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Some trace elements investigation in surface water of Ghaggar River

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Abstract

In the present study, a total of 21 surface water samples were collected from Ghaggar River from Haryana and Punjab regions during September (2006). Collected water samples were analyzed for seven heavy metals viz., Fe, Zn, Cu, Cd, Pb and Hg. Concentration of heavy metals in the river water exhibited the following order: Cd > Hg > Fe > Cu > Zn > Pb. High concentrations of heavy metals in the river water may be due to discharge of industrial and agricultural wastes. The obtained results will be useful for policy makers for water quality management purposes.

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Introduction

The Ghaggar, a major river of Haryana originates from the Siwalik Hills of Himachal Pradesh and Haryana. It runs along the foot of the Siwaliks Hills and flows through Haryana and Punjab to Rajasthan and then disappear itself in the sands of the Thar Desert. The selected research area covers parts of different districts of Haryana and Punjab viz., Panchkula, SAS Nagar (Mohali), Patiala, Ambala and Kaithal. At downstream sites various point and non-point sources are joining the river and discharging their wastes into it. The river water is used for bathing or drinking particularly for cattle but it is mainly exploited for dumping of industrial, municipal and agricultural wastes.

In general, heavy metals are present in trace amounts in water bodies. Some of the trace elements are useful or essential in physiological function of living beings. The deficiency of heavy metals in animals and human beings has been identified (Frienden, 1972). But at the increased level their toxicological effects were also noticed in human beings (Chapman, 1992). Chemical weathering and soil leaching are also the significant natural sources contributing the increasing of trace elements concentration in water (Drever, 1988). Al-Khashman (2008) attributed the low concentration of trace elements in water to the alkaline nature of the water. He further found that both the natural and anthropogenic sources are responsible for heavy metals pollution of water. Some anthropogenic activities like mining, disposal of treated and untreated waste effluents from industries along with indiscriminate use of heavy metal containing fertilizers, pesticides, herbicides and fungicides in agriculture resulted in deterioration of water quality causing serious health hazards on human beings (Lantzy and Mackenzie, 1979; Nriagu, 1979: Ross, 1994) and sustaining aquatic biodiversity (Ghosh and Vass, 1997; Dass, *et al.*, 1997). Several other studies have also been conducted to evaluate the heavy metal contents of various rivers like Beas (Sharma *et al.*, 1993), Ganga (Haque, *et al.*, 2005; Kar *et al.,* 2008). A decade ago Kaushik *et al.* (2000) also studied heavy metals concentration in the Ghaggar water but that was limited to the lower stretch of the river. Keeping this in view, the present study was undertaken to evaluate the heavy metal contents of the Ghaggar in the upper stretch.

Material and methods

The sampling of Ghaggar River surface water was done in between Badisher-Koti to Bhadshapur stretch from 21 sites during September (2006). Collected water samples were analyzed for iron (Fe), zinc (Zn), copper (Cu), cadmium (Cd), lead (Pb) and mercury (Hg). Samples were filtered through filter paper, Whatman No. 42, to remove the suspended impurities. Water samples were collected in narrow mouth hard polyethylene bottle of 250 ml capacity with the addition of 2 ml concentrated HNO_3 in order to preserve the metals and to avoid precipitation. Determination of water samples was carried out according to the standards fixed by APHA (2005) by using atomic absorption spectrophotometer (AAS).

Results and discussion

Table 1 is showing distributional pattern of heavy metals in the Ghaggar River water at different monitoring sites. In the river water, cadmium concentration ranged from 0.016 to 0.247 ppm. Maximum concentration was observed at Devigarh-D/S where point and non-point sources adding their effluents into the river water. Excessively high concentration of cadmium was observed in the downstream direction sites where Dhakansu Nallah mixing its industrial and municipal wastes into the main river. Cadmium metal is used in the steel industry and in plastics. Cadmium compounds are extensively used in batteries. It is released to the environment in wastewater, and diffuse pollution is caused by contamination from fertilizers and local air pollution. Cadmium is biologically non-essential and non-beneficial constituent. Excessive exposure to Cd results in severe health hazards. Cadmium accrues primarily in the kidneys and has a long biological half-life in humans of 10-35 years (WHO, 2011).

Ghaggar water contained very high concentration of Cd and even crossed maximum permissible limit of BIS (1991) in its entire route.

Table 1. Results of heavy metal analysis of ghaggar river surface water.

