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Comparative Study of Textural and Chemical Characteristics of Riverine and Estuarine Sediments of a bar Built Estuary in Tamil Nadu, India

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Abstract

Pazhayar is one of the main river systems in Kanyakumari District. It receives water from both Pechiparai and Perunchani reservoirs. The Pazhayar takes its origin at Surulacode. The total length of the river is about 37km and it passes through Boothapandi, Thazhakudi, Putheri, Nagercoil, Suchindrum and finally joins with Arabian Sea through a Manakudy estuary. The present investigation was done to evaluate the sediment characteristics of riverine and estuarine zones. For the study three stations were taken in the riverine zone (S1, S2 and S3) and three stations were selected on the estuarine zone (S4, S5 and S6).The sediment texture revealed the fact that grain size ranged from 0.063mm to 0.5mm. Sand was predominant in the riverine side. The mud (silt + clay) was abundant in the estuarine region than the riverine zone. The estuarine zone was highly silty. The sulphur content decreased from the riverine side to estuarine zone. The organic carbon also showed the same trend of decreasing from the riverine zone to estuarine region. However a negative trend was observed in calcium carbonate which increased from the riverine zone to estuarine region. Probably due to the abundance of molluscan shells in the estuarine zone. The various parameters of surface sediments in the six stations were subjected to two way ANOVA and it was found that they are significantly correlated.

Keyword: Estuary, sediment, organic carbon, calcium carbonate, sulphur.

Introduction

Sediments contained large fractions of sand than silt and clay. The physico chemical character of sediments regulates the type of food, feeding and other life activities of benthic forms to a great extent[1]. The variability of fresh water discharge at the upstream boundary is a major control on sediment concentration and transport[2]. In mangrove the distribution of organic carbon in sediment and total microbial population was found to be directly proportional with each other which indicates microbial population will be more if organic carbon of sediment increases[3]. Higher organic carbon content in mangrove forest is due to larger quantities of mangrove detritus. Mangrove regions are highly productive and play an important role as breeding and nursery grounds for many commercially important fishes especially shrimps[4]. Jingzhang observed that the river sediments are sandy silt and are coarse grained[5]. Muraleedharan Nair and Ramachandran observed that estuary sediments are clayey silt and fine grained though at the head of the estuary sand is dominant[6].

Mangrove deforestation contributing to fisheries declines, degradation of clean water supplies and stalinization of coastal soils, erosion, and land subsidence, as well as the release of carbon dioxide into the atmosphere[7]. Sesamal observed that organic carbon in the sediment was low during monsoon and it might be due to incessant stirring up of the sediment releasing the organic carbon from the sediment to the water column[8]. Further the sediment was mainly composed of sand brought out by incessant flow of waters during monsoon season. Nasnolkar found that organic carbon contents showed seasonal fluctuations influenced by rainfall[9]. Higher values of organic carbon was found during the post monsoon period and it was attributed to influx of land run off containing considerable amount of terrigenous organic matter. Geetha Bhadram observed that sediments in Ashtamudi estuary contained large fractions of sand than silt and clay[10]. Selvam based on the studies found that the sediments of Adayar, Ennore back waters had higher percentage of sand and decreased percentage of silt and other finer particles during monsoon period[11]. They opined that it could be attributed to the flushing of finer materials from estuarine region to the sea. The study showed predominance of sand in the majority of the regions irrespective of the seasons. It may be due to the physical process of transportation and deposition of sand by the incoming river flow. Ghosh and Choudhury observed that the texture of the sediment controls the organic carbon content[12]. Several workers found fine grained sediments generally have higher amounts of organic matter than coarse grained sediments.

Goldhaber and Kalpan studied sulphur in sediments and found that the concentration levels are higher in the interior mangrove sediments than the estuarine sediments[13]. In the mangrove sediment, sulphate reduction was dominant and the mineralization processes was upto the depth of 1m. Schemainda found the river drained nutrients can contribute to a considerable increase in the primary production of organic matter[14]. Muraleedharan Nair and Ramachandran studied the

river sediments and found that texturally, the river sediments are sand and silt are coarse grained, whereas in an estuary the sediments are clayey silt and fine grained though at the head of the estuary, sand was dominant[6].

Material and Methods

Description of the study area: Pazhayar river: Pazhayar is one of the major river systems in Kanyakumari district and this river is used for cultivation purposes for the entire NanchilNadu delta. Pazhayar river which originates from the forested area of Surulacode, carries small streams from Mahendragiri peak and flows through Thovalai and Agastheeswaram Taluk. The total length of the river is about 37km and it passes through Boothapandi, Thazakudi, Putheri, Nagercoil, Suchindrum and finally joins with the Manakudy estuary.

