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ASSESSMENT OF HEAVY METAL CONTENTS IN SURFACE WATER OF SELECTED LOCATIONS IN RIVER BHAVANI

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ABSTRACT

Heavy metals enter into the rivers from variety of sources like mine discharge, run off, chemical weathering of rocks and soils, wet and dry fallout of atmospheric particulate matter and anthropogenic activities. In the present investigation, River Bhavani one of the major rivers in Tamil Nadu, a State in India is chosen and an attempt is made to analyse the river water for heavy metal load determined through surface water analysis. All the analysed metals, Cadmium, Chromium, Copper, Iron, Nickel, Lead, Zinc and Mercury are within the prescribed limits set by Bureau of Indian Standards. However, presence of these heavy metals even in smaller quantities in surface water is a warning signal because the sediments may have higher concentration of these heavy metals. Because heavy metals pollution is less visible but its effects on the ecosystem and humans can be intensive and very extensive when compared to other types of aquatic pollution, concerned authorities should wake up and take steps to contain the quantum of such heavy metals present in surface water.

KEY WORDS: **Heavy metals, River Bhavani, Bureau of Indian Standards, surface water.**

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INTRODUCTION

Heavy metals contamination in river is one of the major quality issues in many fast growing countries like India. sMaintenance of water quality, sanitation and infrastructure did not increase along with population and urbanization[1]. Trace metals enter in to the rivers from a variety of sources either through natural or through anthropogenic activities[2]. Less attention has been paid towards atmospheric deposition linked heavy metal contamination of freshwater bodies, especially rivers. In India, the data so far available on these lines have been mainly confined to acidic depositions[3]. Atmospheric deposition of pollutant aerosols is of global concern; this problem is rapidly increasing in developing countries including India due to continued population pressure coupled with accelerated urban-industrial growth and lack of efficient control measures[4]. Metals enter into river water through mine discharge, run off, chemical weathering of rocks and soils, wet and dry fallout of atmospheric particulate matter[5,6]. . Heavy metal concentration in the Upper Lake of Bhopal is a consequence of a wide range of use of chemical fertilizers in catchment area near the lake[7]. Trace metal contaminations are causing potential toxicity for the environment and human beings[8,9]. Metals like Cu, Fe, Ni and Zn are essential as micronutrients for the life processes in animals and plants while many other metals such as Cd, Cr, Pb and Co have no known physiological activities[10,11]. In the present investigation, River Bhavani one of the major rivers in Tamil Nadu, a State in India is chosen and an attempt is made to analyse the river water and its properties and pollution load of the river determined through heavy metal analysis.

MATERIALS AND METHODS

The surface water samples were collected during January 2011 for analysis of metal contamination from 10 sampling stations of River Bhavani. The samples were collected from a depth of 1 foot below the surface and kept in previously cleaned polythene containers of 500 ml capacity with the addition of 2 ml concentrated nitric acid (HNO_3) in order to preserve the metals and also to avoid precipitation. For the analysis of Mercury, samples were collected in a separate 250 ml narrow mouthed glass container with the addition of 1 ml HNO_3 + 5 ml potassium dichromate ($K_2Cr_2O_7$) as preservative. Various heavy metals like Cadmium (Cd), Chromium (Cr), Copper (Cu), Iron (Fe), Nickel (Ni), Lead (Pb), Zinc (Zn) and Mercury (Hg) were analysed. Analyses were carried out following the procedures of "The Standard Methods for the Examination of Water and Wastewater"[12]. Bureau of Indian Standards (BIS, 2004 and 2005) for river water quality has been considered for comparison of surface water metal quality.

Study area

The study area includes 10 locations starting from Bhavani Sagar Dam to Bhavani Kuduthurai of River Bhavani stretch. The locations chosen are 1. Bhavani Sagar dam, 2. Sathiyamangalam, 3. Ariyappampalayam, 4. Periyakodiveri, 5. Bangalapudur, 6. Athani, 7. Aapakkudal, 8. Thalavaipettai, 9. Jambai and 10. Bhavani Kuduthurai. The global positioning of the locations is presented in Table 1.

