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Original Article

Metal concentration in Manakudy estuarine sediments South West Coast of India

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Abstract

Estuary is a transition zone between land and sea as well as freshwater and saltwater. Sediments are important sinks of various pollutants and play a significant role in the remobilization of contaminants in aquatic system between water and sediments. Low content of organic carbon is attributed to low bioproductivity and active hydrodynamics. The Electrical conductivity is continuously decrease from station I to V. Among the trace metals copper is very low. This investigation was under taken to study the metal concentration in Manakudy estuarine sediments.

Keywords: Sediments, Trace metals, Estuary, Major elements

Introduction

The chemistry and ecology of an estuarine system are entirely different from the fluvial as well as the marine system. Estuarine environment is characterized by a constantly changing mixture of salt and freshwater. Sedimentary material carried out into the estuary from the sea and rivers, which form the mud flats. Estuaries have been claimed to be the most productive natural habitats in the world. They provide vital spawning nursery and feeding grounds for fish and shellfish and support many species including wading birds, reptiles, migratory water fowl, shore birds, amphibians and mammals.

Many geochemical studies have been carried out on the shelf and slope sediments of the south west coast of India (Shajan kuttickat, 2000).Geochemical studies of bottom sediments of water bodies like rivers, estuaries and marine basins are helpful in understanding the different sediment sources and element distribution pattern Such studies throw light on establishments of sediment characteristics, facies relationship and depositional process (Gandhi *et al.*, 2000).

The heavy minerals in the shelf are being supplied by the rivers and from the lowered sea level. Apart from this, the daily rise and fall of the tides, and the movement of saltwater, influence the characteristics and composition of the sediments (Prakash, 2000).

Rates of sedimentation vary from as low as 1mm yr^{-1} in coastal marine water to 10-20 mm yr^{-1} in some riverine and estuarine systems. Accelerated sedimentation is generally detrimental to the estuarine health while geological rates of sedimentation are usually beneficial (Rengaswamy *et al.*,2005). Rivers, the major source of irrigation are used as repositories for disposal of domestic sewage, industrial effluents containing toxic substances, heavy metals and agricultural run-off. The amount of fresh water flowing into an estuary varies from season to season and from year to year. Moreover, in the estuary the water carrying agricultural, industrial and domestic wastes are deposited as sediment (Daskalakis and O' connor, 1995).

Estuaries are often contaminated with a range of organic and inorganic contaminants. Sources of environmental contaminants to the coastal system are numerous. They enter the estuarine system through different pathways mainly rivers. Contaminated sediments may be directly toxic to aquatic life or through bio accumulation. The biomagnification can cause long term chronic effects (Swartz *et al.*, 1985).

Contamination of sediments, water resources and biota by heavy metals are of major concern. Many industrialized areas are affected due to their toxicity, persistence. and bio-accumulative nature. Organic carbon in riverine and estuarine sediments is controlled mostly by the rate of organic to inorganic constituents, primary productivity, composition and texture of the sediments. Textural control over total organic carbon is indicated by the correlation of total organic carbon with sand, silt and clay percentages of the sediments. Association of total organic carbon with clay minerals is of particular significance in estuarine sediments(Muraleedharan Nair *et al.*,2002).

Plant nutrients like calcium, magnesium potassium, sodium and phosphorus are present in the minerals and in solution. Oxygen, silicon and aluminum occur as constituents of minerals and as oxides. Nitrogen and phosphorus are present in organic and inorganic forms. Metals may be present in the estuarine system as dissolved species, free ions or forming organic complexes with humic and fulvic acids. The metals present in the environment cannot be degraded either by chemical or biological process.

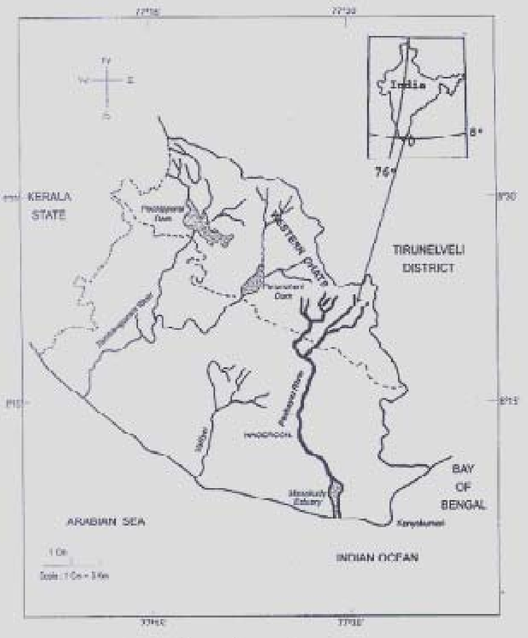
Many of the trace metals are highly toxic to humans and other living organisms. They may be bioconcentrated in the food chain. Estuarine and coastal sediments act as ultimate sink for trace elements that are discharged into the aquatic environment (Achyuthan *et al.*,2002). Physical properties such as grain size and density are important parameters in sedimentation and transport processes. Therefore, the present study has been under taken to investigate the metal concentration in Manakudy estuary.

