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Intertidal sedimentology along Ambalappuzha coast, Kerala

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Abstract

Ambalappuzha coast in central Kerala is well known for persistent occurrence of mud bank at Purakkad. The results of the investigation carried out during July - December 2000 on sediment characteristics of Purakkad mud bank shelf, surrounding shelf of Ambalappuzha outside the mud bank and the shelf of the backwater outlet at Thottappally are reported. Considerable variations in sediment composition in relation to the environmental conditions were observed. Fine-grained particles in the mud bank shelf were the maximum during the active phase of mud bank. The mud bank shelf sediment was quite distinctive from the intertidal sediments outside the mud bank area, in having much higher values of organic matter, pH, chloride, sulphate and alkalinity, but with low phosphate content.

Keywords: Intertidal zone, mud bank, backwater outlet, sediment

Introduction

Monsoonal circulation is unique in the Arabian Sea. Kerala coast, experiencing heavy southwest monsoon, is subjected to various dynamic seasonal changes, notably in the environmental and sedimentary characteristics of the shelf regions. A considerable amount of river runoff enters the sea to add nutrient load to the inshore waters while the neritic bottom conditions are subjected to major changes, particularly through the process of upwelling during the monsoon and immediate postmonsoon months.

The formation of mud banks along certain stretches of the coast of Kerala during the southwest monsoon season is an annual phenomenon. The formation of mud bank is restricted to a sector of 270 km of the Kerala coast between Quilon and Cannore, where the sandy intertidal region of the coast is followed by a muddy substratum just below the tidal belt. The bottom sediments play an important role in the formation of mud banks. The mud bank area is characterised by the presence of loose and non-rigid surficial sediments. Mud of appropriate quality and texture accumulates at a particular water depth where the waves create a dense suspension of mud (Nair and Balchand, 1992). The mud bank formation influences the fish catches and thereby the socio-economic life of the fishermen community of Kerala by providing calm fishing grounds during the rough monsoon.

Ambalappuzha taluk in the central part of the Kerala coast is well known for the lucrative inshore fishery as well as mud bank fishery during the monsoon period. Purakkad, known for the persistent occurrence of mud bank, is situated at the southern end of Ambalappuzha taluk. Thottappally spillway, the controlled outlet of Vembanad backwater, is about 15 km south of Purakkad. The present study is aimed at analysing the variations in sediment characteristics of the neritic bottom in relation to the formation of mud bank along the coast of Ambalappuzha.

Material and Methods

The study was carried out in three selected stations in the intertidal coast in Ambalappuzha taluk extending from Karoor in the north to Thottappally in the south. Station I was located at Purakkad mud bank shelf while Station II at Karoor, 2 km north of station I and Station III in the backwater outlet at Thottappally, 15 km south of Purakkad. Samples were collected during July - December 2000 at fortnightly intervals. The mud bank during the year existed from July to October.

Triplicate samples of sediments were collected using a hand-operated metallic corer (25 cm long and 6.5 cm diameter) following the method of Holme and McIntyre (1971). The collected samples were analysed for temperature, pH, chloride, alkalinity, phosphate, sulphate, organic carbon, organic matter and texture following standard procedures (Krumbein and Pettijohn, 1938; El Wakeel and Riley, 1956; Strickland and Parsons, 1972; Grasshoff *et al.*, 1983).

Results and Discussion

The sand-silt-clay ratios determined showed higher percentage of silt in the mud bank sediments over the sediments of the surrounding shelf unaffected by the mud bank formation (Table 1). Sand particle in the sediment at station I (mud bank) was maximum during December (99.92%) after the dissipation of mud bank and lowest (96.60%) during July when the mud bank was active. The percentage of sand varied between 99.57 (July) and 100 (October, December) at Station II and between 97.38 (July) and 99.92% (October) at Station III. The difference in sediment texture between different stations could be due to the difference in environmental conditions like waves, tides and inland water flow. During the period of existence of mud bank (July - October) the percentage of sand was comparatively less at station I whereas station III which receives estuarine water had higher percentage of fine particles in the sediment during July when the inland water flow was maximum. Station II had less fine grained particles (silt & clay) throughout the period as strong tides and waves flushed out all the accumulated fine materials. The mud bank bottom is expected to be mostly silty clay in nature (Rao *et al*., 1984). But the sand particles were found to be very high in the present study at all stations mainly due to the proximity of the stations to the shore and the impact of nearshore activities on the sediment. However, the texture of the sediment varied spatially as well as temporally, the temporal changes being less evident at station II.