Table 1
GLOBAL POSITIONING DETAILS OF RIVER BHAVANI

Locations	Latitude	Longitude	Fix time
Bhavani Sagar Dam	11^0 47.8321' N	77^0 48.4167' E	FEB 22,2009,12.49 am
Sathiyamangalam	11^0 38.7247' N	77^0 45.4309' E	FEB 21,2009,11.54 pm
Ariyappampalayam	11^0 33.6661' N	77^0 44.2954' E	FEB 21,2009,11.22 pm
Periyakodiveri	11^0 47.8321' N	77^0 41.8451' E	FEB 22,2009,2.27 pm
Bangalapudur	11^0 27.0983' N	77^0 41.5489' E	FEB 21,2009,10.35 pm
Athani	11^0 25.9106' N	77^0 40.9842' E	FEB 22,2009,3.15 pm
Aapakkudal	11^0 25.0124' N	77^0 40.916' E	MARCH16, 2009, 10.47 pm
Thalavaipettai	11^0 22.9942' N	77^0 42.7541' E	FEB 21,2009,8.41 pm
Jambai	11^0 22.3000' N	77^0 43.4805' E	FEB 21,2009,8.10 pm
Bhavani Kuduthurai	11^0 25.9106' N	77^0 40.9842' E	FEB 22,2009,3.00 pm

RESULTS

Results of the analysis of different heavy metals for the 10 study locations of River Bhavani are presented in Table 2. Minimum and maximum cadmium values are 0.06 µg/l in Bhavani Sagar station, 0.32 µg/l in Aapakkudal and Bhavani Kuduthurai stations and the average was 0.2 µg/l. The minimum and maximum of chromium level was 0.08 µg/l in Sathiyamangalam, Ariyappampalayam and Aapakkudal stations and 0.14 µg/l in Jambai and Bhavani Kuduthurai stations with the average of 0.13 µg/l. Maximum level of Copper was 3.64 µg/l recorded in Jambai station, minimum of 0.4 µg/l in Ariyappampalayam and the average was 1.5 µg/l. Average Iron content was 25.15 µg/l and 79.06 µg/l was the maximum in Jambai and 4.32µg/l was the minimum in Ariyappampalayam and Periyakodiveri stations. The minimum and maximum of Nickel was 0.08 µg/l in Bhavani Sagar and Ariyappampalayam stations and 1.2 µg/l in Bangalapudur station, the average was 0.76 µg/l. Lead content of 0.72 µg/l was the maximum recorded in Periyakodiveri and Aapakkudal stations while the minimum of 0.1 µg/l was recorded in Bhavani Sagar and Ariyappampalayam stations and the average was 0.47 µg/l. Zinc content of 1.66 µg/l was the maximum in Sathiyamangalam station and minimum of 0.14 µg/l in Athani station and the average was 0.49 µg/l. Mercury was not detected in any of the stations in the present study.

Table 2
HEAVY METAL QUALITY OF RIVER BHAVANI

SI NO	SAMPLING LOCATIONS	HEAVY METALS (µg/l)							
		Cd	Cr	Cu	Fe	Ni	Pb	Zn	Hg (ng/ml)
1	Bhavani Sagar Dam	0.06	0.1	0.4	4.32	0.08	0.1	0.16	0
2	Sathiyamangalam	0.08	0.08	1.62	21.82	0.86	0.32	1.66	0
3	Ariyappampalayam	0.14	0.08	0.4	4.32	0.08	0.1	0.16	0
4	Periyakodiveri	0.18	0.1	0.9	4.32	0.96	0.72	0.36	0
5	Bangalapudur	0.14	0.12	0.96	15.26	1.2	0.5	0.18	0
6	Athani	0.32	0.1	1.4	21.82	0.82	0.66	0.14	0
7	Aapakkudal	0.32	0.08	1.4	33.54	0.86	0.72	0.2	0
8	Thalavaipettai	0.24	0.1	2.14	43.52	0.96	0.52	1.16	0
9	Jambai	0.24	0.14	3.64	79.06	0.94	0.52	0.36	0
10	Bhavani Kuduthurai	0.32	0.14	1.7	23.5	0.84	0.5	0.5	0
	Minimum	**0.06**	**0.08**	**0.4**	**4.32**	**0.08**	**0.1**	**0.14**	**0**
	Maximum	**0.32**	**0.14**	**3.64**	**79.06**	**1.2**	**0.72**	**1.66**	**0**
	Average	**0.204**	**0.1**	**1.5**	**25.15**	**0.76**	**0.47**	**0.49**	**0**
	BIS – 10500 (2004 - 2005) Desirable Limit (µg /l)	**3**	**50**	**50**	**300**	**20**	**10**	**5000**	**1**

