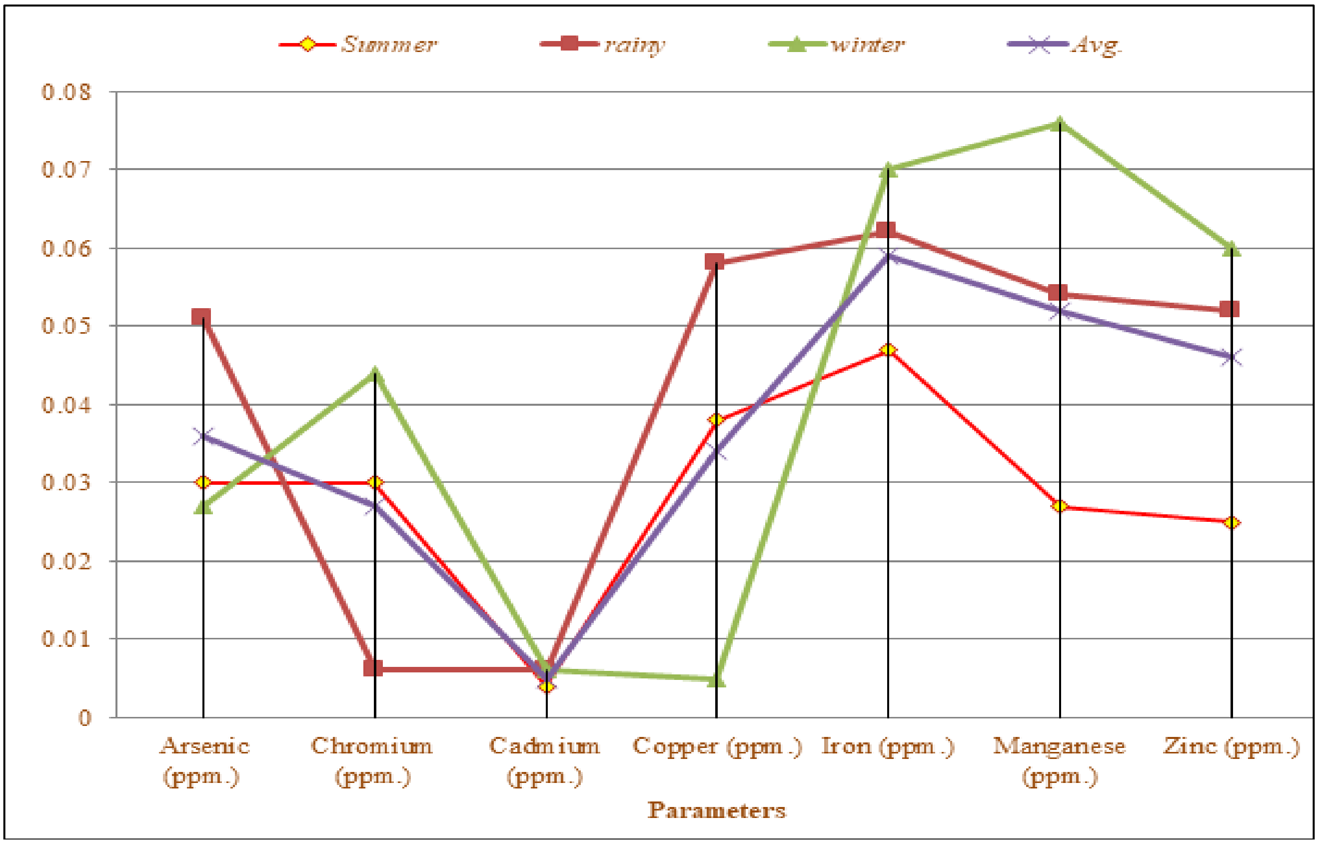
S. No.	Site code	Sites	Description
1.	S1	Near to Kalyanpur	Where the river Murna enters the city
2.	S2	Near to Koni, Amrita hospital	Located in the middle of the course of the River Murna through the city.
2.	S3	Near to MPEB colony	Located in the middle of the course of the River Murna through the city.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

The analysis/measurements of heavy metal concentration were carried out with an Atomic Absorption Spectrophotometer (AAS) and the results were compared with WHO standard values. All concentrations were determined using the absorbance made with airacetylene flame. Eight working solutions were prepared from the stock solutions for each of the metals by successive serial dilution and each of the standard solutions was then aspirated into the flame of AAS and the absorbance recorded in each case. A plot of the concentration against the corresponding absorbance gives the calibration curve of each metal. The samples, after aspirated into the flame and the absorbance obtained were then extrapolated from the calibration plot to obtain the corresponding concentration.

3. Results and Discussion
The obtained results of heavy metals are tabulated in Table 1. The results are discussed and compared with standard values.

