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HEAVY METAL POLLUTION OF RAMGANGA RIVER IN MORADABAD AND BAREILLY STRETCH OF UTTAR PRADESH, INDIA

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ABSTRACT

Water quality has become a major issue due to growing industrial development, urban development, e-waste, wastewater irrigation and sewage which causes the toxicity of heavy metals in river water. The current study presents the findings of the work on the heavy metal toxicity of river Ramganga in Bareilly and Moradabad districts. River water samples were collected from five different sites of Moradabad and Bareilly stretch during the summer and winter season of year 2018. Two sampling sites namely MDA colony (S1) and Nawapura Nalla (S2) were at Moradabad while the remaining three sites viz. Ucha Gaon (S3), Ramganga bridge (S4) and chaubari village (S5) were at Bareilly region. The concentrations of trace metals such as Chromium, copper, nickel, iron and lead were determined using atomic absorption spectrophotometer. The result indicated that higher concentration of heavy metals was found at both sites of Moradabad region in both seasons while it was lower in Bareilly stretch. Proper attention from concerned authorities was recommended in order to control/ protect the river from further pollution.

Keywords: Atomic absorption spectrophotometer, Heavy Metals, Pollution, River Water.

Abbreviations: Cr, Chromium; Cu, Copper; Fe, Iron; Pb, Lead, Ni, Nickel.

INTRODUCTION

Water is the most key resource required to sustain the life on this planet and Rivers play an imperative role in the development of nation and sustenance of life, which are being polluted due to speedy urbanization, industrialization and other developmental activities. Heavy metals are a collective term applied to the group of metalloids and metals with their atomic density greater than 4 g/cm or 5 times or more, greater than water **[1].** Heavy-metal contamination is not a modern problem arising due to industrialization but it began when humans started processing ores **[2, 3]** Since then the use of metals and their impacts on the environment have increased tremendously, with a major increase during the 19th and 20th centuries **[4]**. The presence of heavy metals in the industrial wastewater is an impending risk for the animals and humans. A high concentration of heavy metals often causes a serious threat to biota and the environment of any ecosystem **[5]**.

The rising awareness about the health risks linked with environmental chemicals has brought a major change in global concerns towards the prevention of heavy metal accumulation in water and soil **[6]**. The increased level of heavy metals in river water shows that river water is not safe for bathing, drinking and other activities. Heavy metals like Iron (Fe), Chromium (Cr), Copper (Cu), Nickel (Ni) and Lead (Pb) have an adverse effect on aquatic as well as human health. The evidence of heavy metals in water bodies can increase the human intake through food chain as well as through drinking water. These heavy metals are entering into the river system through biomagnifications and bioaccumulation **[7]**.

Heavy metal contaminations are important because of their impending toxicity for the human beings and environment **[8, 9]**. Some of the metals such as Zinc and Copper are essential as micronutrients for the life processes in plants and animals, while several other metals such as Lead and Cadmium have no known physiological activities **[10, 11]**. Metals are non-degradable and therefore can build up in the human body system, causing damage to internal organs and nervous system **[8]**. The present study aimed to investigate the water quality status of River Ramganga with respect to its heavy metal concentrations in summer and winter season at Bareilly and Moradabad districts of Uttar Pradesh, India. The research work was carried during summer (May, 2018) and winter (December, 2018).

MATERIALS AND METHODS

Study area

The study area of Ramganga river in Moradabad and Bareilly comes under humid sub tropic climate. The average annual temperature in Moradabad is 24.5 °C and the average annual rainfall is 976 mm whereas the average annual temperature in Bareilly is 25.1 °C and the rainfall here averages 1093 mm. Presently, there are several large and medium scale industries where River Ramganga is used as a sink for their harmful effluents. These industrial activities affect various components of the environment and disturb ecological balance and therefore convey heavy metal contamination in the river water.

Field sampling

Samples were collected from five different sites of Moradabad and Bareilly during the summer and winter season of year 2018. Two sampling sites namely MDA colony (S1) and Nawapura Nalla (S2) were at Moradabad while the remaining three sites viz. Ucha Gaon (S3), Ramganga bridge (S4) and Chaubari village (S5) were at Bareilly region. To avoid unpredictable changes in characteristic, acid washed plastic containers were used to take the samples 10 to 15 cm below water surface, as per the standard procedures (APHA, 1998). Samples were collected in May 2018 for summer season, and in December 2018 for winter season. Attention and care was taken to collect subsequent samples from same location in both the seasons.

Laboratory methods

Water samples were collected from all the respective sampling stations of Ramganga River. The samples obtained were filtered (Whatman no. 42) and preserved with 6N of HNO_3 for further analysis **[12]**. Heavy metal concentrations in water samples were determined with an atomic absorption spectrophotometer (AAS) for particular metal with a specific lamp. Average values of three replicates were taken for each determination. Before the analysis of samples, appropriate blank was taken.

