ASSESSMENT OF HEAVY METAL IMPURITY IN GANGA RIVER, UTTARAKHAND, INDIA

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Abstract: The present investigation was conducted to assess the contamination of heavy metals in Ganga River. The samples of Ganga water were collected from six sampling sites namely Goumukh, Gangotri, Uttarkashi, Rishikesh, Bhimgoda Barrage (Haridwar) and Railway Bridge (Roorkee). The samples were analyzed for six heavy metals *viz.*, iron, zinc, copper, chromium, lead and manganese seasonally during March 2009 to February, 2010. The results revealed that seasonal variation occurred in heavy metal concentration at different sampling sites of Ganga River and it might be due to the many anthropogenic and hydro-geological activities. Water samples from Railway Bridge (Roorkee) showed the maximum concentration of Fe (0.21mg/l), Cr (0.046 mg/l), Pb (0.049 mg/l) and Mn (0.086) respectively. Therefore, the present study emphasized the need of regular monitoring of Ganga River water to keep away from the contamination of heavy metals in the water.

Keywords: Heavy metals, Ganga River, anthropogenic and hydro-geological activities.

1. INTRODUCTION

River Ganga is the largest riverine system, originating from the Gangotri glacier in the Himalayan Mountains, at an elevation of 7138 m above the sea level. While travelling the long distance from Gangotri to Bay of Bengal, it crosses many states like Uttarakhand, Uttar Pradesh, Bihar, West Bengal, etc. and receives many chemical substances coming from different routes. The toxic compound (metals usually), has either natural or manmade origin (Kar *et al.*, 2008). Metal in water occur as complex and mixture of soluble and insoluble form, such as ionic species, inorganic and organic complexes associated with colloids and suspended particulate matter. Metals are probably the most harmful pollutants because of their non-biodegradable nature. Once these chemicals enter into the water channel, severely get acted on the aquatic life. When the water is used for the consumable purpose may also get incorporated into the human tissues and organs, thus affecting the proper metabolic activities. Heavy metal intake through the water bodies may also result into the carcinogenic effect inducing tumor promotion. Sometimes, it may lead into fatal condition also (Schwartz, 1994). Due to the deposition of the heavy metals, the total biogeochemical cycle have altered dramatically (Azini *et al.*, 2003). The transport of pollutant into the inland water bodies have come into attention recently (Pandey and Pandey, 2009; Thornton and Dise, 1998). On seeing the health risk associated with the heavy metals, people start thinking about that how to prevent accumulation of these chemicals into the water bodies (Pandey and Pandey, 2009; Pandey and Pandey, 2009; Voutsa *et al.*, 1996).This paper mainly deals with the accumulation of heavy metals into the Ganga River, thus toxicating and disturbing the whole phenomenon associated with it.

2. Material and Methods

2.1 Study area

The water samples were collected from the six different sites, along the river Ganga viz. Goumukh, Gangotri, Uttarkashi, Rishikesh, Bhimgoda barrage (Haridwar) and Railway Bridge (Roorkee). The detailed description of the sampling sites is given in the Table 1.

Table 1: Sampling Stations and their geo-coordinates of Bhagirathi River

S.No.	Name of study sites	Geo-coordinates
1.	Goumukh	30° 47' 25.19" N, 79° 04' 6.00" E
2.	Gangotri	30° 58' 48.00" N, 78° 55' 48.00" E
3.	Uttarkashi	30° 43' 48.00" N, 78° 27' 0.00" E
4.	Rishikesh	30° 5' 13.77" N, 78° 16' 5.20" E
5.	Bhimgoda barrage	29° 57' 22" N, 78° 10' 48" E
6.	Railway Bridge Roorkee	29° 51' 01" N, 77°52' 48" E

2.2 Collection of water samples

Water samples were collected by grab sampling method. Sampling was done seasonally from March 2009 to February 2010. Mainly sampling was divided into three seasons *viz.* summer (March- June), monsoon (July-October) and winter (November- February). Sterilized Tarson bottles were used for the sampling purpose. Mainly heavy metals contamination in river Ganga from different sites was assessed during this period. For preserving the heavy metal concentration into the sample concentration HNO_3 is added.