Manakudy Estuary: Kanyakumari District is located on the Southern extremity of the Indian Peninsula between lat $8^0 2'$ and $8^0 4'$N and between long $77^0 26'$ and $77^0$30'E The district receives heavy rains during the South West (June to August) and North East monsoons (October to December). Pazhayar is one of the main river systems in the District and this river takes its origin at the Western ghats. From the place of its origin it traverses 23.1km before entering the Arabian Sea through the Manakudy estuary.

In order to study the state of health of the Manakudy estuary three stations were selected from the mouth to the head of the estuary. The results of the present investigation are based on the analyses of one time collection of sediments from the three stations.

The locations of the stations selected include 1-3 are in course of the Pazhayar river. Station 4-6 are selected in the Manakudy estuary.

Station : 1 Surulacode: It is located exactly at the place of origin 14.3 km from the district headquarters. The water is very clear and the bottom is sandy.

Station: 2 Suchindrum: The station is very near to the famous Suchindrum temple. The station is almost completely surrounded by paddy fields. Vegetation is not very abundant but not scarce. The bottom soil is sand mixed with clay.

Station: 3 Mission Dam: This station is very near the Manakudy estuary. The water is stagnant except during rainy season. The soil is very hard with abundance of molluscan shells.

Station: 4 Head of the Estuary: This station is located at the head of the estuary where the fresh water of the river enters the estuary.

Station 5: Mangrove Forest: This station is located at the middle of the estuary. The Society of Environmental Education and Development (SEED) has a pilot project of afferestation to establish Mangrove forest in the Manakudy estuary. The Mangrove forest is well established and has become the nesting place for birds. The bird dropping and decaying mangrove litter has increased the organic profile of this area.

Station: 6 Mouth of the Estuary: This station is situated at the mouth of the estuary almost near the sand bar. A boat jetty is located at the banks of this station.

Sample collection: Surface sediment samples were collected from three stations in Manakudy estuary and three in the course of Pazhayar River. The collected sediment samples were air dried and used for estimating sulphur, organic carbon and calcium carbonate. Textural studies on the sediments were performed for sand, silt, clay distribution and grain size. Organic carbon was determined by exothermic heating and oxidation with potassium chromate and concentrated sulphuric acid followed by titration of excess dichromate with 0.5N ferrous ammonium sulphate solution. Sulphur was estimated gravimetrically. Grain size are determined by different sieves.

Results and Discussion

Grain size : The textural studies revealed the nature of sediment texture in the riverine and estuarine sediments. Percentage of grain size in the estuarine and riverine sediments are shown in table 1. The grain size varied from 0.063mm to 0.5mm. Station S2 showed the minimum (1.52%) and S3 showed the maximum (14.26%) in 0.063mm. In 0.106mm S3 showed the maximum (16.94%) and S2 the minimum (7.9%). In 0.15mm the maximum value (28.52%) was obtained in S6 and minimum (9.31%) in S2. In 0.25mm S5 showed the maximum (27.48%) and S3 showed the minimum (18.29%). There was only marginal difference in S4, S5 and S6. In 0.30mm S3 showed the maximum (18.66%) and S4 the minimum (11.21%). In 0.355mm S2 showed the maximum (38.56%) and S3 showed the minimum (8.34%). In 0.5mm S3 showed the maximum (16.9%) and S6 showed the minimum (6.00%).

Soil Profile: The percentage of sand and mud (silt and clay) differed markedly in all the six stations. The percentage of sand ranged from 70.1to 91.08. Station 3 showed the maximum percentage of sand (91.08) followed by S2 (87.31) and S5 (85.89). The minimum value was found in S4 (70.12) .The percentage of silt ranged from 7.25 to 29.33. The maximum silt concentration was noted in S4 (29.33) followed by S6 (17.91). The minimum value was found in S3 (7.25).

The amount of clay ranged from 0.55% to 1.67%. Station 3 showed the maximum amount of clay (1.67%) and the minimum was found in S4 (0.55%). The percentage of clay was uniformly low in all the stations. The mud (silt + clay) also showed marked variation ranging from 8.92% to 93.88%. The maximum was obtained in S4 (93.88%) and minimum was obtained in S3 (8.92%).

Sulphur: The amount of sulphur varied from 0.961% to 3.112%. The minimum value of sulphur was recorded in S6 (0.961%) and maximum in S1 (3.112%). The average values of sulphur decreased from riverine (2.154%) to estuarine (1.201%). The decrease in sulphur from riverine to estuarine sediments is attributed to oxidation of H_2S along the riverine sediments resulting in low values in estuarine sediments[15].

