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RESEARCH ARTICLE

Distribution of Heavy Metal Pollution in Vaipar Coastal Sediments, Southeast Coast of India

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Abstract

This study is the first documented evidence on heavy metal levels in surface sediments of the Vaipar coastal environment in Gulf of Mannar, Southeast coast of India. Sediment samples were collected for 12 months period from January 2008 to December 2008. Chromium, Copper, Lead and Zinc metals concentration were estimated from the sediment samples. The concentrations of Chromium ranged between 15 - 40. µg/g; Copper 18 - 48 µg/g; Lead 15 - 36 µg/g and Zinc 180 - 410 µg/g in the surface sediment. Highest metals concentration is recorded in November 2008 followed by May 2008. The significant increase of metals in the sediment is mainly due to pollution effect, related to anthropogenic wastes discharged through river runoff.

INTRODUCTION

Sediments are the ultimate reservoir for the numerous potential chemical contaminants that may be contained in effluents originating from urban, agricultural and industrial lands and recreational activities (Apitz et al., 2005). Discharges from extensive urban and industrial development have adversely impacted the quality of coastal water and sediments around the world (Tuncer, et al., 1998 and Owen & Sandhu 2000). In general, heavy metals tend to be adsorbed onto suspended particles and are' scavenged from the water column into proximal sediment. Analysis of surficial sediment off Palos Verdes Peninsula, California, USA effectively demonstrated enrichment of heavy metals in an ocean out fall field (Hershelman, et al.,, 1977) and confirmed that the proximal sediment metal concentration was roughly fivefold higher than in sediments several kilometers from the pollution sources. Metals like mercury, bio accumulated by organisms. The magnitude of the problems associated with chemical diagnosis of Minamata (nervous disorder in human) and Itai-Itai disease (softening of bone) due to mercury and cadmium poisoning is well documented. To avoid such deleterious effects on human and aquatic organisms by heavy metals, it is highly essential to assess the heavy metal concentration in the coastal environment. Assessment of sediment quality is recognized as a critical step in estimating the risks associated with man-made pollution in riverine systems (Vignati et al., 2003).

There is no information available on trace metal concentrations for Vaipar coastal environment, which receives agricultural drainage, industrial effluents, and untreated sewage outfall through Vaipar and Gundar rivers respectively. The present work addressed the spatial distribution of heavy metals like Cr, Cr, Pb and Zn in surficial sediments of Vaipar coastal environment, Southeast coast of India.

Geographical Location of the Sampling Station:

Vaipar is located at about 26 km North of Tuticorin, Tamil Nadu, India between latitude 8° I to 8° , north and longitudes 78° I to 78° I east (Fig: 1). Major ecosystem present, in vicinity is a patch of estuarine mangrove and rich coral biodiversity and forms one of the ecologically important biotopes, endowed with a unique kind of coastal environment in the Gulf of Mannar, South India as it retains connection with the Indian Ocean.

Methodology:

Sediment samples were collected around Vaipar coastal environment Southeast coast of India for 12 months from January 2008 to December 2008. Sediments collected with the help of plastic corer were oven dried. Heavy metal levels were analyzed from five replicates of sediment samples collected during each month. One gram of dried and powdered sediment samples was used for metal analysis by the hot acid digestion method One gram sample of powdered sediment was used for heavy metals analysis. Sediments were digested by hot acid (conc. HNO_3 and $HClO_3$) as per the method of Chester and Hughes (1967). All the sediment metals concentrations were estimated using a Furnace Atomic Absorption Spectrometer, (Shimadzu Model AA 6800) with adequate number of standards for calibration of the instrument. The precision and the detection limit of the instrument is ±0.01 µg.

