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Heavy Metal Pollution of Ghaggar River in Upper Reaches

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ABSTRACT
A total of 21 surface water samples were collected from river Ghaggar during May (2006). Concentrations of heavy metals viz., Cd, Zn, Fe, Cu, Pb and Hg were studied in the water of Ghaggar River all along its route in upper reaches particularly in Panchkula, Patiala, SAS Nagar (Mohali) and Panchkula districts. In the selected research area, the Ghaggar River is receiving the domestic, industrial and municipal wastewaters/effluents all along its course. All in all, the ascendancy of the analyzed heavy metals in the surface water of Ghaggar followed the sequence: Cd > Fe > Cu > Hg > Pb > Zn.
***KEYWORDS**: River Ghaggar, Heavy Metals, Health Hazards, Wastewaters, Effluents*

INTRODUCTION

Rivers are natural steam of water emptying into an ocean, sea, or other bodies of water and usually fed along its course by joining tributaries. Rivers are very important carriers of water and nutrients to regions all around the earth [1]. In the present study, the Ghaggar River was selected to evaluate the heavy metal characteristics of its surface water in upper reaches. The Ghaggar River originates from the Siwalik Hills of Himachal Pradesh and Haryana. It runs along the foot of the Siwaliks and flows through Haryana and Punjab to Rajasthan and then disappear itself in the sands of the Thar Desert. The selected study area falls within the boundaries of several states and covering parts of different districts of Haryana and Punjab. At downstream sites various point sources viz., Medkhali Nallah, Sukhna Choe, Jharmal Choe, Dhabi Nallah, Dhakansu Nallah and Patiala Nadi are joining the Ghaggar River and discharging their untreated effluents into it.

Generally, heavy metals are present in trace amounts in water. Some of the heavy metals or trace elements are essential for physiological functions of living tissue and regulate many biochemical processes. The deficiency of heavy metals is harmful. The deficiencies of heavy metals in human beings and animals have been identified [2]. The same metals, however, at increased level may have severe toxicological effects on human beings [3]. During the last decade some studies have been conducted to evaluate the physico-chemical status of the Ghaggar River [4, 5]. Therefore, monitoring these heavy metals is important for safety assessment of the aquatic environment and human health in particular.

MATERIAL AND METHODS

Sampling of Ghaggar River water between Badisher-Koti to Bhadshapur was done from 21 sites in May, 2006 (pre-monsoon season). Determination of water samples was carried out according to the standard methods fixed by APHA [6]. Collected water samples were analyzed for Fe, Zn, Cu, Cd, Pb and Hg. For this purpose water samples were filtered through filter paper, Whatman No. 42, to remove the suspended matter. Samples were collected in narrow mouth hard polyethylene bottle of 250 ml capacity. The water samples were acidified using HNO3 for minimizing the interference by organic matter prior to the estimation of heavy metals by atomic absorption spectrophotometer (AAS).

RESULTS AND DISCUSSION

Table 1 is showing distributional pattern of trace elements in Ghaggar River water at different monitoring sites and impact of point sources wastewaters/effluents on the river. Cadmium is released to environment in wastewater, and disperse pollution is caused by contamination from fertilizers [7]. Cadmium precipitates from solution at high pH and toxicity of it depends on pH and hardness of water [8]. Cadmium is biologically non-essential and non-beneficial constituent. In the river water, concentration of cadmium varied from a minimum of 0.016 ppm at Bhadshapur to a maximum of 0.085

ppm at Tepla. Concentration of Cd exceeded the maximum permissible limit of 0.01 ppm at all the sampling sites.

TABLE 1: RESULTS OF HEAVY METALS ANALYSIS OF GHAGGAR RIVER SYSTEM SURFACE WATER (MAY, 2006)

S.No.	Location Parameter	Cd	Zn	Fe	Cu	Pb	Hg
1	Badisher-Koti	0.043	0.059	0.294	0.094	ND	0.113
2	Bijdoli-Ki-Doli	0.041	0.055	0.282	0.098	ND	0.118
3	Thapali-Narda	0.036	0.054	0.274	0.124	ND	ND
4	Burjkotian	0.030	0.046	0.420	ND	ND	ND
5	Chandimandir (J+K+G)	0.032	0.042	0.298	ND	ND	ND
6	Panchkula S-3	0.032	0.041	0.280	ND	ND	ND
7	Dafarpur	0.026	0.045	1.500	ND	ND	0.137
8	Mubarkpur-Camp	0.041	0.043	0.334	ND	ND	0.131
9	Bhankarpur	0.032	0.054	0.312	ND	0.020	0.120
10	Tepla	0.085	0.048	1.887	0.056	ND	0.112
11	Devinagar	0.062	0.043	1.989	0.051	ND	0.080
12	Nanheri	0.061	0.045	1.856	0.045	ND	ND
13	Utsar	0.060	0.049	1.102	0.044	ND	ND
14	Surala-D/S	0.039	0.068	0.845	0.098	ND	ND
15	Maru	0.033	0.047	0.700	0.052	ND	ND
16	Devigarh-D/S	0.032	0.098	1.560	ND	0.098	ND
17	Mohamdpur	0.025	0.068	0.860	ND	ND	ND
18	Tatiana	0.024	0.067	0.858	ND	ND	ND
19	Rattakhera	0.020	0.056	0.774	ND	ND	ND
20	Ratanheri-D/S	0.018	0.045	0.522	ND	ND	ND
21	Bhadshapur	0.016	0.042	0.518	ND	ND	ND
	Desirable	0.01	5	0.3	0.05	0.05	0.001
BIS (IS: 10500, 1991)	Max Permissible	N. R.	15	1.0	1.5	N. R.	N. R.
All the parameters are expressed in ppm, ND = Not detectable, N. R = No relaxation							

.Excessive exposure to cadmium results in severe health hazards. Some adverse health effects of Cd are hypertension, growth inhibition and genetic defects.