Materials and Methods

Study Area

Manakudy estuary is the second largest estuary in Kanyakumari District. It has a total area of 145 hectares. The tail end of pazhayar river merges with the Arabian sea at Manakudy. Manakudy estuary is situated about 8 kilometers north west of cape comorin falling with in the latitude $8^0 4^1$ and $8^0 21^1$N and longitude $77^0 26^1$ and $77^0 30^1$E. The climate of the region is greatly influenced by both the South -West and North- East monsoons. There is not much variation in the mean monthly air temperature (36.67°C to 23.89 °C). Shallow open waters, fresh and small marshes, sandy beaches, muddy flats, rocky shores, oyster reefs, mangrove forests, river deltas, tidalpools and sea grass are the some important habitats found in and around the estuary. Khondalites, charnockite, and the river and marine aluviam are the geological formations observed in these study area.Water samples were collected from five different stations from estuarine mouth bed to river basin. A total of twenty five sediment samples were collected in polythene bags labelled before transporting to the laboratory.

The collected samples were initially air dried and finely powdered using agate motor. The percentage of sand silt and clay were determined by the pipette method (Krumbein and pettijohn, 1936). Percentage of organic carbon was determined by titration method of Walkley Black (1934) as well as Elwakeel and Riley (1957). Nitrogen was estimated by kjeldhal method (Technicon Industrial System,1973). Electrical conductivity was measured using Elico conductivity bridge and the pH was recorded using Elico pH meter. Silicondioxide was estimated gravimetrically (AOAC,1962) Calcium oxide and magnesium oxide were estimated titrimetrically by EDTA method (APHA,1998). Phosphorus was estimated by ammonium phosphomolybdate method (APHA,1998). Aluminum was estimated by Alizarin Red-5 method. Iron was estimated by 1.10- phenanthroline method. Sodium oxide and potassium oxide were estimated by flame photometric method (APHA, 1998). All the trace



Location of study area

metals were estimated by Atomic Absorption Spectroscopic method.

Results and Discussion

The Present study on the metal concentration of the sediments in Manakudy estuary in twenty five samples spread over all the five stations indicate wide variation for all the parameters studied. The values are tabulated and represented graphically and pictorially.

From the results, the low C/N ratio (3.3) may be due to lack of suspended matter in the estuary. The higher C/N ratio (10.7) is due to terrigenous organic matter enriched with residual of mangrove grasses which contain high contents of lignin and cellulose. Higher concentration of phosphorus is due to the larger supply of terrigenous material by the river, organic productivity and agricultural waste discharge from the paddy fields of the region. Low concentration of phosphorus is due to the process of flocculation and the change in salinity. low in station I due to low quantity of fine sediments and high degree of desorption under saline condition.

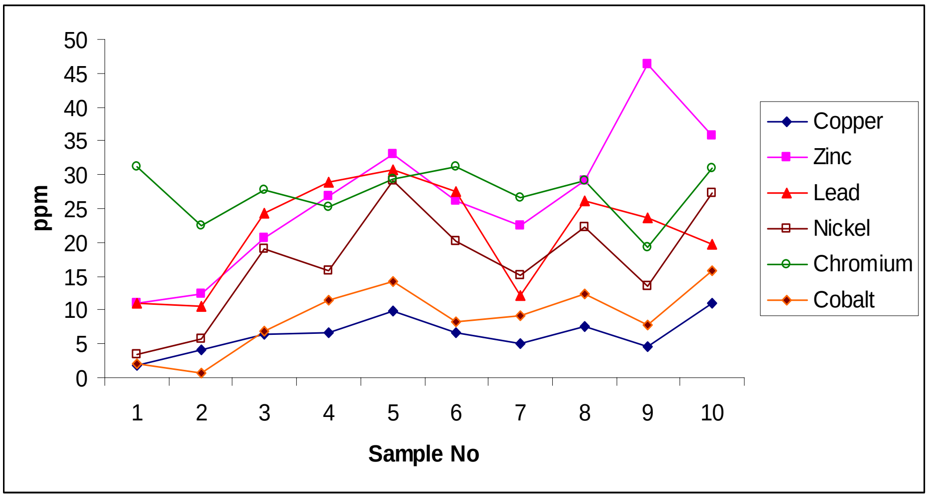


Fig-1: Variation of Trace Metals in sediments in ppm units

Accordingly, Station II and III are more polluted with respect to trace elements especially zinc, lead and chromium. The concentration of nickel is also higher in these region, however it is associated more in the coarser sediments rather than in fines. The higher concentration of lead in sediments is indicated by the low degree of desorption of the metal under estuarine conditions. Based on the analytical works, the mouth of the estuary has very low quantity of fine sediments due to turbulent conditions. The continuous decrease of electrical conductivity from sea mouth towards the river mouth is an indication of calm hydrodynamic conditions prevailing in the estuary, as the sediments have not undergone sufficient mixing.