Fig. 1. Cadmium levels in different stations of River Bhavani

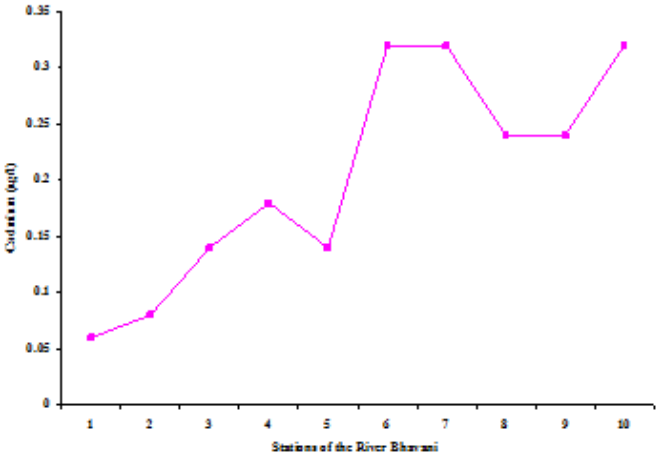


Fig. 2. Chromium levels in different stations of River Bhavani

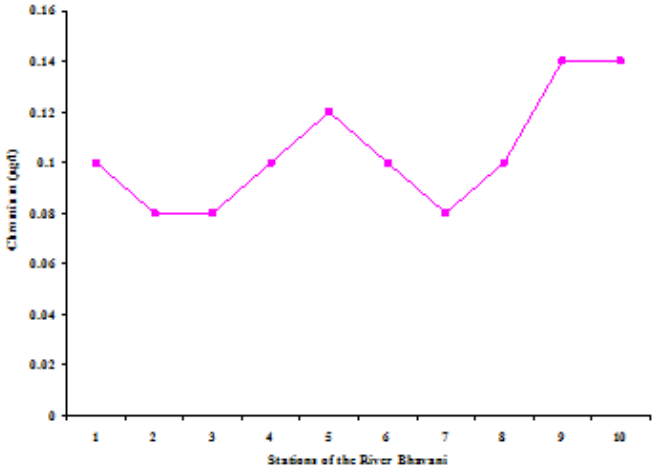


Fig. 3. Copper levels in different stations of River Bhavani

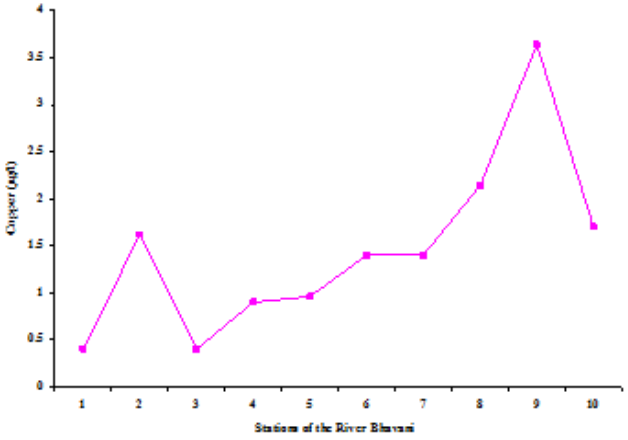


Fig. 4. Iron levels in different stations of River Bhavani

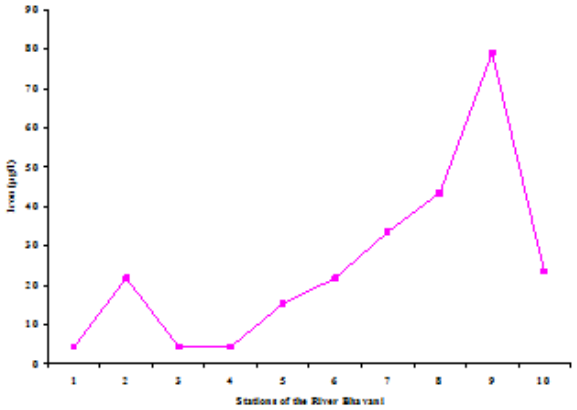


Fig. 5. Nickel levels in different stations of River Bhavani

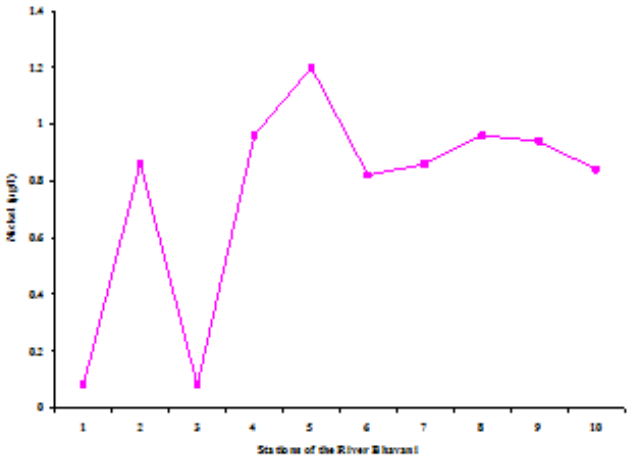


Fig. 6. Lead levels in different stations of River Bhavani

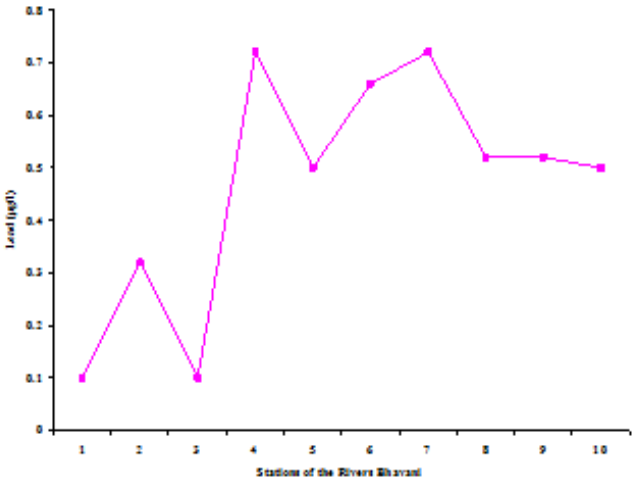
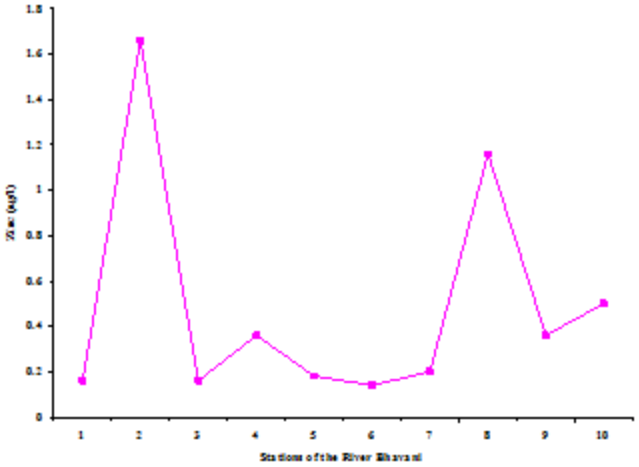


Fig. 7. Zinc levels in different stations of River Bhavani



DISCUSSION

In urban areas, the deliberate disposal of industrial effluents and other wastes contributes greatly to the contamination of the water[13]. River Bhavani flowing through urban areas is prone to influx of heavy metal containing effluents discharged from Tanneries, Dyeing units and Sugar mills without proper treatment. Effluents from sugar industry may have different amounts of heavy metals, solid particulate matter either as suspended solids or total dissolved solids that affect the light intensity of water[14]. A sugar mill in Aapakkudal station of River Bhavani adds to the woes of pollution load to this river. In textile industry, the process of dyeing produces large amounts of wastewater exhibiting intense coloration[15]. Countless textile industries are found in many stations of River Bhavani. Wastewaters from these textile industries contain different types of synthetic dyes having metals, which are mostly toxic, mutagenic and carcinogenic. Moreover, they are very stable to light, temperature and microbial attack, making them recalcitrant compounds reported[16]. The discharge of the wastewaters into receiving streams not only affects the aesthetic nature but also interferes with transmission of sunlight into streams and therefore reduces photosynthetic activity[17]. Physico-chemical changes in the aquatic environment due to the above-mentioned industries located in River Bhavani were those most frequently recorded as the primary cause of harm to aquatic organisms and the presence of heavy metals in these aquatic ecosystems causes serious impact on the biological components[18,19]. Elemental pollutants are essentially immutable by any biological and physical process, whereas organic substances are mineralized into relatively non-toxic constituents[20].