2.3 Analysis procedure of water samples

Some heavy metals like Iron, Copper, Zinc, Chromium, Lead and Manganese were focused mainly for the analysis during the study of one year i.e., March 2009 to February 2010. Iron, Copper, Manganese and Zinc are crucial micronutrient required by plants and animals for performing various life processes. Atomic Adsorption Spectroscopy was used for analyzing the respective heavy metals at different specifies wavelengths. The wavelength at which iron was analyzed was 248.3 nanometers (nm), Copper at 324.7nm, Zinc at 213.9nm, Chromium at 357.9nm, Lead at 217.0nm and Manganese at 279.5nm respectively.

3. Results and Discussion

Seasonal variation in values of six heavy metals in Ganga at all the six sampling sites namely Goumukh (Site-1); Gangotri (Site-2); Uttarkashi (Site-3); Rishikesh (Site-4); Bhimgoda Barrage, Haridwar (Site-5) and Railway Bridge, Roorkee (Site-6) are presented in Table 2.

Iron: An increasing level of iron may significantly change both the structure and functioning of freshwater ecosystems. At a high level of iron cause the Eco toxicological effect on the biological system in the water body (Vuori, 1995). The minimum concentration of iron was found as 0.01 mg/L at site-1 during winter season, while maximum was recorded as 0.421 mg/L (within the permissible limit of BIS and WHO) at S-6 site during the winter season. The desirable concentration of iron at all sites within the permissible limit (0.3-0.5 mg/L) as per BIS (2005) and WHO (1993) standards (Table 3). Iron is the metallic pollutants it may be high due to weathering

of rocks, industrial waste and anthropogenic sources like metal, steel and other types of pipes. Therefore, its deficiency and increasing concentration cause the harmful effects on plants as well as animals (Anonymous, 2008).

Zinc (Zn): Zinc is an essential component in biological systems. But extreme concentration in water body may cause an adverse aesthetic effect. The scarcity of zinc in the human body may result in infantilism and impaired wound healing. Zinc concentration was found as below the detectable limit in Goumukh, Gangotri, Uttarkashi and Rishikesh. Whereas, maximum zinc value was found as 0.125 mg/L at Bhimgoda Barrage (Site-5) during the summer season, which was observed well below than its desirable limit (1.5 mg/L) of BIS, 2005 and WHO, 1993 (5mg/l). The high concentration could be attributed to human activities such as the use of chemicals and zinc-based fertilizers (Beg *et al*., 2008).

Copper (Cu): It plays a vital role in hemopoiesis maintenance of vascular and skeleton integrity and function of the nervous system. Copper concentration was found as below the detectable limit in Goumukh, Gangotri, Uttarkashi and Rishikesh. Cu value ranged from 0.003-0.026 mg/L in Site-4, 5 and 6, which occurred within the permissible limits of BIS, 2005 (1.5mg/l) and WHO, 1993 (2.0mg/l). The maximum concentration of copper metal was found as 0.026 in Railway Bridge at Roorkee during the monsoon season. Copper is a necessary metal required by all living organisms in some of their enzyme systems but higher concentration it works as essentially a pollutant. Copper is useful to the human body in very small concentration, but at higher concentration of 25 mg/100 gram copper can be poisonous. Cu is an essential component of numerous key metal enzymes, which are critical in melanin myelin formation and cross-linking of collaged and Dustin. It plays a vital role in hemopoiesis maintenance of vascular and skeleton integrity and function of the nervous system.

