

Distribution of heavy metals in estuaries of southeast coast of India

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Concentration of Zn in water showed higher level in the Vellar estuary when compared to other areas. The Zn and Cu level in sediment was found to be higher in Vellar and Uppanar estuary respectively largely due to their sediment texture and source of metal. A distinct seasonal pattern of both water and sediment metal concentration was observed with higher levels coinciding during monsoon and lower values during summer period.

The fate and behaviour of the heavy metals in the estuarine environment are of extreme importance due to their key role in the biogeochemical cycles. The distribution pattern of heavy metals such as copper, zinc, cadmium and lead in water and sediments from Uppanar (lat. 11°42'N, long. 79°46'E), Vellar (lat. 11°29'N, long. 79°46'E) and Kaduviar (lat. 10°49'N, long. 79°51'E) estuaries located in the southeast coast of India (Fig. 1), is presented in the paper.

The water and sediment samples were collected from three estuaries during October 1986 to September 1988 at monthly intervals. Surface water samples were collected with pre-cleaned polythene bottles. The sample pH were adjusted to 4 ± 0.1 using 50% HNO₃ and brought to the laboratory and filtered immediately through 0.4 μ millipore HA membrane filter. Metals were then preconcentrated by APDC and MIBK¹ chelation and solvent extraction technique and quantified using an atomic absorption spectrophotometer (Perkin Elmer model 373). The precision was found to be ± 0.05 for copper and zinc and ± 0.01 for cadmium and lead.

The sediment samples were collected with the aid of peterson grab and placed in polyethylene bag and were frozen in the laboratory until further treatment. The preserved sediment samples were dried at 110°C to constant weight for estimation of metals. For extraction of metals from the sediments, an improved acid digestion procedure was adopted². The percentage recovery using NIES reference sediment was found to be 95, 96, 94, 94 for copper, zinc, cadmium and lead respectively.

The concentration of zinc in water showed higher levels in the Vellar estuary (25.51 $\mu\text{g.l}^{-1}$) when

compared to other two areas (Uppanar-19.20 $\mu\text{g.l}^{-1}$; Kaduviar-14.75 $\mu\text{g.l}^{-1}$). This may be due to more discharge of zinc containing fertilizers, pesticide and rodenticide residues from the nearby agricultural fields. The concentration of cadmium and lead both in water and in sediment showed insignificant differences between estuaries since their input is quite less into the systems. The zinc in sediment of Vellar estuary showed higher level (60.10 $\mu\text{g.g}^{-1}$) when compared to the other estuaries (Uppanar-50.57 $\mu\text{g.g}^{-1}$; Kaduviar-43.93 $\mu\text{g.g}^{-1}$). This is because of the clayey nature of sediment that would facilitate higher adsorption of metals³⁻⁵.

Higher values of metal concentration were associated with large amount of land and river drainage during the monsoon (Oct.-Nov.) season. Lower levels were observed during summer period (April-June) due to poor sources and active utilisation of metals by organisms.

The metal concentration in water and sediment was found to increase and vice versa indicating a significant inverse relationship (Table 1) as reported earlier in Zuari estuary⁶, and in Pitchavaram mangroves⁷. The inverse relationship between metals in water and salinity was attributed to the dilution of metal rich river water by metal impoverished seawater and rapid sedimentation processes in the estuary. In addition, the sharp increase in salinity as the freshwater mixes with seawater would result in the precipitation and coagulation of colloidal clay particles and coprecipitation of metal with/or adsorption on to the particles and remove considerable amount of metals from the solution⁸.

