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Seasonal Distribution of Heavy Metals in the Mullipallam Creek of Muthupettai Mangroves (Southeast Coast of India)

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Abstract: The present study was carried out the heavy metals level in the Mullipallam creek of Muthupettai mangrove, during the period of April to September 2007. The heavy metals level of water and sediment samples were analyzed by using ICP. The results of present study, the iron was ranged from 124.37 to 667.94 µg/l in water and 1170 to 4669 µg/g in sediment, zinc (water 15.46 to 34µg/l and sediment 128.8 to 308.02µg/g), copper (water 102.817 to 258.7µg/l), manganese (water 15.45 to 23.79µg/l and sediment 130.32 to 381.44µg/g), cadmium (water 0.67 to 5.61 µg/l and sediment 0.99 to 4.97 µg/g) and mercury (water 15 to 194 ng/l and sediment 17 to 191ng/g) in the two stations of study area and also was recorded higher levels of heavy metals during pre-monsoon and lower values in during summer season. Heavy metals level as follow Fe>Mn>Zn> Cd>Hg in the present study area.

Key words: Mullipallam creek · Muthupettai mangroves · Heavy metals (water, sediment) · Southeast coast of India

INTRODUCTION

The cycling of heavy metals, because of their toxicity, bio-accumulation capacity and persistence, is a serious question recently addressed by many studies on mangrove environments [1-7]. In contrast with organic pollutants, heavy metals cannot be biologically or chemically degraded and thus may either accumulate locally or be transported over long distances. In natural environments, the associations of metals and their distributions depend on various parameters including redox conditions [8] and organic contents [9, 10]. These parameters may influence the toxicity of metals through processes like mercury methylation and by controlling their availability for living organisms [11]. In addition, metals can be adsorbed onto the surface of minerals, like clay minerals, Fe and/or Mn oxy-hydroxides [12, 13]. Consequently, high concentrations of heavy metals can accumulate in sediments and especially in fine-grained oozes, which present high mineral specific surfaces.

Mangrove ecosystems, developing in the intertidal zone of most tropical and subtropical regions, are characterized by major contrasts in redox conditions and high rates of organic carbon accumulations [14]. They may act as a sink or a source of heavy metals in coastal environments because of their variable physical and chemical properties [15]. Moreover, many countries have decided to use mangroves in the treatment of sewage effluents. The present study aims at determining the distribution of various heavy metals in mangrove water and sediments.

Study Area: Muthupettai mangroves (Lat. 10° 25'N; Long. 79° 39'E) situated 400km south of Chennai lies along the south east coast of India. It has total area of 6800ha in which the water spread area covers approximately 2720 ha. Many tributaries of the river Cauvery delta viz, Paminiyar, Koraiyar, Kilaithangiyar, Kandankurichanar and Marakkakoraiyar flow through Muthupettai and nearby villages and form a lagoon before they enter into the sea, Bay of Bengal. *Avicennia marina* is the dominant mangrove species in Muthupettai and accounts for nearly 95% of the vegetative cover. Mullipallam Creek, situated at the southern most end of the Cauvery delta in Palk Strait, is part of Muthupet mangroves and is connected with the Bay of Bengal in the north and the Gulf of Mannar and the Indian Ocean in the south (Fig. 1). The sampling areas for present study viz., Station 1 (Aquaculture discharge area); Station 2 (Sea mouth).

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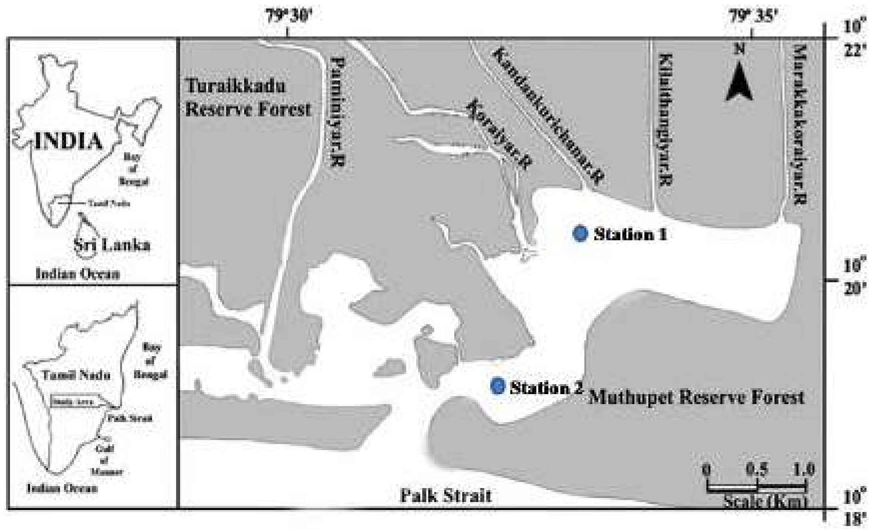