In view of the direct consumption of water by humans, the domestic water supply is considered to be the most important use of water and drinking use has been given priority on utilization of water resource in the National Water Policy. Bureau of Indian Standards (BIS) 10500 (2012) **[13]** have formulated drinking water standards in India while World Health Organization (WHO) has considered international drinking water standards. According to BIS 10500 (2012), the requirement (acceptable limit) and permissible limit in the absence of alternative source is given in **Table 1**.

RESULTS AND DISCUSSION

Heavy metals or trace elements are among the mostharmful of the elemental pollutants **[14]**. These heavy metals easily enter into food chain and accumulation of such metals may cause some serious effects **[15]**. Different concentration of heavy metals in both (summer and winter) seasons was given in **Figure 1 to 5**, while the overall contribution of heavy metals as pollutant (in percentage) at each site was given from Figure 6 to 10.

Chromium

As per the BIS (Bureau of Indian Standard) 10500 (2012), the acceptable limit of 0.05 mg/l (50 µg/L) of chromium in drinking water was recommended. The maximum value in summer was at site 1, with a value of 1.49mg/l and in winter was at site 2 with a value of 2.11 mg/l. Chromium contributed maximum 31% **(Figure 6)** of all investigated heavy metal pollution at site S3. High concentrations of Chromium have toxic effects in causing allergenicity and carcinogenicity in humans as well as animals **[16]**.

Copper

A contour map **(Figure 3)** is plotted by taking average copper concentration for the whole study period. In the summer season the maximum value 2.17 mg/l was noted at the site MDA Colony (S1), Moradabad and minimum value 0.02 mg/l at the site Chaubari village, Bareilly (S5).In the winter season maximum value 1.79 mg/l was noted at the site MDA Colony, Moradabad (S1) whereas minimum value 0.01 mg/l was observed at Chaubari village, Bareilly (S5). The higher values of copper at S1 in summers may be attributed to domestic sewage and runoff from extensive farmlands areas **[17]**. While at other remaining sites low values of copper indicate no significant pollution and it was under the permissible limit of 2 mg/l given by WHO (Table 1). Copper contribution to the pollution extent was ranged from 1% at site S5 (Fig 10) to 34% at site S2 **(Figure 9)**.

Nickel

A contour map **(Figure 3)** is plotted by taking average nickel concentration for the whole study period. The maximum permissible limit for Nickel in water is 0.02 mg/l (BIS, 2012). The highest value 1.04 mg/l was observed at the site MDA Colony, Moradabad (S1) and the lowest value 0.01 mg/l was noted at the site Chaubari, Bareilly (S5) in the summer season. In winters the highest value was noted 0.84 mg/l at MDA Colony, Moradabad (S1) and the lowest value 0.01 mg/l was noted at Ramganga Bridge, Bareilly (S4) whereas it was found nill at the site Chaubari village, Bareilly (S5). The highest values of nickel at S1 in both seasons could be due the runoff and industrial release into the river water. Nickel (Ni) confirms deadly if it surpasses the allowed amount in edibles. Nickel contribution was <1% at site S4 and S5 while contributing maximum of 15% at site S1 **(Figure 6-10)**.

Iron

According to BIS, the acceptable limit of iron is 0.3 mg/L (300 µg/L). The occurrence of iron in river water ranges

1.02 to 1.41 mg/L in summers and from 1.01 to 1.11 mg/L in winters. Iron contributed the most (77%) amongst all heavy metal pollutant at site S5 **(Figure 10)**. All the samples exceed the acceptable limit prescribed by BIS. In the summer season maximum value 1.41 mg/l was noted at the site MDA Colony (S1), Moradabad and minimum value 1.021 mg/l at the site Chaubari village (S5), Bareilly. In winter season maximum value 1.11 mg/l was noted at the site MDA Colony (S1), Moradabad and minimum value 1.01 mg/l was observed at the site Chaubari village (S5), Bareilly. Iron values are found to be more than acceptable limit which may be assigned to the soil-water interaction **[18]**.

Lead

BIS (2012) has recommended an acceptable limit of 0.01 mg/L (10 µg/L) for lead in drinking water. The maximum value 0.56 mg/l was observed at the site MDA Colony (S1), Moradabad and the minimum value 0.006 mg/l was noted at the Ramganga Bridge (S4) and Chaubari village (S5), Bareilly respectively in the summer season. Highest value observed could be due to the high release of lead containing effluent into the river. No contribution of lead was observed at site S4 and S5 while it was maximum at site S1 (7%) **(Figure 6-10)**.