Chromium (Cr): It is one of the vital nutrients for numerous living organisms only in trace amount (Okendro *et al*., 2007 and Sati and Paliwal, 2008). But the excessive concentration of chromium in drinking water is toxic to the living organisms from a health point of view. Copper concentration was found as below the detectable limit in Goumukh, Gangotri, Uttarkashi and Rishikesh. Chromium was detected 0.046 mg/L as maximum concentration at Railway bridge road, Roorkee during summer season. Kar *et al*., 2008 found the similar chromium concentration (0.010-0.018mg/l) in Ganga River in West Bengal, India. The BIS (2005) and WHO (1993) has prescribed its desirable limit up to 0.05 mg/L, but there is permissibility beyond this range.

Lead (Pb): Maximum concentration of lead was found as 0.049 mg/l in Railway Bridge, Roorkee during monsoon season and there were also its concentration in Goumukh, Gangotri, Uttarkashi and Rishikesh were found as below the detectable limit. The permissible limits of lead are 0.1 mg/l (BIS, 2005) and 0.01mg/l (WHO, 1993). Therefore, the lead concentration at Railway Bridge during monsoon season was found beyond the desirable limits according to WHO standards. It might be due to the discharge of lead-containing material from industrial activities and other anthropogenic lead contaminants into the water body at that particular site. The

higher concentration of lead cause harmful effects and plants and animals. It may cause anaemia, kidney disease and nervous disorder in animals and human beings.

Manganese (Mn): Manganese is an essential trace element for plants, animals and human beings. It occurred naturally with iron and found in water as well as soil. The compounds of manganese might be present in the atmosphere as suspended particulates resulting from emissions from industries, soil erosion, and volcanic emission and burning of Methylcyclopentadienyl Manganese Tricarbonyl (MMT) containing petrol (IPCS, 1999). Higher Concentration of Mn was found as 0.086 mg/l in Railway Bridge during summer season and found as below the detectable limit in Goumukh, Gangotri, Uttarkashi and Rishikesh. The permissible limits of lead are 0.1-0.3 mg/l (BIS, 2005) and 0.01mg/l (WHO, 1993).

Table 2 Seasonal variations in heavy metal concentration in Ganga River

Parameters	Goumukh (Site-1)			Gangotri (Site-2)			Uttarkashi (Site-3)			Rishikesh (Site-4)			Bhimgoda Barrage (Site-5)			Railway Bridge Roorkee (Site-6)		
	Sum	Mon	Win	Sum	Mon	Win	Sum	Mon	Win	Sum	Mon	Win	Sum	Mon	Win	Sum	Mon	Win
Fe (mg/l)	0.014	0.021	0.010	0.015	0.022	0.012	0.016	0.024	0.013	0.019	0.028	0.017	**0.374**	0.246	0.308	0.363	0.349	**0.421**
Zn (mg/l)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.125	0.01	0.094	0.054	0.029	0.01
Cu (mg/l)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.003	0.002	0.021	0.006	0.026	0.003
Cr (mg/l)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.002	0.012	0.003	**0.046**	0.039	0.017
Pb (mg/l)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.004	0.005	0.001	0.005	**0.049**	0.003
Mn (mg/l)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.027	0.016	0.025	**0.086**	0.017	0.021

(ND= Not detectable)

Table 3 BIS Standard (2005) and WHO (1993) for heavy metal concentration in water

Parameters	**BIS (2005)**	**WHO (1993)**
Fe (mg/l)	0.3-0.5	0.3
Zn (mg/l)	1.5	5
Cu (mg/l)	1.5	2
Cr (mg/l)	0.05	0.05
Pb (mg/l)	0.1	0.01
Mn (mg/l)	0.1-0.3	0.1

4. Conclusion

The present study was summarized the heavy metal pollution in Ganga basin at different areas during 2009-2010. Bioaccumulation and bio magnification of heavy metal in living organism are very harmful. Hence, it is necessary to take step for minimize the load of heavy metals deposited in to the Ganga river. Least amount of iron concentration was found in Goumukh, Gangotri, Uttarkashi and Rishikesh. Whereas, Bhimgoda barrage and Railway bridge Roorkee having the maximum load of heavy metal concentration. These high concentration of selected heavy metals might be due to industrial influent discharge and dumping of other non-point and point effluent sources into the Ganga water.

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