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Research Paper

Determination of Surface Sediment Characteristics in Manakudy Estuary, Kanyakumari District, Tamilnadu, India

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Abstract
Estuary receives the highest amount of nutrients, minerals, trace and heavy metals and other compounds. In this study, the surface sediment characteristics of the Manakudy estuary were analyzed based on the parameters like temperature, pH, Electrical Conductivity (EC), Total Nitrogen (TN), Total Phosphorus (TP), Sodium (Na), Potassium (K), Calcium (Ca), Calcium Carbonate ($CaCO_3$), Organic Carbon (OC), Sulphur (S), Sediment texture (Sand, Silt, Clay) and Grain size distribution. Sediment analysis was carried on six sampling stations during the period from August 2019 to July 2020. The results showed that themaximum value of the majority of the parameters observed in S1 and S5, which may be caused by anthropogenic activities and saltwater intrusion within its catchment. Grain size analyses were also performed using Ro Top sieve shaker. During this study, all six stations have different grain sizes. The characteristics of surface sediment indicate the contamination, heavy metal accumulation of soil and explain the quality of a particular aquatic environment.
Key Words: *Estuary, Sediment texture, Grain size.*

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I. Introduction

Water is an essential natural resource for all living organisms in the world. In today's scenario, unplanned urbanization, rapid industrialization, modern agriculture and indiscriminate use of chemicals cause of heavy pollution in aquatic environments leading to a deterioration of water quality. Sediment may act as a sink for a large number of contaminants and also it contains a record of the previous pollution. Sediments are indicators of the quality of overlying water and their study is a useful tool in the assessment of environmental pollution.

Sediments play an important role in the transport of nutrients, metals and other contaminants through river systems to the world's oceans and seas (Hussein K Okoro et al., 2012). The contaminated sediments could be a second source of pollution of the overlying water when the environmental conditions to which the sediment is exposed are altered (Nriagu, 1988). The land practices, nutrients and pesticides to rivers as leach out shall affect biological integrity (Vinod Gopal and Sabu Joseph, 2015).

The chemical composition of sediment is informative. So the Characterization of surface sediment in an estuary is important with respect to water use. The basic parameters like temperature, pH, the electrical conductivity of surface sediment were largely influenced by the quality of the aquatic environment. Major nutrients like nitrogen, phosphorus, and potassium are essential to plant nutrients. In large quantities, they can encourage the growth of nuisance aquatic plants (Gulfem Bakan et al., 2010). The main components of aquatic ecosystems are of calcium and calcium carbonate, which influence organic productivity. Calcium carbonate was mainly found in sedimentary rocks. Excessive consumption of it can be hazardous. Determination of organic carbon reflects the organic content of the surface sediment, which is an essential component for the growth of the benthic organism in an aquatic environment (Sharma et al., 2018).

Sediment is an important repository and sink for sulphur (S). The anaerobic zones in the aquatic ecosystems are strongly affected by the chemical form of Sulphur (Wag Jingfu et al., 2016). The distribution

pattern of sediment texture identifies the hot spots or contaminated sites (Sheela et al., 2013). Sediment grain size gives specific characteristics to the sediment like nutrient holding capacity, sediment stability.
The present work focuses on the determination of contamination or pollution of the Manakudy estuary based on the characteristics of surface sediment through the geochemical parameters.

II. Materials and Methods

2.1 Description of the study area:

The Manakudy estuary is one of the major estuaries in the Kanyakumari district. It is one that naturally connects the Arabian Sea and the Pazhayar river. It has an area of about 150 hectares and lies between the latitude $8^0$09'N and longitude $77^0$48' E. It is the second-largest estuary in the Kanyakumari district where geochemical, biological, and sedimentological processes are highly variable. A lot of aquatic communities such as fish, corals, birds, etc., depend on this estuary.
In the present work , six stations (S1-S6) were selected around the Manakudy estuary.

Table- 1: Sampling stations and their coordinates

Sampling stations	Locations	Coordinates (DD)	
		Latitude	Longitude
S1	Starting point of Manakudy estuary	8.112682	77.480686
S2	Near Mangrove forest	8.102550	77.483152
S3	Near Coir retting area	8.094151	77.486818
S4	Manakudy bridge	8.091796	77.484306
S5	Near salt pan	8.095646	77.4865
S6	Manakudy river mouth	8.08850	77.48550

2.2 Sampling

The surface sediment samples were collected using Petersen's grab sampler. The samples at each station were stored in a plastic bag and labeled. Sediment samples were air-dried for three weeks under room temperature and used for determining geochemical characteristics of sediment such as temperature, pH, Electrical Conductivity (EC), macronutrients (N, P, K) level, sodium (Na), calcium (Ca), Calcium carbonate (CaCO3), Organic carbon (OC), Sulphur (S), sediment texture (sand, silt, clay) and Grain size.