Fig. 1: Map of Mullipallam Creek of Muthupettai Mangroves environment showing different locations

MATERIALS AND METHODS

Field sampling: Water samples were collected from the sampling locations using polyethylene bottles. Sediment samples were collected with the aid of cleaned and dried corer. Sediment sub samples were transferred from the corer to clean polyethylene cover using cleaned plastic spatula. The preserved sediment sub samples were dried at 110°C to constant weight for estimation of metals. Water and sediment samples at two stations were collected during April to September (2007) and transported on ice to the laboratory and processed within 18-24h.

Heavy metal determinations: The heavy metals of Fe, Zn, Cu, Mn, Cd and Hg were analysed by using standard method for water [16]. Sediment and plant samples were dried and ground with an agate pestle and mortar. The concentrations of Fe, Zn, Cu, Mn, Cd and Hg from the sediments and improved acid digestion procedure were adopted [17].

RESULTS

The month wise concentration of water and sediment fraction of heavy metals (Fe, Zn, Cu, Mn, Cd and Hg) during the period from April to September (2007) at two stations are presented in Fig: 2-12.

The concentration of iron in the water samples ranged from 124.37 to 667.94µg/ml with mean concentration of 292.94µg/ml. The values of zinc were ranged from 15.46 to 34 µg/l with mean values of22.77µg/l. The concentration

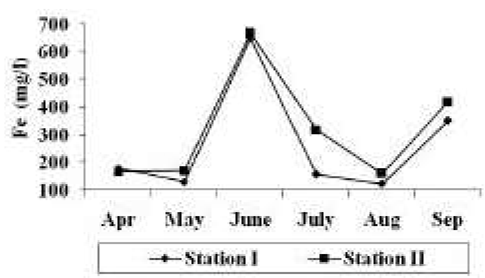

Fig. 2: Variations in iron concentration in water recorded at two stations

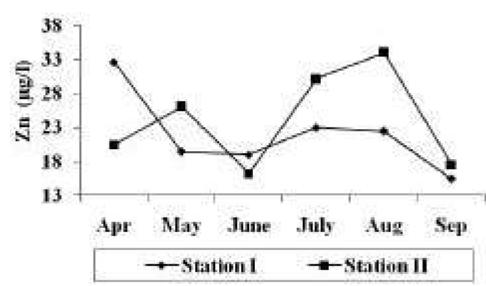

Fig. 3: Variations in zinc concentration in water recorded at two stations

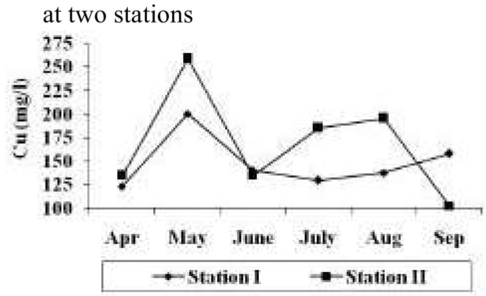

Fig. 4: Variations in copper concentration in water recorded at two stations

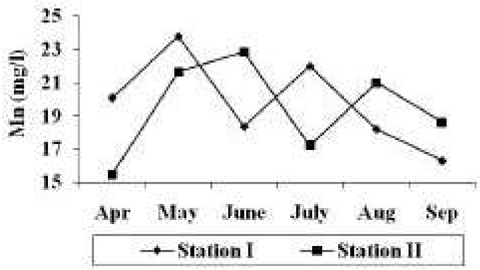

Fig. 5: Variations in manganese concentration in water recorded at two stations.

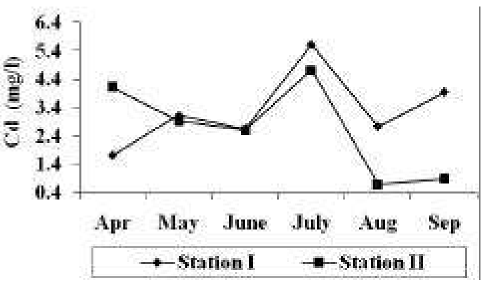

Fig. 6: Variations in cadmium concentration in water recorded at two stations.