Results and Discussion:

The concentrations of chromium in the sediment ranged between 15 - 40 µg/g; Copper 18 - 48 µg/g; Lead 15 - 36 µg/g and Zinc 180 - 410 µg/g; in the surface sediment samples. Highest levels of metal concentrations were recorded during November 2008 by the end of northeast monsoon season and followed by May 2008. Lowest concentration of each metal was recorded in different months, which. was not uniform with seasons. The analyzed sediment metal concentrations are shown in Fig: 2 - 5.

Levels of sediment heavy metals recorded in the present study generally confirmed the earlier obtained in similar environments. The chromium concentration levels in the current study is quite comparable to that reported by Donazzolo et al., (1984) and Owen & Sandhu (2000) who recorded 15 - 75 µg/g and 14 - 30 µg/g of chromium levels in the Adriatic Sea and Tolo harbour sediment samples respectively. Rajkumar and Persad (1994) recorded 15.95 µg/g of Cu concentration in the sediments of near shore areas of Tobago, West Indies. These results are almost identical to the resultas obtained in the present investigation from Vaipar coastal sediment on Cu values.
Lead concentration in Vaipar coastal sediment samples are quite comparable to the study results reported elsewhere which ranged between 35 to 135 µg/g in Tolo harbour, Hong Kong (Owens and Sandhu, 2000). Similarly Martin et al., (1983) and Lee, et al., (1998) recorded 9 - 438 µg/g from Jakarta bay, Indonesia and 2.5 - 50.1 µg/g of lead contents in the Taiwan coast, respectively .
In the current investigation the zinc concentrations were relatively high in all sediment samples. In the present study the observed zinc concentration around the Vaipar coastal sediment samples are quite comparable to the results reported by John & Fanny (1984) and Pragatheeswaran, et al.,., (1988) on sediment zinc contents in Greek (244 µg/g), and Kodiyakkarai coast (560 µg/g), Southeast India, respectively. Donazzolo, et al., (1984) have also recorded similar zinc concentration (1.68 to 870 µg/g) trend in the northern Adriatic Sea sediment samples.

Chromium, copper and lead input into the coastal environment is mainly through industrial and sewage effluents. Davide et al., (2003) study results showed that increased Cu, Cr and Pb concentration in Mediterranean rivers are mainly due to industrial and sewage direct outfall. Further Lopez-Sanchez et al., (1996) have also confirmed that the increased metal concentration off the coast of Barcelona is mainly due to sludge dumping. Tuncer et al., (1998) estimated that 340 tons of Cu, 60 tons of Pb and 900 tons of Zn is annually discharged into the Turkish coast through river and stream runoff. He opined that land based activities are the main cause for dumping heavy metal contamination in Black Sea waters through sewage outfall. Elevated metal concentrations in Vaipar coastal shore sediment samples are mainly influenced by river and stream runoff. This is further substantiated by our record of highest levels of heavy metals during post monsoon season.

Hallberg (1974) noted a linear relationship between metal concentration and sediment organic carbon. Martin (1973) studied the fate of metals by flocculation and their subsequent deposition along with organic matter in the sediments. In the present investigation, the concentrations of metals were found to be high in sediments during the post monsoon season. The increased levels of metals in sediment samples during post northeast monsoon and floods can be attributed to the settlement of metal ions along with organic matter on to the bottom. However, no season wise uniform trend could be discerned in the current study on metal distribution trend in the Vaipar sediment.

Increased levels of metals in the present study mainly due to wastes from chemical industries, sewage, land drainage and river run off floods into the Vaipar coastal environment, which is more evident that during the year 2008 Vaipar River was heavily flooded in both April and October months. The pollution problem around the Vaipar coastal environment has been increasing over the last couple of years. However, the heavy metal concentrations have not yet reached alarming levels that could be detrimental to the biota of the estuarine system. However it is apparent that Vaipar coastal sediment concentrations were highly influenced by river runoff.