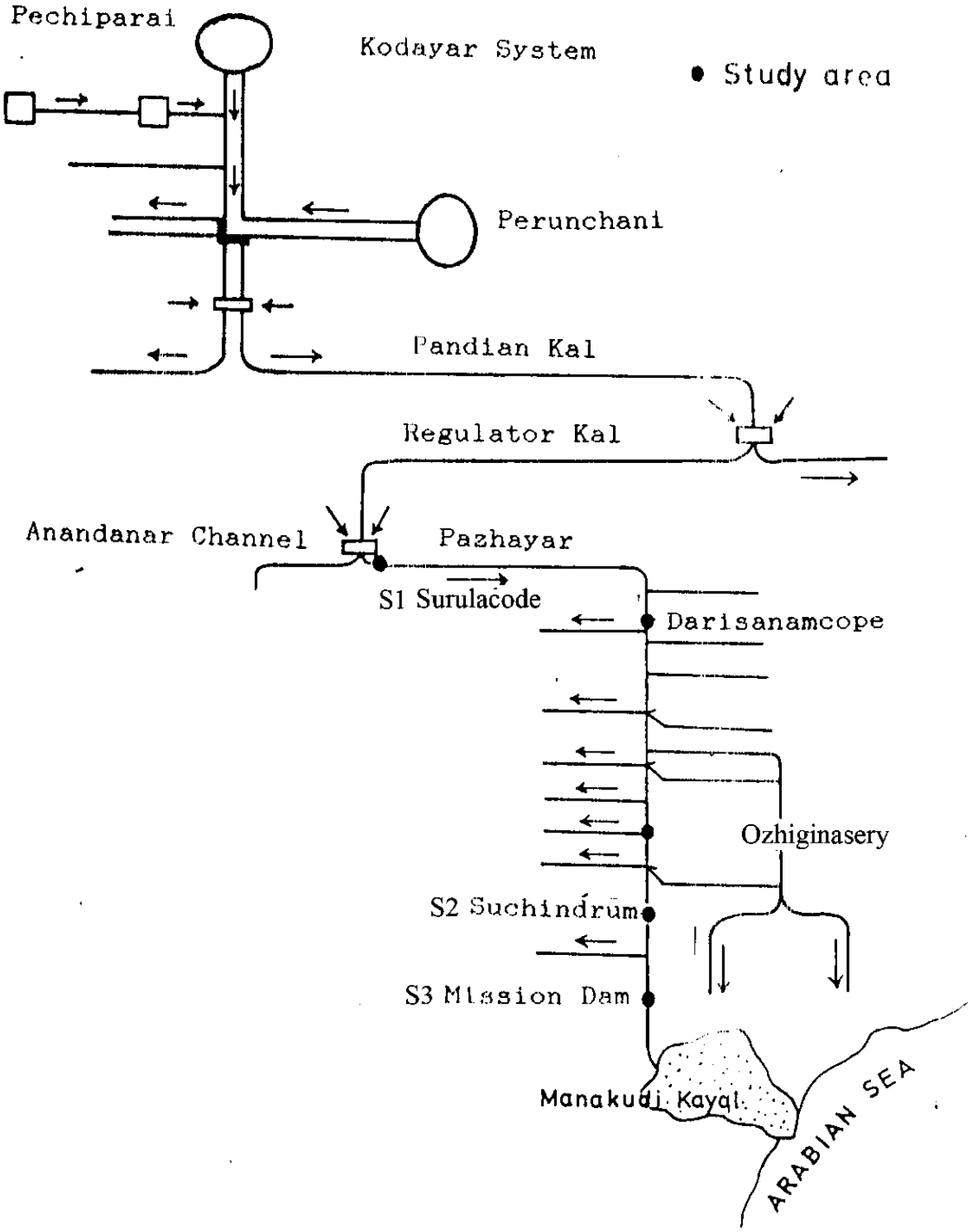

Figure-1
Location of the study area

Organic carbon: Organic carbon ranged from 0.62% to 3.11%. The minimum value was recorded in S4 (0.62%) and the maximum was recorded in S3 (3.11%). The average values of organic carbon decreased from the riverine zone (2.08%) to the estuarine zone (1.45%). Organic carbon increases with increasing finer fraction and decreases with increasing coarser fraction in the sediments. One of the features of organic carbon in the sediments is that its concentration increases as the particle size of the sediments decrease[16]. The finer fractions (silt and clay) showed as efficacious relationship with organic carbon while the coarser fractions have no patent kinship. The relatively lower percentage of organic carbon in the estuarine side should be attributed to the constant flushing activity by tides along with the impact of waves which removes the finer fractions of the sediments and there by decreases the organic carbon. Further clay content of the sediment showed a positive correlation with organic carbon. Rajamanickam and Setty have expressed the possibility of greater accumulation of organic carbon in the case of clayey sediment which offers larger surface area for the adsorption of organic carbon[17]. The organic carbon increases with increase in silt and clay percentage and decrease with sand percentage. Since the percentage of clay was relatively higher in the riverine side there is increase in organic carbon. The texture of sediment also controls the organic carbon[12].