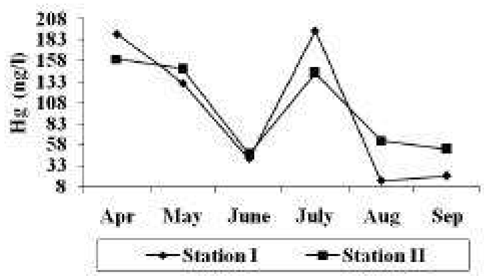

Fig. 7: Variations in mercury concentration in water recorded at two stations.

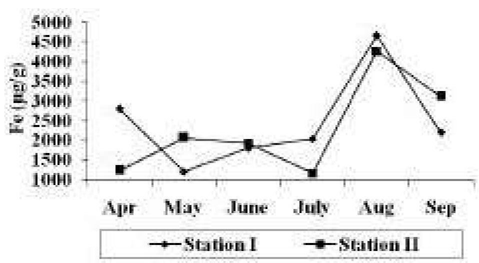

Fig. 8: Variations in iron concentration recorded in sediment sample.

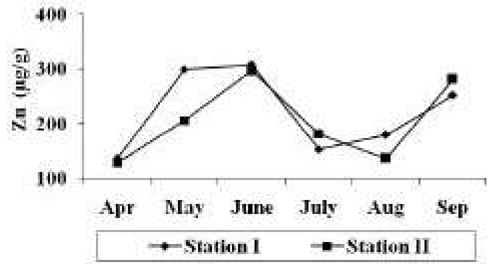

Fig. 9: Variations in zinc concentration recorded in sediment sample.

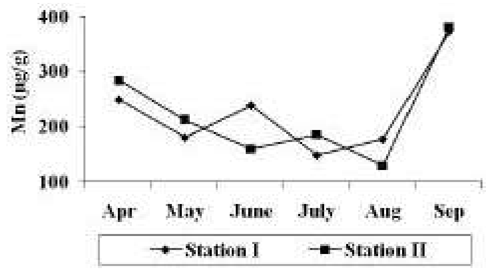

Fig. 10: Variations in manganese concentration recorded in sediment sample.

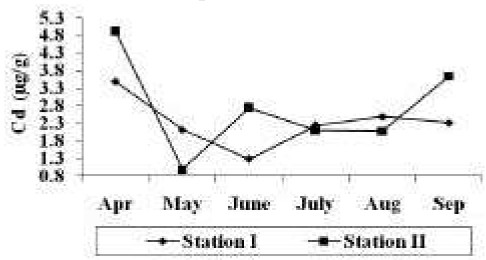

Fig. 11: Variations in cadmium concentration recorded in sediment sample.

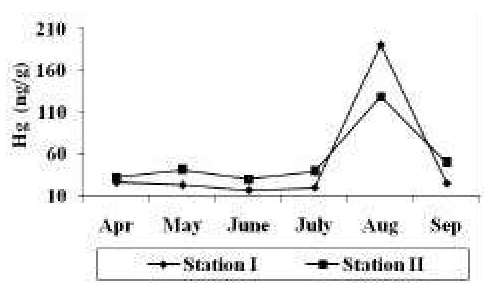

Fig. 12: Variations in mercury concentration recorded in sediment sample.

of copper was ranged between 102.817µg/l to 258.7µg/l with mean concentration of161.43 µg/l. The concentration of manganese ranged from 15.45 to 23.79µg/l with mean concentration of19.42 µg/l. The concentration of cadmium was varied from 0.67µg^{-1} to 5.61µg/l with mean concentration of 3.02µg/l. The concentration of mercury was ranged between 15ng/l to 194 ng/l with mean concentration of 100.17 ng/l.

The concentration of iron in the sediment samples ranged from 1170 µg/g to 4669 µg/g with mean concentration of 2335.92µg/g. The concentration of zinc was ranged between 128.8602 µg/g to 308.02 µg/g with mean concentration of 210.10µg/g. The concentration of manganese was ranged from 130.32 µg/g to 381.44 µg/g with mean concentration of 223.14µ µg/g. The concentration of cadmium was ranged from 0.99 µg/g to

4.97 µg/g with mean concentration of 2.32 µg/g. The concentration of mercury was ranged from 17ng/g to 191ng/g with mean concentration of 53.50 ng/g.