The organic carbon is highly positively correlated with nitrogen (r =0.95) revealing that the accumulated fine sediments are nitrogenous organic matter The linear Fe-Al relationship indicates that reactive iron is retained more efficiently in fine sediments due their lower permeability of tidal water flushing.

Strong positive correlation between copper and nickel (r =0.94) indicates the strong association between them, because both are having same ionic radii in + 2 state (0.72^0 A). Nickel is positively correlated with lead (r= 0.74) and are mutually correlated to organic carbon (Ni : r =0.51, and pb: r =0.49)due to high degree of adsorption of these metal ions and their complexing ability with organic carbon.

Table - 1: Physico-Chemical properties of the sediments

Locations	pH %	EC dS/m	Organic Carbon%	Nitrogen ppm	Phosphorus ppm	C/N ratio
1	8.82	4.94	0.18	280	250	6.428
2	8.68	7.93	0.24	280	250	8.571
3	8.70	5.68	0.29	420	300	3.320
4	8.75	5.4	0.29	420	340	3.320
5	8.64	3.18	0.30	420	340	7.142
6	8.55	2.8	0.36	420	300	8.571
7	8.49	2.61	0.36	420	340	9.047
8	8.36	1.58	0.41	420	300	8.571
9	8.28	2.24	0.41	560	380	9.761
10	8.05	2.32	0.57	840	430	9.464
11	7.83	2.91	0.57	840	430	10.178
12	8.31	3.71	0.68	700	430	8.095
13	7.98	3.58	0.69	840	380	9.857
14	8.04	2.20	0.71	840	340	8.452
15	8.12	3.79	0.72	700	300	8.571
16	7.72	2.74	0.60	700	380	8.571
17	8.27	2.46	0.53	560	430	8.142
18	7.85	2.58	0.51	560	470	7.571
19	7.43	2.08	0.41	420	510	9.107
20	7.62	1.73	0.36	420	470	7.321
21	7.55	1.34	0.38	520	510	8.571
22	7.45	1.22	0.45	520	430	9.047
23	7.35	1.18	0.45	280	430	8.653
24	7.46	1.17	0.30	280	340	10.714
25	7.25	1.35	0.32	420	300	7.619

Table – 2: Percentage of Major elements

Locations	Si	K	Ca	Mg	Na	Fe	Al
1	41.0	0.049	4.132	0.9	0.111	0.28	0.832
2	39.8	0.057	4.054	0.84	0.103	0.84	1.716
3	39.6	0.057	0.795	0.66	0.066	2.17	3.328
4	39.6	0.082	0.752	0.3	0.066	0.98	3.952
5	40.7	0.082	2.186	0.372	0.074	0.63	1.612
6	40.5	0.090	1.434	0.408	0.066	0.56	2.184
7	40.7	0.098	0.795	0.432	0.074	0.77	1.768
8	40.4	0.098	0.752	0.42	0.066	0.84	2.496
9	40.9	0.098	0.397	0.192	0.066	0.77	2.808
10	40	0.131	0.355	0.18	0.074	1.05	3.328
11	39.1	0.164	0.319	0.24	0.103	1.19	3.588
12	41.9	0.098	0.553	0.06	0.066	0.98	2.392
13	41.1	0.098	0.198	0.156	0.074	0.91	2.184
14	39.3	0.172	1.065	0.132	0.074	1.75	4.16
15	41.4	0.114	0.873	0.216	0.066	0.77	2.548
16	40.9	0.094	0.795	0.252	0.103	0.91	3.224
17	38.8	0.106	0.397	0.3	0.066	1.68	4.212
18	38.5	0.098	0.276	0.192	0.066	1.82	4.888
19	38.4	0.090	0.241	0.204	0.074	1.61	5.564
20	37.6	0.090	0.198	0.168	0.066	1.82	5.668
21	37.3	0.098	0.319	0.24	0.074	1.89	6.136
22	39.1	0.098	0.113	0.084	0.081	1.68	4.212
23	39.6	0.147	0.120	0.078	0.081	1.19	4.316
24	38.8	0.155	0.156	0.06	0.118	1.47	4.628
25	38	0.082	0.156	0.066	0.111	1.68	4.992

Table – 3: Concentration of trace elements in ppm units

Samples	Cu	Zn	Pb	Ni	Cr	Co
I	1.775	11.09	10.92	3.35	31.1	2.02
II	4.175	12.38	10.47	5.65	22.37	0.75
III	6.325	20.73	24.22	18.95	27.75	6.775
IV	6.7	26.79	28.8	15.77	25.3	11.55
V	9.8	33.08	30.82	29.02	29.42	19.25
VI	6.6	26.1	27.5	20.22	31.12	8.3
VII	5.05	22.45	12.27	15.15	26.55	9.1
VIII	7.475	29.13	26.2	22.17	29.15	12.3
IX	4.525	46.22	23.62	13.57	19.22	7.9
X	11.02	35.74	19.72	27.22	30.92	15.72

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