Calcium carbonate: The calcium carbonate values ranged from 0.5% to 34.5%. The minimum was recorded in S3 (0.5%) and the maximum was recorded in S4 (34.5%). The average values of calcium carbonate increased from riverine zone (4.3%) to the estuarine zone (12.83%). The increase in calcium carbonate in the estuarine sediments is due to the large quantities of mulluscan shell fragments and foraminiferan shells. The various parameters of surface sediments in the six stations were subjected to two way ANOVA and it was found that they are significantly correlated and shown in table 2.

Table-1
Percentage of Grain size in the estuarine and riverine sediments

Size	S1(%)	S2(%)	S3(%)	S4(%)	S5(%)	S6(%)
0.5mm	6.59	9.76	16.9	9.87	7	6
0.355mm	15.16	38.56	8.34	13.73	16.66	11.74
0.3mm	12.58	14.09	18.66	11.21	17.49	10.55
0.25mm	19.92	18.86	18.29	25.76	27.48	27.16
0.15mm	20.8	9.31	21.82	20.9	19.44	28.52
0.106mm	13.03	7.9	16.94	10.84	8.7	12.11
0.063mm	11.92	1.52	14.26	7.69	3.23	3.92

Table-2
Two way ANOVA of sediment parameters between the stations

Source of Variation	SS	df	MS	F	P-Value	F crit	Remark
Stations	134.821	5	26.9642	0.520232	0.758548	2.602987	NS
Parameters	31057.49	5	6211.498	119.8411	1.24E-16	2.602987	*
Error	1295.778	25	51.8311	-	-	-	-
Total	32488.09	35	-	-	-	-	-

*Significant at 5% level

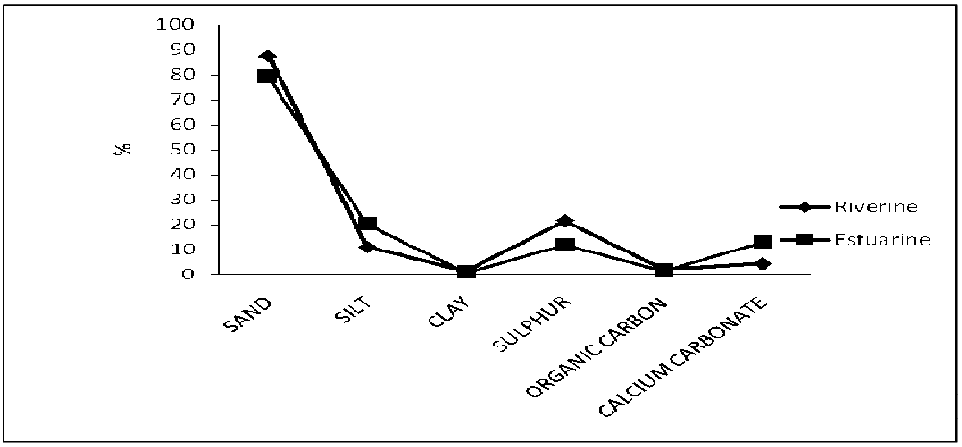

Figure-3
Comparative account on the parameters of riverine and estuarine sediment (%)

Table-3
Comparative account on the parameters of riverine and estuarine sediment (%)

Station	Sand	Silt	Clay	Sulphur	Organic Carbon	Calcium Carbonate
Riverine (S1,S2,S3)	87.63	10.99	1.373	2.1536	2.0766	4.3333
Estuarine (S4, S5,S6)	79.04	20.12	0.836	1.2016	1.453	12.8333

Conclusion

The sediments of manakudy estuary showed varied texture and sediment type. The percentage of sand and mud (silt and clay) differed markedly in all the six stations. Due to the oxidation of H_2S along the riverine sediments, sulphur decreased from riverine to estuarine. Decrease in organic carbon in estuarine zone was due to constant flushing of tides. The increase in calcium carbonate in the estuarine sediments was due to the large quantities of mulluscan shell fragments and foraminiferan shells.

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