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Estimation of heavy metal contents in surface water of river Cauvery in Salem, erode and Namakkal district, Tamil nadu, India

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ABSTRACT

Heavy metals find their entry into fresh water bodies form various sources like agricultural run off, mine discharge, chemical weathering of rocks and soils, wet and dry fallout of atmospheric particulate matter and in recent times more through anthropogenic activities. In the present investigation, River Cauvery one of the major rivers in India is chosen and an attempt has been made to analyse the heavy metal load of the river determined through surface water analysis. The results showed that all the metals are within the prescribed limits set by Bureau of Indian Standards and WHO 2006. However, presence of these heavy metals even in smaller quantities in surface waters is a warning signal sine there is a danger that the sediments may have more concentration of these metals. Because heavy metals pollution is less visible but its effects on the ecosystem and man can be intensive and very extensive when compared to other types of aquatic pollution. Hence, it is suggested that concerned authorities should wake up and take steps to contain the quantum of such heavy metals present in surface waters.

Introduction

Heavy metals contamination in river is one of the major quality issues in many fast growing countries including India. Maintenance of water quality, sanitation and infrastructure did not increase along with population and urbanization (Ahmad *et al*., 2010). Trace metals enter in to the rivers from variety of sources either through natural or through anthropogenic activities (Akoto *et al*., 2008).

Less attention has been paid towards atmospheric deposition linked heavy metal contamination of freshwater bodies, especially the rivers. In India, the data so far available on these lines have been mainly confined to acidic depositions (Kumar *et al*., 2001). 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 (Singh and Agrawal, 2005).

Metals enter into river water through mine discharge, agricultural run off, chemical weathering of rocks and soils, wet and dry fallout of atmospheric particulate matter (Singh *et al*., 2008; Venugopal *et al*., 2009). Trace metal contaminations are causing potential toxicity for the environment and human beings (Lee *et al*. 2007; Adams *et al*., 2009). 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 (Kar *et al*., 2008 ; Aktar *et al*., 2009).

In the present investigation, River Cauvery one of the major rivers in India is chosen and an attempt has been 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 for analysis of metal contamination studies from 10 sampling stations of River Cauvery during January 2011. The samples were collected from a depth of 1foot 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. Heavy metals 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"(APHA, 1998). Bureau of Indian Standards BIS (2004 and 2005) and WHO (2006) for river water quality has been considered for comparison of surface water metal quality.

Study area:

The study area includes 10 stations starting from Stanly Reservoir to Odapalli of River Cauvery stretch. The spots chosen are 1. Stanly Reservoir of Salem District 2. Nerinjipettai, 3. Uratchikottai 4. Komarapalayam 5. Bhavani Kudu thurai 6. R. N. Pudur 7. B. P. Agraharam 8. Vairapalayam of Erode District and 9. Pallipalayam and 10. Odapalli of Namakkal District **(Table 1).**

Results

The water quality monitoring study was carried out in River Cauvery in January 2011. During the study period water samples for heavy metal quality were analyzed and their results are presented in **Table 2**. Minimum cadmium levels of 0.14 µg/l recorded in Uratchikottai station, maximum of 0.32 µg/l in Bhavani Kudu thurai station and the average was 0.21 µg/l. The minimum and maximum of chromium levels were 0.04 µg/l in Uratchikottai and 0.62 µg/l in B. P. Agraharam**.** Average of the river was 0.13 µg/l. Maximum level of Copper was (3.32 µg/l) recorded in B. P. Agraharam station, minimum of 0.38 µg/l in Komarapalayam station and the average was 1.6 µg/l. Average Iron content was 21.93 µg/l and 62.7 µg/l in B. P. Agraharam and minimum of 1.62 µg/l in Uratchikottai station were recorded.