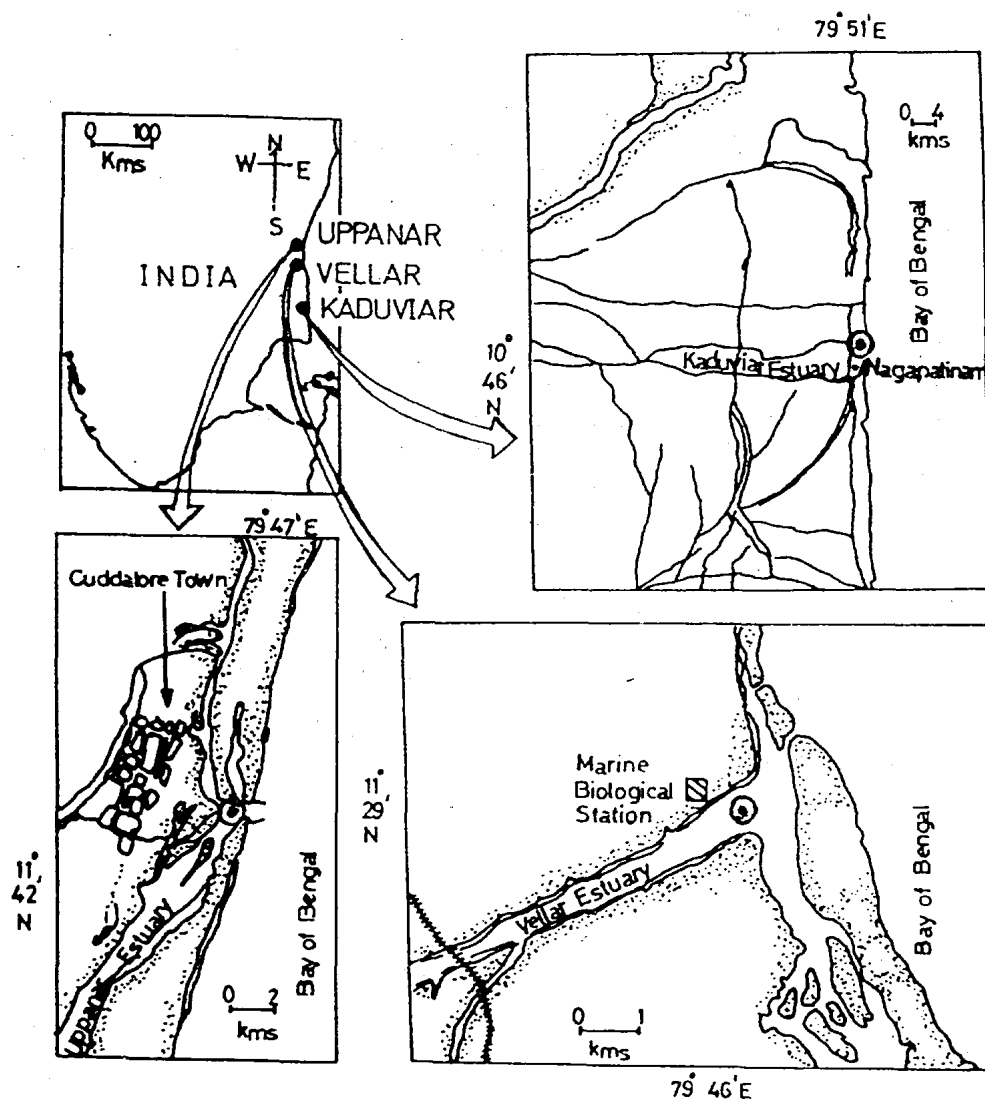


Fig 1—Location (⊙) of the study area.

Table 1—Correlation coefficient (r) between metal concentration in water, sediment and salinity

Correlation	Metal	Estuary		
		Uppanar	Vellar	Kaduviar
Metals (water) vs Salinity	Cu	-0.5218	-0.5484	-0.5516
	Zn	-0.5559	-0.6095	-0.5369
	Cd	-0.8315*	-0.6964*	-0.7524*
Metals (sediment) vs Salinity	Pb	-0.7905*	-0.8408*	-0.8640*
	Cu	-0.4208	-0.6118	-0.8291*
	Zn	-0.7273*	-0.8365*	-0.7564*
Metals (water) vs Metals (sediment)	Cd	-0.7951*	-0.6201	-0.7992*
	Pb	-0.7612*	-0.7469*	-0.6562*
	Cu	0.4963	0.7400*	0.6360
	Zn	0.5553	0.6315	0.7407*
	Cd	0.8428*	0.7728*	0.8713*
	Pb	0.8734*	0.8741*	0.8463*

*P < 0.001

A significant positive correlation was observed between metal concentration in water and sediment (Table 1). The metal enrichment is related to the removal of metal from the solution by terrestrial organic matter which eventually becomes incorporated into the sediment⁹.

The pattern of distribution of metals in water and sediment followed the order of $Zn > Cu > Pb > Cd$. The higher content of zinc and copper would be largely due to the discharge of agricultural wastes from the nearby upland area of the study area. The lead and cadmium in water and sediment was found to be very low because of the lack of source of these metals in the vicinity of the study area. The data obtained in the present investigation were well below the ISI limit (copper=3 mg.l⁻¹; zinc=

5 mg.l⁻¹; cadmium=2 mg.l⁻¹ and lead=0.1 mg.l⁻¹), recommended for the discharge of industrial effluent into the surface water including estuaries¹⁰, suggesting, comparatively less metal contamination in these estuaries.

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