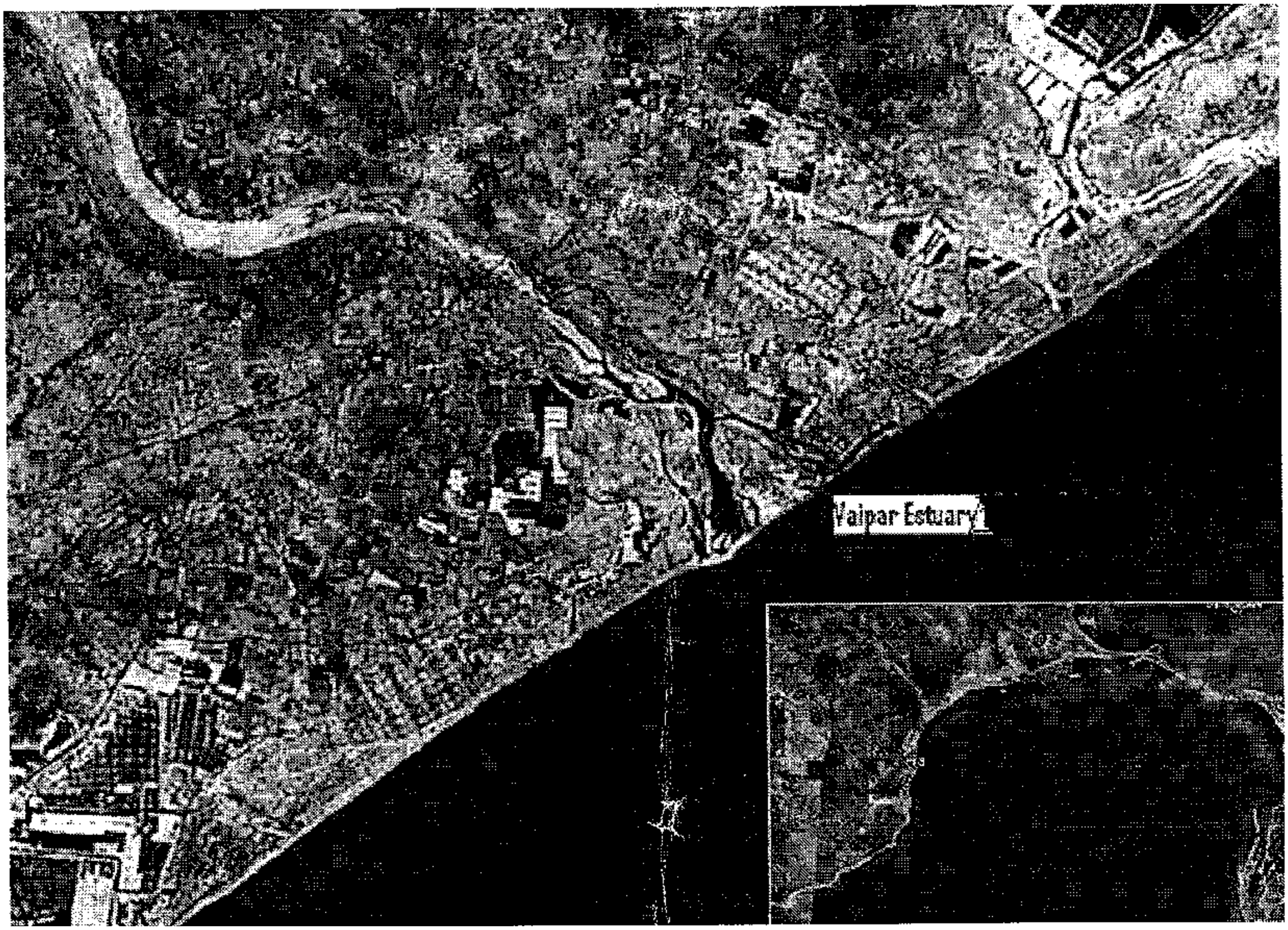


Fig: 1 Satellite Images of Vaipar Estuary, Gulf of Mannar, India

Fig: 2 Chromium Concentration ug/g

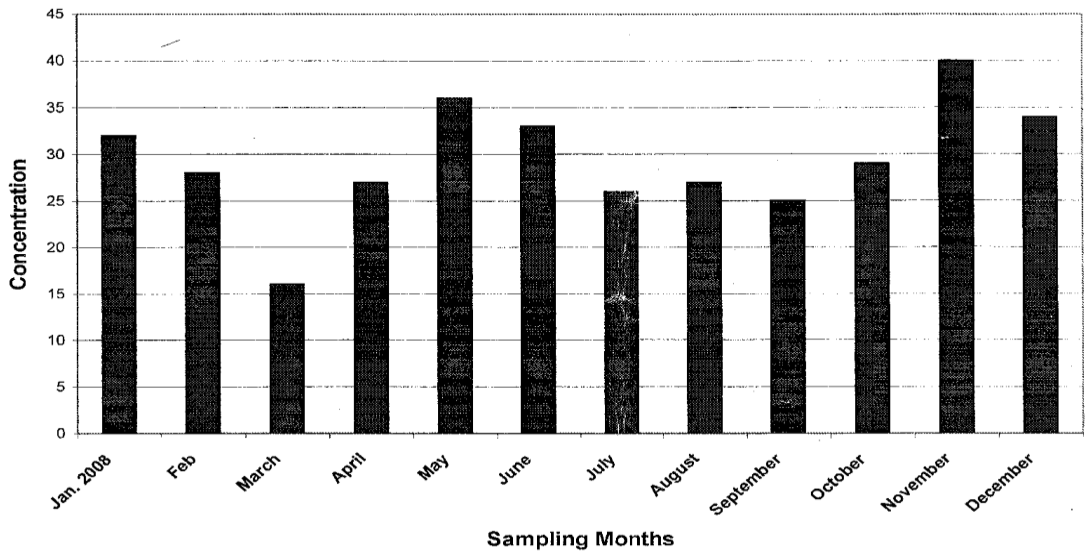


Fig: 3 Copper Concentration ug/g

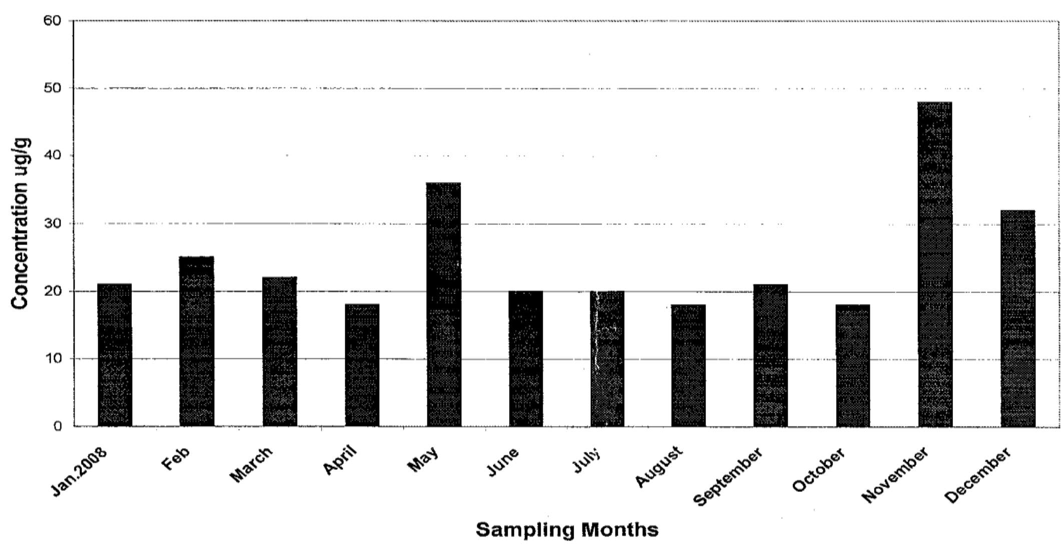


Fig: 4 Lead Concentration ug/g

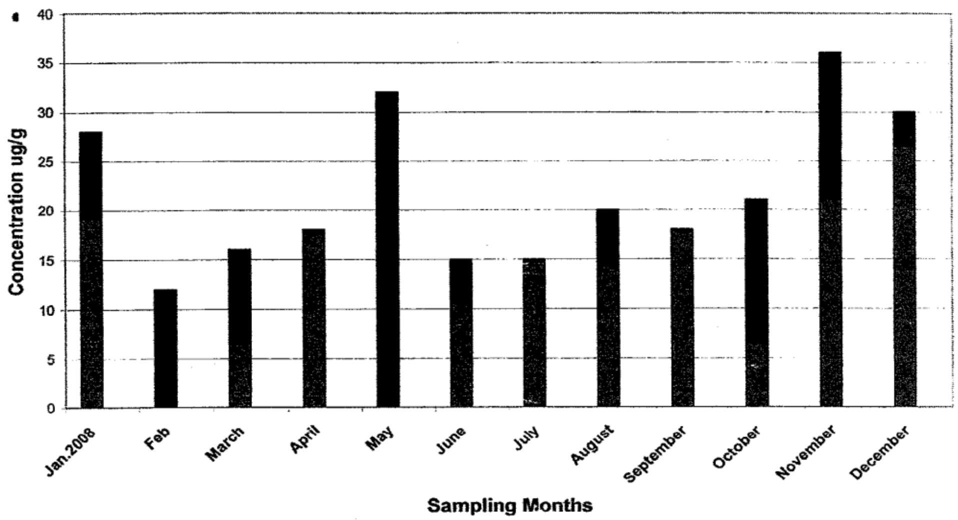
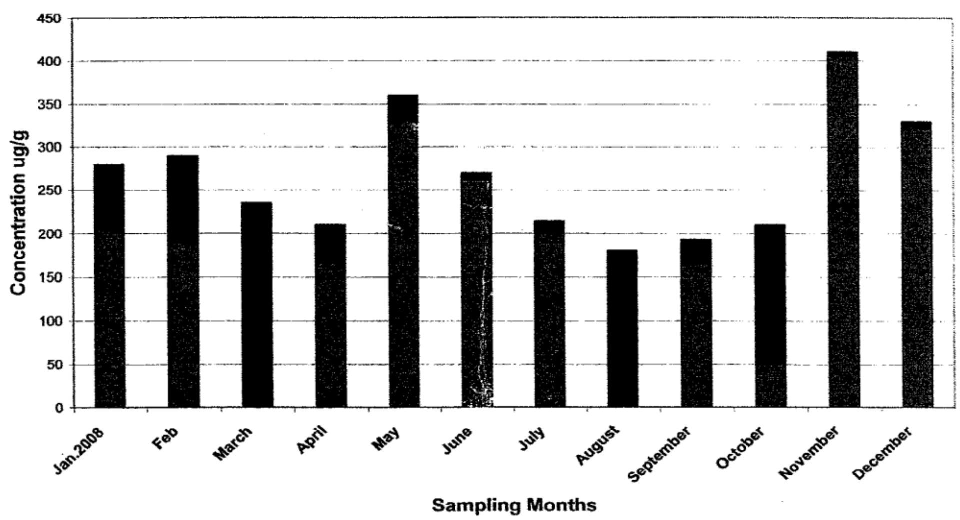


Fig: 5 Zinc Concentration ug/g



Conclusion:

The metal concentrations in sediments from Vaipar coastal environment, though low, are indicative of pollution from point sources in and around the coast and from diffuse sources such as urban runoff. Though the present results indicate that the studied metal concentrations were well within the threshold limits, it is likely that the estuarine system will face heavy metal pollution since the surrounding area is facing heavy industrialization. This situation calls for regular monitoring so that the safe limits are not exceeded due to increased industrial activities. This may contribute to the degradation of the marine ecosystems in future.

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