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Table 1. Global positioning details of river cauvery

Station ID	Latitude	Longitude	Fix time
Stanly Reservoir	11^0 47.8321 N	77^0 48.4167' E	FEB 22,2009,12.4 am
Nerinjipettai	11^0 38.7247 N	77^0 45.4309' E	FEB 21,2009,11.5 pm
Uratchikottai	11^0 47.8321 N	77^0 41.8451' E	FEB 22,2009,2.2 pm
Komarapalayam	11^0 27.0983 N	77^0 41.5489' E	FEB 21,2009,10.3 pm
Bhavani Kuduthurai	11^0 25.9106 N	77^0 40.9842' E	FEB 22,2009,3.0 pm
R. N. Pudur	11^0 25.0124 N	77^0 40.916' E	MAR16, 2009 10.27 pm
B. P. Agraharam	11^0 22.9942 N	77^0 42.7541' E	FEB 21,2009,8.4 pm
Vairapalayam	11^0 22.3000 N	77^0 43.4805' E	FEB 21,2009,8.1 pm
Pallipalayam	11^0 20.9635 N	77^0 45.2311' E	FEB 21,2009,1.5 pm
Odapalli	11^0 20.4294 N	77^0 45.3962' E	FEB 22,2009,12.2 pm

The Minimum and maximum levels of Nickel content in River Cauvery were 0.02 µg/l in Ponni Sugars station and 1.34 µg/l in B. P. Agraharam respectively, the average was 0.63 µg/l. As for as lead is concerned, 0.96 µg/l was recorded as the maximum in Vairapalayam station. The minimum of 0.02 µg/l was recorded in Uratchikottai station and the average was 0.49 µg/l. Zinc content of 0.68 µg/l was recorded in Stanley Reservoir station and minimum of 0.02 µg/l in Uratchikottai and Komarapalayam stations and the average was 0.2 µg/l. A maximum of 0.006 µg/l mercury was detected in Stanly Reservoir and Uratchikottai stations and no trace of mercury was detected in other stations