Heavy metal pollution of aquatic environment has become a great concern in recent years because they are very harmful as a result of their non-biodegradable nature, long biological half-life and their potential to accumulate in different body parts of organism. They can also be concentrated along the food chain, producing their toxic effect even at points far removed from the source of pollution. In the present investigation heavy metal concentration of River Bhavani was within the prescribed limits set by Bureau of Indian Standards, but among the USEPA listed most common potential toxic elements cadmium, chromium, copper, nickel, lead and zinc are found to be present in the water samples. Metal containing effluents released into the river may results in accumulation of these metals in aquatic organisms and the remaining portions may be detected in the analysis. This was amply supported by Agarwal et al[21] who suggested fish are used as bio indicator of aquatic ecosystems for estimation of heavy metal pollution and potential risk for human consumption. Heavy metals discharged from various industries have tendency to accumulate in various organs of organisms especially fish, which in turn may enter into the human metabolism through consumption causing serious health hazards[22]. The accumulation of heavy metals in the tissues of fishes may cause various physiological defects and mortality[23]. Heavy metals accumulated in the tissues of aquatic animals may become toxic when accumulation reaches a substantially high level[24].

CONCLUSION

Even though the heavy metals analysed are within the prescribed limits set by Bureau of Indian Standards their presence in smaller quantities itself is the indication that the levels may go up with the increased industrialization and urbanization. It is suggested enough precautionary measures should be taken before the levels cross the danger line.

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