Compared to mineral constituents of the sediment, organic compounds are more varied and complex. Organic matter in the shelf sediments is mainly due to plant and animal matter brought from land through runoff. There is considerable variability in the supply of organic matter to the sediment as a result of spatial and temporal differences in the rate of primary production and zooplankton grazing, chemical and hydrological regimes in the water column and environmental conditions (Anila Kumary *et al*., 2001). Figs.1 and 2 represent the variations in organic carbon and organic matter. Monthly variations in organic carbon levels were found to be significant (ANOVA: $p < .05$). Associated with freshwater runoff, the silt in colloidal suspension containing large quantities of soil humates is brought into the shelf water and the humic material precipitates and settles if the environmental conditions are favorable. The materials transported to the mud bank area is deposited in the sediments during the period of existence of mud bank as its further movement is arrested as a result of absence of waves in this area. High organic content in mud bank sediments compared to adjacent non-mud bank sediments were reported earlier (Nair and Balchand, 1992). After the dissipation of mud bank, the organic content in the sediment was the maximum at station III. The effect of land drainage and the possible organic supply from the estuarine part account for the high organic content at station III.

Table 1. Sediment composition (%) at the three stations during July-December 2000

Month	Station I			Station II			Station III		
	Sand	Silt	Clay	Sand	Silt	Clay	Sand	Silt	Clay
July	96.60	2.60	0.80	99.57	0.01	0.47	97.38	0.82	1.80
August	96.74	3.08	0.18	99.82	0.03	0.15	98.90	0.75	0.35
September	97.24	2.71	0.05	99.87	0.08	0.50	99.90	0.10	0.00
October	98.77	1.19	0.04	100.00	0.00	0.00	99.92	0.25	0.05
November	99.34	0.10	0.66	99.98	0.00	0.02	99.02	0.68	0.20
December	99.92	0.00	0.08	100.00	0.00	0.00	99.79	0.15	0.06

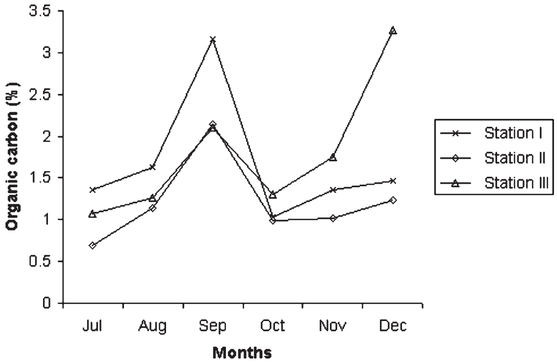

Fig. 1. Monthly variations in soil organic carbon (%) at the three stations

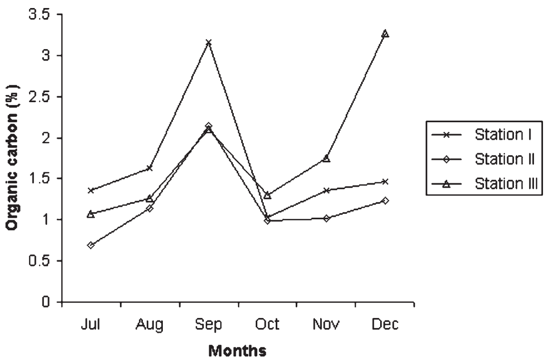

Fig. 2. Monthly variations in soil organic matter (mg/g) at the three stations

Soil phosphorus ranged from 0.013 to 0.056 mg/g at station I, 0.018 to 0.375 mg/g at station II and 0.013 to 0.218 mg/g at station III (Fig. 3). The distribution of phosphate in the sediment mainly depends on biological activity (Satyanarayana *et al.*, 1985). Lower phosphate values at station I can be attributed to its leaching to the overlying water and increased utilization by phytoplankton which is abundant in the mud bank waters. Leaching of phosphates to the overlying water because of heavy influx of freshwater followed by turbulence and its transportation to the offshore waters accounts for low levels of sediment phosphate at station III. Incorporation of phosphorus into the sediment through biological activity resulted in high values at station I after the dissipation of mud bank. The precipitation of phosphate is attributed to the pH of water, the solubility of phosphate decrease with increasing pH. A pH range of 7 to 7.5 and restricted

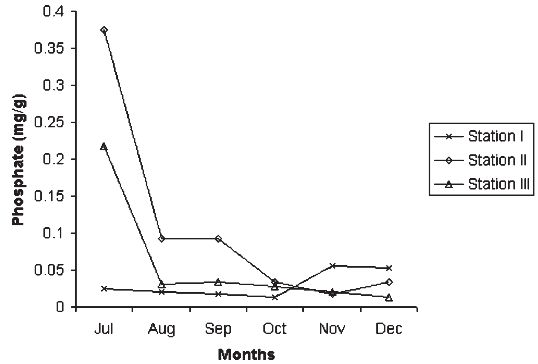

Fig. 3. Monthly variations in soil phosphate (mg/g) at the three stations

depositional environment are favourable for the formation of sedimentary phosphates.