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

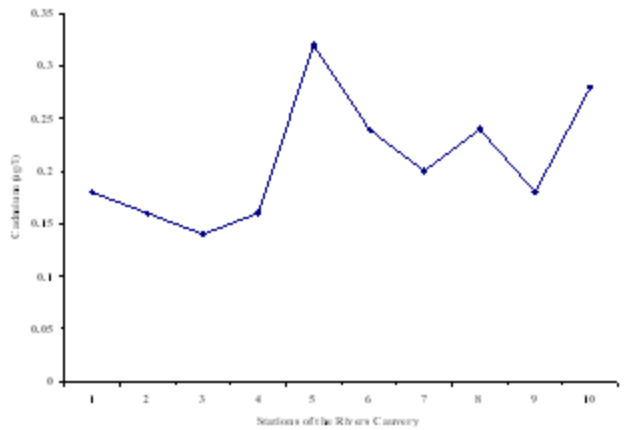


Fig. 2. Chromium levels in different stations of River Cauvery

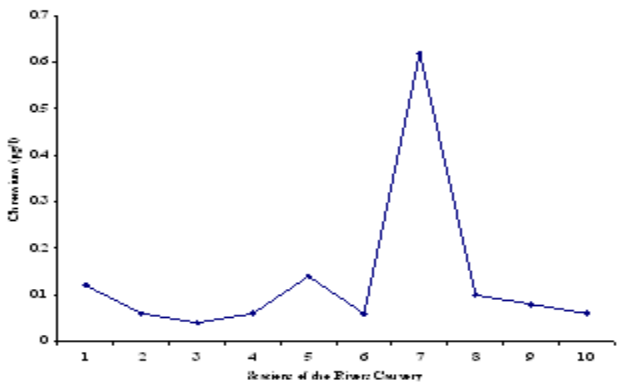


Fig. 3. Copper levels in different stations of River Cauvery

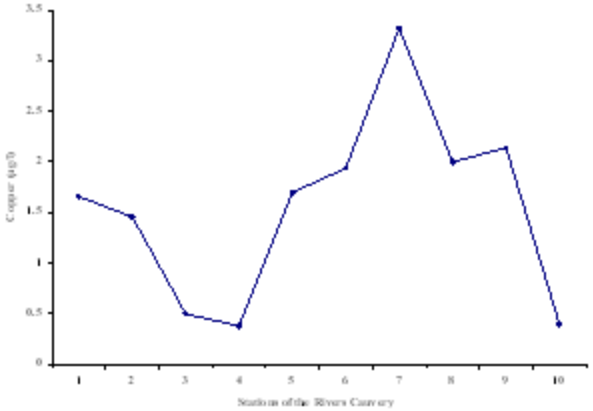


Fig. 4. Iron levels in different stations of River Cauvery

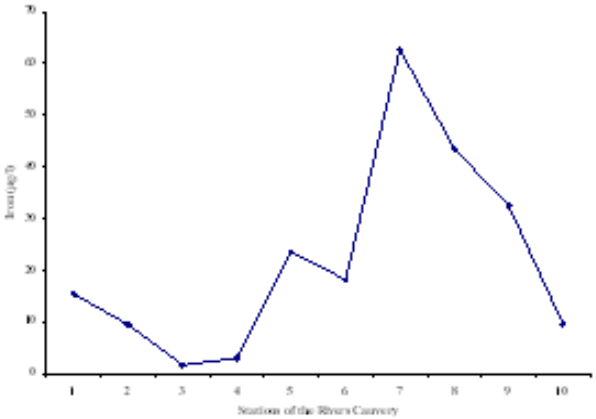


Fig. 5. Nickel levels in different stations of River Cauvery

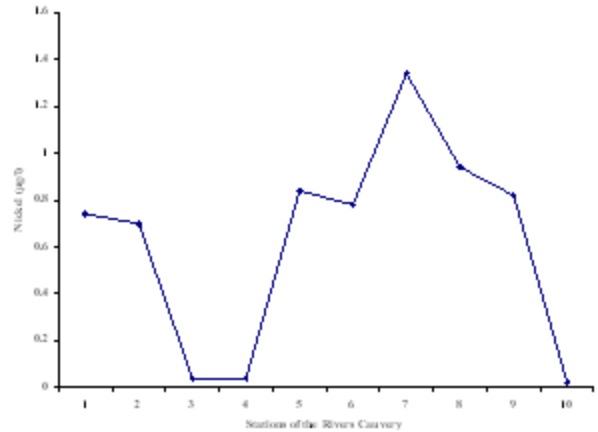


Fig. 6. Lead levels in different stations of River Cauvery

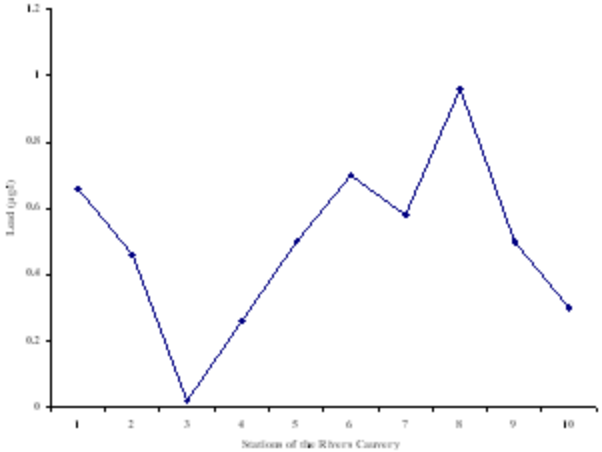
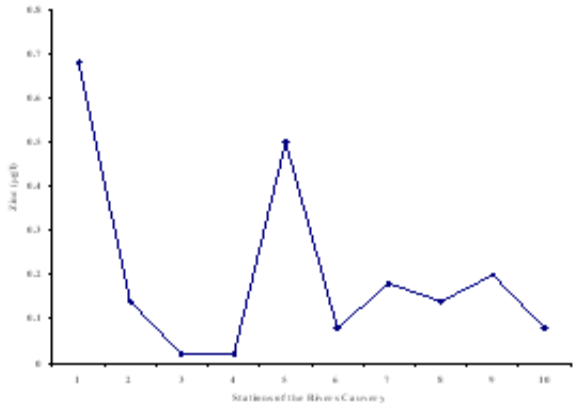


Table 2. The levels of heavy metals detected in various stations of River Cauvery during January 2011