DISCUSSION

Generally, the natural sources of heavy metals in coastal waters are through land, heavy fresh water inflow, agricultural waste, aquaculture discharge and river run off and the mechanical and chemical weathering of rocks. Also, the components washed from the atmosphere through rainfall, windblown dust, forest fires and volcanic particles add to the distribution of heavy metals in water [18].

Among the two stations investigated almost all the heavy metals (Fe, Zn, Cu, Mn, Cd and Hg) except Fe registered high concentrations at station 2. This was mainly due to the discharge of aquacultures ponds, domestic wastes, land and agricultural drainages along with the seven river inputs into the sea near the station 2. Apart from these sources, aquaculture and boating activities such as loading and unloading of materials, antifouling paints from boats and fishing activities contribute to the enhanced levels of metals. In addition, increasing anthropogenic activities along this coast might certainly have a significant effect on metal concentration in the coastal waters of station 2.

The order of abundance of different metals at the two stations during the present study period was as follows: Fe>Cu >Zn>Mn>Cd>Hg. At both the stations, the same trend of abundance of different metals was observed during the present study period with the essential metal (Fe) recording the maximum concentration and the non-essential metal (Hg) recording the minimum concentration. The similar trend was observed in the Bay of Bengal along the Tamil Nadu coast [19]. The similar results were observed [20, 21].

Compared to sea water, sediments contained very high concentrations of metals. Concentration of heavy metals in the sediments showed spatial and temporal variation at both the stations during the study period. Concentrations of dissolved metals especially of Hg were high during August. Zn concentration was high during June whereas Mn concentrations were high during September. Cd concentration was high during the April. The order of abundance of different heavy metals in the sediments observed during the present study period at the two stations was as follows: Fe>Mn>Zn>Cd>Hg. Further levels of this metals recorded in the present study are significantly higher than the natural seawater levels. Moreover, concentrations of the heavy metals are increasing from year to year. So it is concluded from the present study that the Muthupet mangrove environment coast of India is rapidly getting polluted with trace metals, thus substantiating reported that the coastal water of the Tamil Nadu state are definitely polluted with heavy metals[19].

The concentration of metals observed in the sediment in present study were compared with the levels reported elsewhere, it is obvious that the levels were higher than the values reported. In areas where higher metal concentrations have been reported [22] were found to be influenced by the influx of industrial wastes, sewage and atmospheric fallout. The data obtained in the present investigation from the study areas were well below the allowable limit. At the same time, the slow built up of metals also cannot be ignored.

In general, the semimetal (Fe, Zn, Mn, Cd and Hg) concentrations observed in the present investigation in the two stations showed similar trend in seasonal distribution with higher levels during monsoon and lower values during summer period. The higher concentration of metals observed during monsoon could be attributed to the heavy rain fall and subsequent river runoff, bringing much industrial and land derived materials along with domestic, municipal and agricultural wastes which include residues of heavy metal containing pesticides. The load of metals was found to be lower during summer months and this could be due to the meager metal rich freshwater influx. This observation supports the earlier reports in the Pichavaram mangrove by [24], in the Kodiakarai coastal area [25] and in the French Guiana coastal line [20].

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REFERENCES

1. Harbison, P., 1986. Mangrove muds: a sink and a source for trace metals. Mar. Pollut. Bull, 17: 246-250.
2. Lacerda, L.D., L.A. Martinelli, C.A. Rezende, A.A. Mozetto, A.R.C. Ovalle, R.I. Victoria, C.A.R. Silva and F.B. Nogeuira, 1988. The fate of heavy metals in suspended matter in a mangrove creek during a tidal cycle. Sci. Total Environ., 75: 249-259.