Alkalinity of sediment indicates the net precipitation of calcium carbonate in the sediments. Alkalinity values fluctuated from 0.84 to 1.59 mg/100 g at station I, 0.80 to 0.94 mg/100g at station II and 0.88 to 1.35 mg/100g at station III (Fig. 4). During the existence of mud bank alkalinity was the maximum at station I and the least values were at station II. The high alkaline nature of the mud bank sediment was due to the decreased dissolution of $CaCO_3$ from the sediment into the water column (Padma and Periyakali, 1999). However, the highly turbulent condition during the southwest monsoon decreases the precipitation of $CaCO_3$ in the non-mud bank sediment.

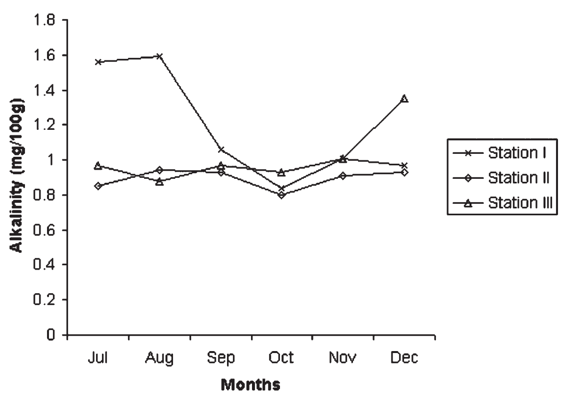

Fig. 4. Monthly variations in soil alkalinity (mg/100g) at the three stations

Sulphate (Fig. 5), pH (Fig. 6) and chlorides (Fig. 7) of the soil were also higher at station I during mud bank formation. Sulphate values ranged between 14.37 and 46.87 mg/g (station I), 20.63 – 37.50 mg/g (station II) and 11.25 – 37.50 mg/g (station III). The maximum sediment pH observed was 8.24 (station I, July), 8.10 (station II, November) and 8.05 (station III, December). The maximum values of chlorides in the sediment were during September at station I (3.94 mg/g), July at station II (3.28 mg/g) and December at station III (1.92 mg/g). Because of increased freshwater discharge, the chloride values were low in the sediment at station III.

The changes in the sediment characteristics were found to be associated with variations in hydrographic features during the southwest monsoon. The high chlorides and sulphates at station I and II depend on the salinity of water. July and August recorded decreased salinity in the inshore waters brought about by dilution due to land drainage. Stations II and I are open coasts with no influx of freshwater except land drainage while at station III freshwater discharge from the canal influences the hydrography considerably (Figs. 8 - 10). Surface water temperature was the minimum during the monsoon season at all stations. The surface replenishment accompanied by high photosynthetic activity resulted in slightly higher dissolved oxygen during the postmonsoon months at all stations.

Sediment characteristics of sea shelf are a function of climate, bathymetry and hydrography. Variations in these parameters result in different depositional environments with characteristic sediment formation (Hashmi *et al*., 1981). Monsoon rains and associated changes in freshwater discharge