Table 1: WHO and BIS Standards for different parameters used

Total Toxic metal	WHO 1993	BIS 10500-2012			
	Health-based guideline by WHO	Requirement (acceptable limit)		Permissible limit in the absence of alternative source	
	(mg/L)	(mg/L)	(µg/L)	(mg/L)	(µg/L)
Chromium (Cr)	0.05	0.05	50	No relaxation	
Copper(Cu)	2.00	0.05	50	1.5	1500
Iron (Fe)	No guideline	0.3	300	No relaxation	
Lead (Pb)	0.01	0.01	10	No relaxation	
Nickel(Ni)	0.02	0.02	20	No relaxation	

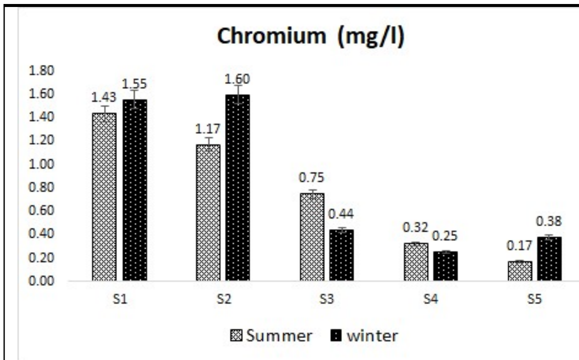

Figure 1: Chromium (Cr) values of different sites in summer and winter season

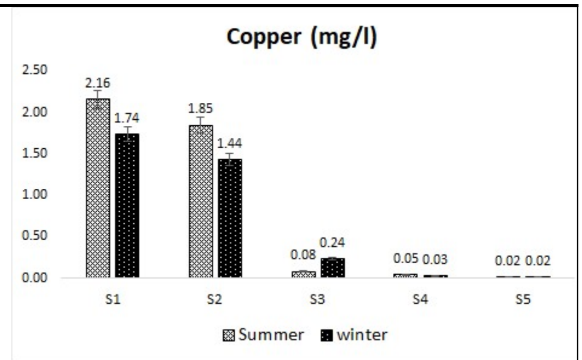

Figure 2: Copper (Cu) values of different sites in summer and winter season

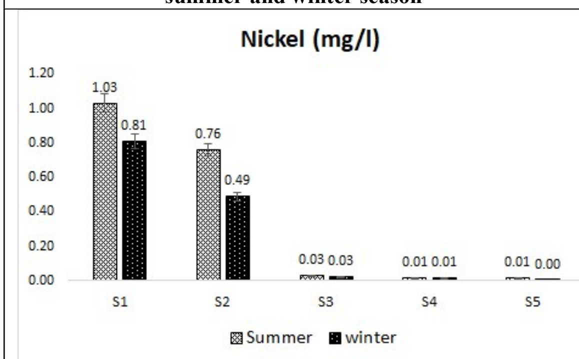

Figure 3: Nickel (Ni) values of different sites in summer and winter season

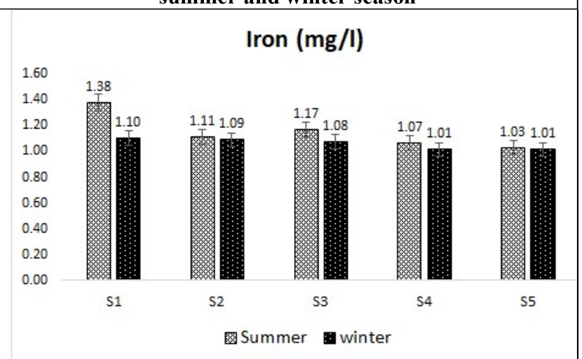

Figure 4: Iron (Fe) values of different sites in summer and winter season

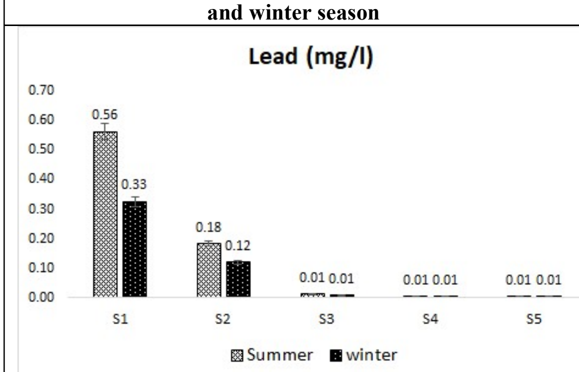

Figure 5: Lead (Pb) values of different sites in summer and winter season

Figure 1-5: Heavy metal concentration at different sites of Moradabad and Bareilly in summer and winter season