2.3 Experimental

Chemical parameters of surface sediment were analyzed by the standard methods obtained from the book of soil and water analytical methods (Clarson, 2012). Sediment texture was analyzed using the pipette method (Krumbein, 1939, Ingram, 1970 and Folk 1981). Grain size analyses were also performed using a Ro Top sieve shaker containing a set of seven sieves ranging from 0.500mm to 0.063mm viz. 0.500mm, 0.355mm, 0.300mm, 0.250mm, 0.150mm,0.106mm, 0.063mm. About 100g of sediment was sieved for 15minutes using Rotop sieve shaker. The materials from different sieves were collected separately for weighing and tabulated.

III. Results and Discussion

The results of the various parameters of surface sediment characteristics for contamination assessment were given in Tables 2 and 3. The parameters reflect the dynamics of the annual river cycle. The results indicate the quality of the estuary is deteriorating from S1 to S6.

3.1 Temperature and pH: The mean temperature and pH value of surface sediments in the estuary during the study period were 28.50°C and 8.06. The sample at S5 (near salt pan) showed the highest mean temperature and pH of 30.2°C and 8.63. This can be indicated that the sites are consuming pollutants and alkaline.

3.2 Electrical Conductivity (EC): EC is directly proportional to soluble salt potential in sediment. The average EC of the estuary during the study period was 2.83 mS/cm. The sample at S5 showed the highest mean EC value of 9.14 mS/cm. This is maybe due to the interference of the river and its pollutants in S1.

3.3 Total Nitrogen (TN): Total nitrogen is the main macronutrient in sediments. The average TN of the estuary during the study period was 139.06 $Kg.ha^{-1}$.The mean total nitrogen of the surface sediment samples varied from 85.9 $Kg.ha^{-1}$ (S4) to 198.53 $Kg.ha^{-1}$ (S2). A high value of TN may be due to the high level of organic matter.

3.4 Total phosphorus (TP): It is an important parameter of surface sediment. In the present study, the average TP of the estuary during the study period was 36.01 $Kg.ha^{-1}$ and the mean TP concentration is from 26.67 $Kg.ha^{-1}$(S6) to 46.88 $Kg.ha^{-1}$ (S1). The high concentration of TP observed in sediments may be due to phosphorus fertilizer and dead organic matter.

3.5 Potassium (K): It is one of the essential macronutrients in surface sediment. In the present work, the average K of the estuary during the study period was 56.13 ppm and the mean TP concentration range is from 17.92 ppm (S3) to110.75 ppm (S1). The high value of K in sediment may be due to the leaching of potassium from the surrounding crop fields, which contained potassium in the form of fertilizer.

3.6 Sodium (Na): Sodium is a naturally occurring component in sediments. In the present work, the average Na of the estuary during the study period was 238.28 ppm. The mean value of Na varied from 76.91 ppm (S3) to 669.49 ppm (S5). The maximum value of Na indicates a high degree of pollution and inflow of water from the neighboring salt pan.

3.7 Calcium (Ca) and Calcium Carbonate ($CaCO_3$): Calcium and calcium carbonate are important parameters of sediments in the estuary. In the present work, the average Ca and $CaCO_3$ of the estuary during the study period was 874.31ppm and 12.33 %. The mean value of Ca and $CaCO_3$ varied from 166.67 ppm (S1) and 6.09 % (S1) to 3796.7 ppm (S6) and 37.78 ppm (S6). The maximum value of Ca and calcium carbonate was found in molluscan shell fragments in sediments.

3.8 OC: The mean value of OC of the sediments during the study period was 2.18 %. The mean value of OC varied from 1.12 % (S6) to 3.82% (S1). The high OC % may be due to the high sewage discharges, increased finer fractions of the sediments, which adsorb organic matter.

3.9 Sulphur (S): The average sulphur content during the study period was 3.84%. The mean value of sulphur within the range of 0.97 % (S4) – 12.16 % (S5), a high value of S indicates the sampling site is highly polluted.

3.10 Sediment texture: The average value of sand, silt, and clay during the study period were 54.81 %, 44.50 % and 0.70% respectively and sediment texture was silty sand. The mean percentage of sand, silt, and clay at different stations in the estuary during the study period were tabulated in Table. 2. The percentage of sand was higher at S4 (73.49 %), the percentage of silt was higher at S1 (59.99 %) and the clay percentage was higher at S1 (1.27 %). The distribution pattern of sediment texture identifies the contaminated sites. The sediment have high in sand fraction, which is characteristically good in drainage and aeration if the sediment has high clay content, which has high nutrient holding capacity and soil stability. Sediment high in silt will be intermediate.