S. No.	Location ↓ Parameter→	Cd	Zn	Fe	Cu	Pb	Hg
1	Badisher-Koti	0.080*	0.027	0.411	0.075	BDL	0.118
2	Bijdoli-Ki-Doli	0.076	0.027	0.389	0.074	BDL	0.112
3	Thapali-Narda	0.054	0.030	0.295	0.118	BDL	0.045
4	Burjkotian	0.043	0.030	3.296	BDL	BDL	BDL
5	Chandimandir (J+K+G)	0.026	0.028	0.223	BDL	BDL	BDL
6	Panchkula S-3	0.023	0.035	0.228	BDL	BDL	BDL
7	Dafarpur	0.018	0.095	0.598	BDL	0.020	0.245
8	Mubarkpur-Camp	0.020	0.046	0.522	0.088	BDL	0.135
9	Bhankarpur	0.016	0.044	0.483	0.054	BDL	0.128
10	Tepla	0.028	0.071	0.655	0.055	0.020	0.234
11	Devinagar	0.022	0.062	0.601	0.050	BDL	0.098
12	Nanheri	0.021	0.060	0.565	0.042	BDL	BDL
13	Utsar	0.023	0.057	0.339	0.044	BDL	BDL
14	Surala-D/S	0.180	0.071	0.255	0.059	BDL	0.231
15	Maru	0.113	0.070	0.225	0.045	BDL	BDL
16	Devigarh-D/S	0.247	0.096	0.239	BDL	BDL	BDL
17	Mohamdpur	0.182	0.079	0.203	BDL	BDL	BDL
18	Tatiana	0.177	0.076	0.223	BDL	BDL	BDL
19	Rattakhera	0.170	0.070	0.195	BDL	BDL	BDL
20	Ratanheri-D/S	0.220	0.137	0.233	0.084	0.023	0.232
21	Bhadshapur	0.218	0.098	0.245	BDL	0.021	BDL
BIS (IS: 10500, 1991)	Desirable	0.01	5	0.3	0.05	0.05	0.001
	Max Permissible	N. R.	15	1.0	1.5	N. R.	N. R.

All the parameters are expressed in ppm, BDL = Below detection limit, N. R. = No relaxation

** Each value is mean of three replicates*

Zinc is an essential trace element found in almost all food and potable water in form of salts or organic complexes. Zinc concentration ranged from 0.027 to 0.137 ppm in the river water and maximum value was noted at Ratanheri-D/S site where Patiala Nadi discharging its wastewater into the Ghaggar river. Concentration of Zn remained well within the desirable limit of BIS (1991) for drinking. Normally levels of Zn in surface water and groundwater do not exceed 0.01 and 0.05 ppm, respectively.

Iron is an important element in human nutrition, particularly in the iron (II) oxidation state. Concentration of Fe in surface water samples varied from a minimum of 0.223 ppm to a maximum of 3.296 ppm at Burjkotian. At 9 sampling sites Fe concentration had crossed the desirable limit. At Burjkotian site its concentration was found even above the maximum permissible limit prescribed for drinking. Copper is one of the essential nutrient and a drinking water contaminant. It is used to make pipes and fittings and is present in alloys and coatings. Copper is also widely used in agriculture in the form of fertilizers, fungicides and pesticides. In the present observation, Cu concentration varied from 0.042 ppm to a maximum of 0.118 ppm at Thapali-Narda. The copper becomes toxic at higher pH level. At nearly 43% sampling sites Cu concentration was found above the desirable level of BIS (1991). At level above 2.5 mg/l, Cu imparts an undesirable bitter taste to water and at further higher level color of water is also affected (WHO, 2O11).

During the investigation, Pb contents were found almost absent in the river water. Generally, Pb is not essential for the functioning of biological systems and the exposure to this metal should be kept low. Mercury is used in the electrolytic production of chlorine, in electronic appliances, in dental amalgams and as a raw material for various Hg compounds. In the river water samples, Hg is ranged from 0.045 to 0.245 ppm with maximum value at Dafarpur. Nearly 48% sampling sites contained very high concentration of Hg above the maximum prescribed limit and hence water was unfit for drinking. Toxic effects of inorganic Hg compounds are seen basically in the kidney in both human beings and laboratory animals (WHO, 2011).

Conclusions

Summing up, it was observed that the Ghaggar River water contained very high concentration of cadmium and crossed the desirable as well as maximum permissible limit of BIS (1991). Hence, river water was unsuitable for drinking purpose as far as cadmium concentration is concerned. At nearly 43% sites, river showed high concentration of Fe and Cu above the prescribed desirable limit. Further, it was observed that in the surface water samples concentration of Zn found absent. But in the river water level of Zn concentrations remained well within the desirable limit. The concentration of metals in the river water exhibited the following order: Cd > Hg > Fe > Cu > Zn > Pb. A perusal of the Table 1 shows that there were little variations in the concentrations of Zn and Pb whereas Cd, Cu and Hg exhibiting high variations. The high concentrations of Cd and Hg in the river water may be due to discharge of industrial and agricultural wastes.

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