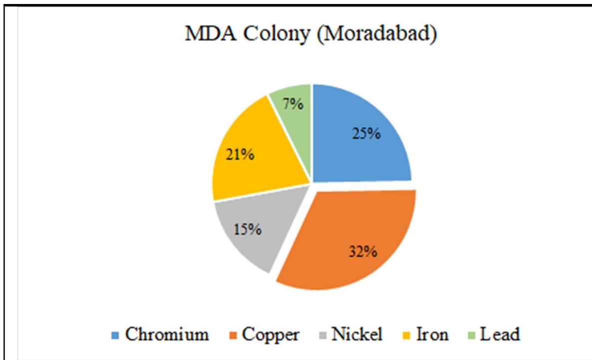

Figure 6: contribution of heavy metal pollution in percentage at site S1

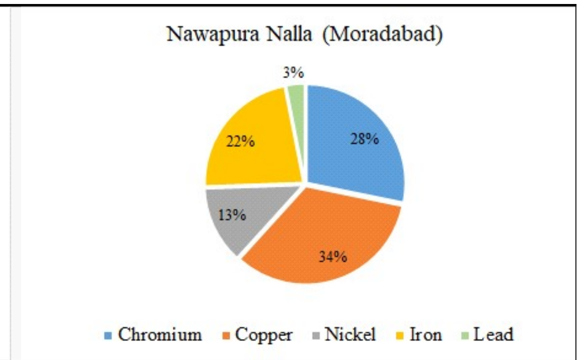

Figure 7: contribution of heavy metal pollution in percentage at site S2

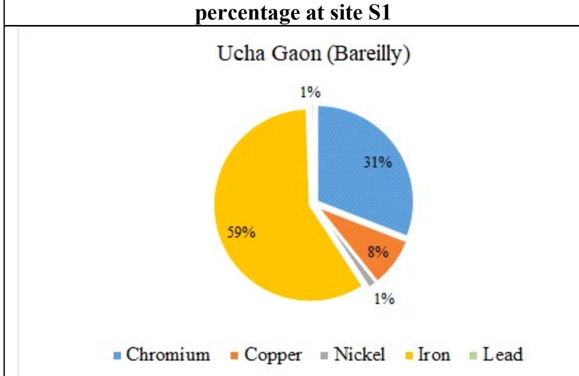

Figure 8: contribution of heavy metal pollution in percentage at site S3

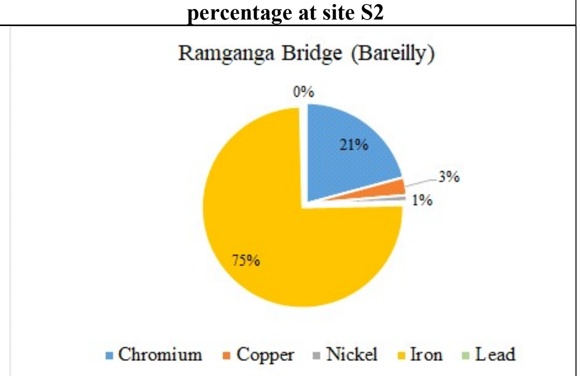

Figure 9: contribution of heavy metal pollution in percentage at site S4

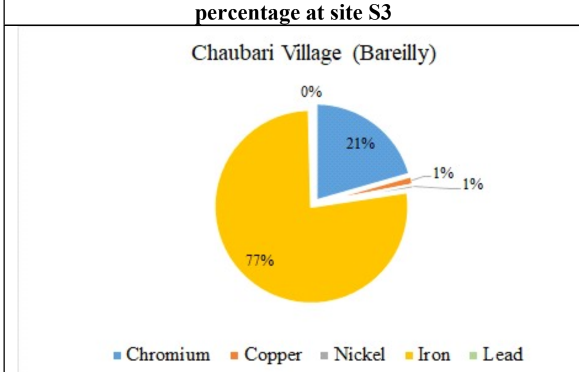

Figure 10: contribution of heavy metal pollution in percentage at site S5

Figure 6-10: Distribution of metals in River Ramganga at different sites during the whole year 2018

CONCLUSION

The results of this study showed that the monitored water sample of river Ramganga in Moradabad and Bareilly stretch were found to be polluted in heavy metal contamination. Only a few samples were under the permissible limit of drinking water given by BIS/WHO. Amongst the heavy metals assessed, Chromium and Nickel, were found to be higher than the recommended limit while copper, iron and lead were detected in all the samples but mostly under permissible limits. The study revealed that water of river is found most polluted during the summer season and low during the winter. It is also concluded that river was found most polluted at the sites situated at Moradabad, which could be associated with the industrial activities and less polluted at the sites situated at Bareilly. It is recommended that potable water sources in the study area should be routinely monitored to ascertain its suitability for drinking and other purposes.

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