Table 1: Concentrations of heavy metal ions in surface water samples during 2019-20 year of the Murna River

S. No.	Parameters	WHO [11] / BIS [12] limit (ppm) (min.-max.)	Seasons			
			Summer	rainy	winter	Avg.
1.	Arsenic (ppm.)	0.01-No relaxation	0.030	0.051	0.027	0.036
2.	Chromium (ppm.)	0.05-No relaxation	0.030	0.006	0.044	0.027
3.	Cadmium (ppm.)	0.01- No relaxation	0.004	0.006	0.006	0.005
4.	Copper (ppm.)	0.05-1.5	0.038	0.058	0.005	0.034
5.	Iron (ppm.)	0.3-1.0	0.047	0.062	0.070	0.059
6.	Manganese (ppm.)	0.1-0.3	0.027	0.054	0.076	0.052
7.	Zinc (ppm.)	5-15	0.025	0.052	0.060	0.046



Graph 1: Graphics analysis of Concentrations of heavy metal ions in surface water samples during 2019-20 year of the Murna River

It is produced as a result of metal refining processes. As it is stored in skeleton muscles followed by skeleton, liver, blood, lungs, kidney and feathers. As exists as trivalent and pentavalent forms Trivalent form of As is much more toxic than pentavalent form. Clinical signs of acute poisoning are vomiting, diarrhea, marked depression and dermatitis (Jarup, 2003) [13]. The present study the Arsenic seasonal variations 0.030 (ppm) summer season, 0.051 (ppm) rainy season and 0.027 (ppm) winter seasons.

It is also responsible for chrome ulcer and kidney damage. The maximum concentration of Cr(VI) permitted in domestic water supplies is 0.054 ppm. Other sources of contamination of chromium in the environment are Chlor-alkali, electroplating, leather textiles, pigments, dyes, metal finishing and mining (Manivasakam, 1996) [14]. Cr content of the present study lies within the prescribed standards except winter season.

Exposure to cadmium is commonly determined by measuring cadmium levels in blood or urine. Blood cadmium reflects recent cadmium exposure (from smoking, for example). Cadmium in urine (usually adjusted for dilution by calculating the cadmium/creatinine ratio) indicates accumulation, or kidney burden of cadmium (Jarup *et al.* 1998, Wittman and Hu, 2002) [15, 16]. The present study the Cadmium seasonal variations 0.004 (ppm)-0.006 (ppm).

Copper is widely distributed and is an essential metal required by all living organisms in some of enzyme systems, but at higher concentration it acts as pollutant. Higher concentrations of Cu cause fishy, fatty and oily taste (Sharma & Kaur, 1997) [17]. The present study values are ranged between (0.005-0.038 ppm).

Iron is one of the most abundant metals in the earth crust and is essential for human beings. But excess iron in drinking water produces inky taste and muddy smelling (Sharma & Kaur, 1997) [17]. In the present study iron content varies between 0.047 to 0.070 ppm.

It is one of the most important trace elements essential for organisms. Shortage of Mn causes fatness, Glucose intolerance. Manganese effects occur mainly in the respiratory tract and in the brains. Manganese can also cause Parkinson and lung embolism (Barik *et al.* 2005) [18]. Chronic Manganese poisoning may result from prolonged inhalation of dust and fume. The central nervous system is the chief site of damage from the disease, which may result in permanent disability. Symptoms include languor, sleepiness, weakness, emotional disturbances, recurring leg cramps, and paralysis. Mn is found to vary between 0.027 and 0.076 ppm.

The major sources of water contamination of Zn are from industrial wastes, deterioration of galvanized iron and dezincification of brass etc. Zinc sulphates containing fertilizers are also responsible for higher values of Zn in water (Wu *et al.* 2008) [19]. In the present study Zn content varied between 0.025ppm and 0.060ppm.

Such studies involve aquatic chemistry, which has a scope for public health as remarked by Johnston (1986) [20]: “aquatic chemistry is a fundamental element of public health.” Bioaccumulation data of toxic heavy metals in different biota such as fish and rice can be used for health risk assessment for the general human population.

4. Conclusions

Water is one of the abundantly available substances in nature and also called an elixir of life. The study assessed the evolution of water quality in surface water and open well water of Murna river, Shahdol district. The water samples were subjected to the concentrations of heavy metal ions. Such as arsenic, chromium, cadmium, copper, iron, manganese and zinc were found to be within the limits. In aquatic ecosystem, heavy metals are considered as the most important pollutants, since they are present throughout the ecosystem and are detectable in critical amounts. The trophic transfer of these elements in aquatic and terrestrial food chains/webs has important implications for wildlife and human health. It is very important to assess and monitor the concentrations of potentially toxic heavy metals and metalloids in different environmental segments as well as in the resident biota.

5. References

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