3. Mackey, A.P. and M.C. Hodgkinson, 1995. Concentration and spatial distribution of trace metals in mangrove sediments from the Brisbane River, Australia. Environ. Pollut, 90: 181-186.
4. Tam, N.F.Y. and Y.S. Wong, 1995. Spatial and temporal variations of heavy metal contamination in sediments of a mangrove swamp in Hong Kong. Mar. Pollut. Bull, 31: 254-261.
5. Tam, N.F.Y. and Y.S. Wong, 1997. Accumulation and distribution of heavy metals in a simulated mangrove system treated with sewage. Hydrobiologia, 352: 67-75.
6. Tam, N.F.Y. and Y.S. Wong, 2000. Spatial variation of heavy metal in surface sediments of Hong Kong mangrove swamps. Environ. Pollut, 110: 195-205.
7. Clark, M.W., D. McConchie, D.W. Lewis and P. Saenger, 1998. Redox stratification and heavy metal partitioning in Avicennia-dominated mangrove sediments: a geochemical model. Chem. Geol., 149: 147-171.
8. Guo, T., R.D. DeLaune and W.H. Patrick Jr, 1997. The influence of sediment redox chemistry on chemically active forms of arsenic, cadmium, chromium and zinc in estuarine sediment. Environ. Int., 23: 305-316.
9. Nissenbaum, A. and D.J. Swaine, 1976. Organic-metal interactions in recent sediments: the role of humic substances. Geochim. Cosmochim. Acta, 40: 809-816.
10. Mounier, S., L.D. Lacerda, R.V. Marins and J. Bemaim, 2001. Copper and mercury complexing capacity of organic matter from a mangrove mud flat environment, Sepetiba bay, Brazil. Environ. Contam. Toxicol., 67: 519-525.
11. Mason, R.P., W.F. Fitzgerald and F.F.M. Morel, 1994. The biogeochemical cycling of elemental mercury: anthropogenic influences. Geochim. Cosmochim. Acta, 58: 3191-3198.
12. Dong, D., Y.M. Nelson, L.W. Lion, M.L. Shuler and W.C. Ghiorse, 2000. Adsorption of Pb and Cd onto metal oxides and organic material in natural surface coatings as determined by selective extractions: new evidence for the importance of Mn and Fe oxides. Water Res., 34: 427-436.
13. Quemerais, B., D. Cossa, B. Rondeau, T.T. Pham and B. Fortin, 1998. Mercury distribution in relation to iron and manganese in the water of the St. Laurent River. Sci. Total Environ., 213: 193-201.
14. Huc, A.Y., 1980. Origin and formation of organic matter in recent sediments and its relation to kerogen. In: Durand, B. (Ed.), Kerogen: Matiere organique insoluble des roches sedimentaires. Technip, Paris, pp: 446-474.
15. Harbison, P., 1986. Mangrove muds: a sink and a source for trace metals. Mar. Pollut. Bull., 17: 246-250.
16. Brooks, R.R., B.J. Presley and I.R. Kaplan, 1967. APDC-MIBK extraction system for the determination of trace metals in saline waters by atomic-absorption spectroscopy. Talanta, 14: 809-816.
17. Watling, R.J. and H.R. Waltling, 1982. Metal surveys in South African estuaries. VI Sundays River. Water, S.A., 8(4): 192.
18. Bryan, G.W., 1984. Pollution due to heavy metals and their compounds. In: marine Ecology (Ed.O.Kinne), Vol.V.Part-3, John Wiley and Sons, New York, pp: 1239-1432.
19. Ramachandran, S., 1990. Marine pollution in Tamil Nadu-A staus report. Proc. Intl. Symp. Mar. Pollution, pp: 143-150.
20. Marchand, C., E. Lallier-Verges, F. Baltzer, P. Alberic, D. Cossa and P. Baillif, 2006. Heavy metals distribution in mangrove sediments along the mobile coastline of French Guiana Marine Chemist., 98: 1-17.
21. Elijah, I. Ohimain, Gbolagade Jonathan and Steve O. Abah, 2008. Variations in Heavy Metal Concentrations Following the Dredging of an Oil Well Access Canal in the Niger Delta Advances in Biological Res., 2(5-6): 97-103, 2008.
22. Sahu, K.C. and S. Mukherji, 1983. Monitoring of water and sediment of Ulhas river in north-east of Bombay. Mahasagar. Bull. Natn. Inst. Oceanogr., 16(2): 135-142.
23. Longston, W.J., 1986. Metals in sediment and benthic organisms in their Mersey estuary. Estuar. Coast. Shelf Sci., 23: 239-252.
24. Glory Dally, S., 1983. Accumulation of iron, manganese, zinc and copper by salt excreting and salt excluding types of mangrove plants. M.Phil thesis, Annamalai University.
25. Pragatheeswaran, V.P. Anbazhagan, R. Natarajan and T. Venugopalan, 1986. Distribution of heavy metals and organic carbon in sediments off Madras and Visakahapatnam. Mahasagar-Bull. Natn. Inst. Oceanogr., 19(1): 39-44.