Zinc is very essential micro-nutrient in human body but at very high concentration it may cause some poisonous effects [9]. Copper and cadmium augment the toxicity of Zn while increase in hardness decreases the toxicity. Zinc concentration in river surface water ranged from a minimum of 0.041 ppm at Panchkula to a maximum of 0.098 ppm at Devigarh-D/S. Concentration of Zn in the river water was highly influenced at Surala-D/S and Ratanheri-D/S sites due to point sources effluents viz., Dhakansu Nallah and Patiala Nadi. Zinc toxicity also increases with increase in temperature and decrease of dissolved oxygen. Zinc is highly and chronically toxic to aquatic organisms particularly to fish when the hardness of water is less and temperature is high [10]. Zinc contents in the Ghaggar remained well within the desirable limit of drinking.

Iron is an essential constituent of human nutrition. Concentration of Fe varied from 0.274 to 1.989 ppm in the selected stretch of the river. The river water quality at Dafarpur, Tepla, Devinagar and Nanheri sites has been affected by various point sources i.e. Medkhali Nallah, Dhabi Nallah and Jharmal Choe effluents. At Devigarh site high concentration of Fe was observed more than the double of the previous site concentration due to non-point pollutants mixing. Downstream to the Devigarh-D/S site concentration of Fe was slowly decreased up to the Bhadshapur. Iron contents exceeded the desirable limit of BIS in almost all the sites except uppermost reaches sites [11]. High concentration of Fe in the water imparts a bitter taste and stains the clothes, if used.

Copper is an essential trace element for human body. Copper contents ranged from a minimum of 0.052 ppm at Maru to a maximum of 0.098 ppm at Surala-D/S. In about 60% of the analyzed sampling sites, the Cu concentrations were found below the detectable limit. Due to point sources influx into the river Cu concentration was reported high in Tepla to Maru stretch. The Cu concentration exceeded the

desirable limit of BIS at Badisher-Koti, Bijdoli-Ki-Doli, Thapali-Narda, Tepla, Devinagar, Surala-D/S and Maru sites. Copper is also extensively used in agriculture in the form of fertilizers, fungicides and pesticides. It has also been established that Cu deficiency is associated with anemia, diarrhoea and demineralization of the bone of the new born baby [12]. Copper concentrations in treated water normally increase during supply, particularly in systems with an acid pH or high-carbonate water with an alkaline pH [7].

Lead concentration varied from 0.020 ppm at Bhankarpur to 0.098 ppm at Devigarh- D/S. Only two sites showed the trace amount of Pb and at Devigarh-D/S. Lead concentration was found above the desirable limit of BIS. It is not known to be essential for the functioning of biological systems and the exposure to this metal should be kept as low as possible. Exposure to high Pb is associated with a wide range of effects, including hypertension, various neurodevelopment effects, impaired fertility and adverse pregnancy outcomes [7]. Mercury concentration ranged from 0.080-0.137 ppm. In Nanheri to Bhadshapur stretch, Hg contents were not detectable. River water at Badisher-Koti, Bijodli-Ki-Doli, Dafarpur, Mubarkpur-Camp, Bhankarpur, Tepla and Devinagar sites even crossed the maximum permissible limit and hence river water was not suitable for drinking. It may pose serious health hazards, if used for drinking. After entering into the aquatic ecosystem, the inorganic mercury is changed into methyl mercury through microbial activity that is the most toxic and most bio-available type of mercury for living organisms [13, 14, 15, 16].

CONCLUSIONS

The concentration of above heavy metals in the river water exhibiting the following order: Cd > Fe > Cu > Hg > Pb > Zn. In the present study the concentration of trace elements like Cd, Fe, Cu and Hg far exceeded the maximum permissible limits of drinking at many sites. The study revealed that the Ghaggar River water contained very high concentration of Cd and crossed the desirable as well as maximum permissible limit of BIS. Hence, river water was unsuitable for drinking purpose as far as Cd concentration is concerned. River water at Tepla, Devinagar, Nanheri, Utsar and Devigarh-D/S sites even crossed the maximum permissible limit prescribed for iron concentration and water was not suitable for drinking. The observed high concentration of heavy metals particularly in downstream stations indicating substantial inputs coming from industrial, agricultural and municipal effluents through point and non-point sources all along the river route. In terms of Pb and Zn concentration river water was least contaminated. The occurrence of heavy metals in the river Ghaggar water more than that of recommended maximum permissible limit all along its route in Haryana was reported by Kaushik *et al.* [17]. They were also found that industrial, municipal and agricultural wastes from Punjab region were main sources of heavy metals pollution in the river water at downstream stations.

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