SI NO	SAMPLING LOCATIONS	HEAVY METALS (µg/l)							
		Cd	Cr	Cu	Fe	Ni	Pb	Zn	Hg
1	Stanley Reservoir	0.18	0.12	1.66	15.36	0.74	0.66	0.68	0.006
2	Nerinjipettai	0.16	0.06	1.46	9.46	0.7	0.46	0.14	0
3	Uratchikottai	0.14	0.04	0.5	1.62	0.04	0.02	0.02	0.006
4	Komarapalayam	0.16	0.06	0.38	2.94	0.04	0.26	0.02	0
5	Bhavani Kuduthurai	0.32	0.14	1.7	23.5	0.84	0.5	0.5	0
6	R. N. Pudur	0.24	0.06	1.94	18.14	0.78	0.7	0.08	6
7	B. P. Agraharam	0.2	0.62	3.32	62.7	1.34	0.58	0.18	0
8	Vairapalayam	0.24	0.1	2	43.52	0.94	0.96	0.14	0
9	Pallipalayam	0.18	0.08	2.14	32.46	0.82	0.5	0.2	0
10	Odapalli	0.28	0.06	0.4	9.58	0.02	0.3	0.08	0
	Minimum	0.14	0.04	0.38	1.62	0.02	0.02	0.02	0
	Maximum	0.32	0.62	3.32	62.7	1.34	0.96	0.68	0.006
	Average	0.21	0.13	1.6	21.93	0.63	0.494	0.204	0.0018
Permissible limits	BIS – 10500 (2004 - 2005) Desirable Limit	3	50	50	300	20	10	5000	1
	WHO 2006 Desirable Limit	3	50	2000	NG	70	10	NG	6

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



Discussion

In urban areas, the deliberate disposal of industrial effluents and other wastes contribute greatly to the contamination of the water (Islam, 2010). River Cauvery, flowing through urban areas is the recipients of heavy metal containing effluents discharged from Tanneries and Dyeing units which are not properly treated. Major problems are due to wastewaters of these industries contain heavy metals, toxic chemicals, chloride, lime with high dissolved and suspended salts and other pollutants (Uberoi, 2003). During tanning process at least 300kg chemicals are added per ton of hide (Verheijen *et al*., 1996). Countless tanneries are found around B. P. Agraharam station of River Cauvery.

In textile industry, the process of dyeing produces large amounts of wastewater exhibiting intense coloration (Mohorcic *et al*., 2006). Countless textile industries are found along many stations of River Cauvery. 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 (Kokol *et al*., 2007). The discharge of these wastewaters into receiving streams not only affects the aesthetic nature but also interferes with transmission of sunlight into streams and therefore reduces photosynthetic activity (Cicek *et al*., 2007).

Physico-chemical changes in the aquatic environment due to the above mentioned industries located along the River Cauvery were those most frequently recorded as the primary cause of harm to aquatic organisms. Especially the presence of heavy metals in these aquatic ecosystems causes serious impact on the biological components (Mergler *et al*., 1994; Doyle *et al*., 2003). Elemental pollutants are essentially immutable by any biological and physical process, whereas organic substances are mineralized into relatively non-toxic constituents (Vagnetti *et al*., 2003).

Of heavy metal pollution of aquatic environment has become a great concern in recent years because they are very harmful they are non-biodegradable in nature, long biological half-life and their potential to accumulate in different body parts of organism. In the present investigation heavy metal concentrations of River Cauvery are within the prescribed limits set by Bureau of Indian Standards and WHO standards, but among the USEPA listed most common potential toxic elements cadmium, chromium, copper, nickel, lead, mercury and zinc are present in the water samples.

Metal containing effluents released into the river may result 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*., (2007) 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 (Sen *et al*., 2011). The accumulation of heavy metals in the tissues of fishes may cause various physiological defects and mortality (Torres *et al*., 1987). Heavy metals accumulated in the tissues of aquatic animals may become toxic when accumulation reaches a substantially high level (Kalay and Canli, 2000).

Conclusion:

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

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