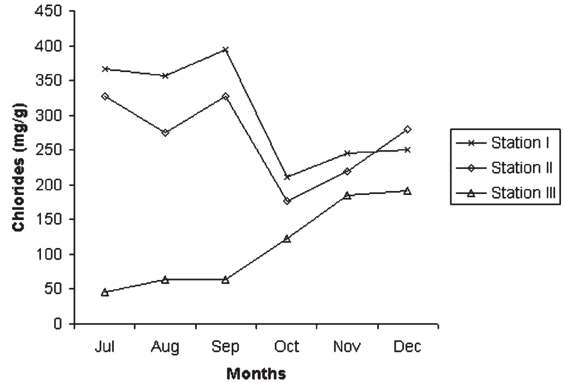

Fig. 7. Monthly variations in soil chlorides (mg/g) at the three stations

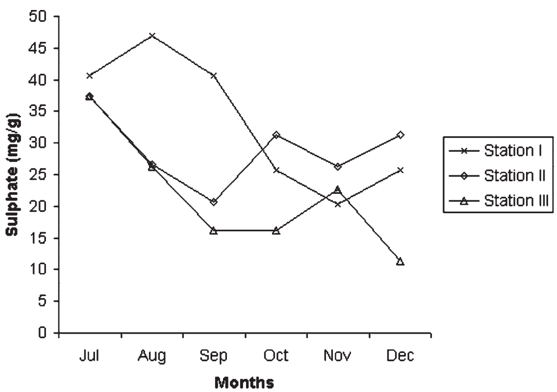

Fig. 5. Monthly variations in soil sulphate (mg/g) at the three stations

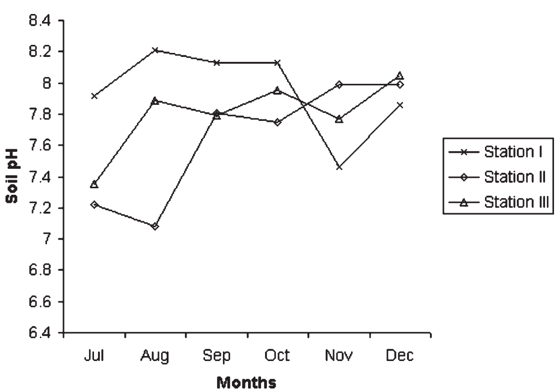

Fig. 6. Monthly variations in soil pH at the three stations

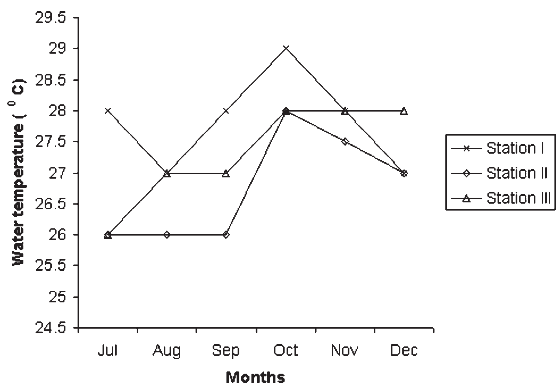

Fig. 8. Monthly variations in surface water temperature (°C) at the three stations

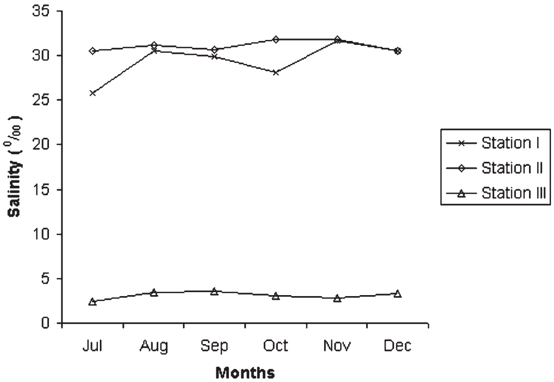

Fig. 9. Monthly variations in surface water salinity at the three stations

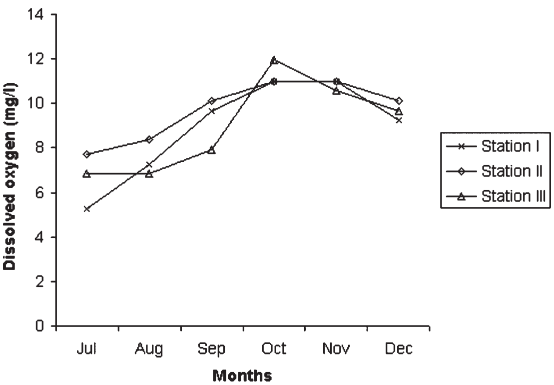

Fig. 10. Monthly variations in surface water dissolved oxygen (mg/l) at the three stations

influence the environmental and sedimentary characteristics considerably. Tides, waves and turbulence are the influencing factors in bringing about seasonal variations in sediment characteristics. Stations II and I in the open coast with no influx of freshwater except land drainage and at station III the estuary outlet influences the sediment characteristics considerably. The mud bank shelf sediments are quite distinctive from the sediments of the intertidal shelf outside the mud bank and also from the sediments of mud bank area itself after the dissipation of mud bank. The mud bank shelf sediments have higher percentage of fine fractions along with higher values of organic matter, pH, alkalinity, chloride and sulphate.

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