3.11 Grain size: Average grain size distribution of surface sediments in the Manakudy estuary was given in table 3. The result showed that S1 has a high percentage of less grain size sediments. This grain size information of sediment can be used to identify the sample deposit in the sediment.

Table-2: Surface sediment parameters of the Manakudy estuary

Parameter	S1	S2	S3	S4	S5	S6	Min	Max	Mean±SD
Temp (◦C)	29.4	27.8	29.8	27	30.2	26.8	26.8	30.2	28.50±1.48
pH	8.43	8.04	7.51	7.88	8.63	7.89	7.51	8.63	8.06±0.41
EC (mS/cm)	4.06	1.43	0.58	0.89	9.14	0.87	0.58	9.14	2.83±3.35
TN ($Kg.ha^{-1}$)	171.27	198.53	118.65	85.9	165.25	94.73	85.9	198.53	139.06±45.76
TP ($Kg.ha^{-1}$)	46.88	41.42	38.92	30.63	31.54	26.67	26.67	46.88	36.01±7.64
K (ppm)	110.75	62.02	17.92	54.60	63.72	27.78	17.92	110.75	56.13±32.69
Na (ppm)	183.46	149.01	76.91	158.65	669.49	192.14	76.91	669.49	238.28±215.14
Ca (ppm)	166.67	293.33	171.67	556.67	260.83	3796.7	166.67	3796.7	874.31±1438.72
$CaCO_3$ (%)	6.09	8.42	6.45	6.43	8.83	37.78	6.09	37.78	12.33±12.52
OC (%)	3.82	3.06	1.59	1.27	2.19	1.12	1.12	3.82	2.18±1.07
S (%)	2.57	1.99	1.97	0.97	12.16	3.38	0.97	12.16	3.84±4.15
Sand (%)	38.74	42.09	65.99	73.49	53.71	54.83	38.74	73.49	54.81±13.38
Silt (%)	59.99	57.19	33.53	26.03	45.58	44.67	26.03	59.99	44.50±13.14
Clay (%)	1.27	0.72	0.48	0.48	0.72	0.5	0.48	1.27	0.70±0.30

Table-3: Average grain size distribution of surface sediments in the Manakudy estuary

Grain size(mm)	Percentage of surface sediment					
	S1	S2	S3	S4	S5	S6
>0.500	46.04	47.01	64.43	36.26	61.35	9.44
0.500>size>0.355	31.7	31.28	21.22	35.41	22.1	37.97
0.355>size>0.300	4.17	2.94	2.95	7.28	3.91	11.91
0.300>size>0.250	10.55	10.5	6.67	13.25	8.97	27.67
0.250>size>0.150	3.95	4.51	2.59	4.78	1.88	8.23
0.150>size>0.106	1.42	1.75	0.71	1.53	0.87	2.38
0.106>size>0.063	0.88	1.35	0.36	0.69	0.72	1.57
<0.063	1.43	0.95	1.28	1.21	0.35	1.05

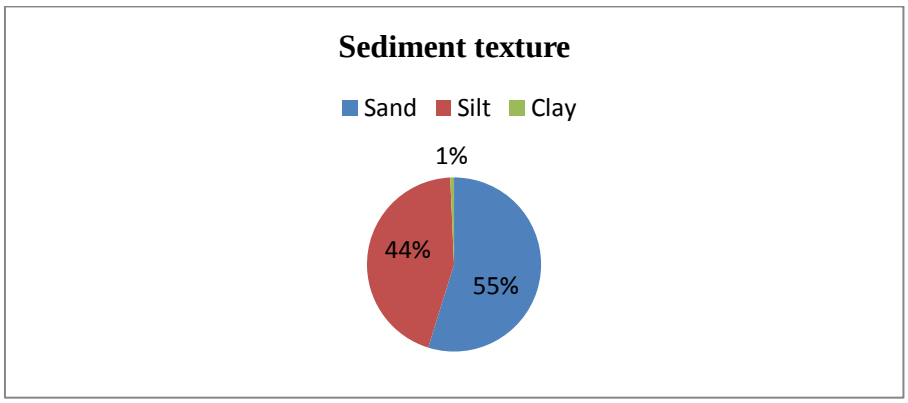

Fig.1 Mean sediment texture of the Manakudy estuary

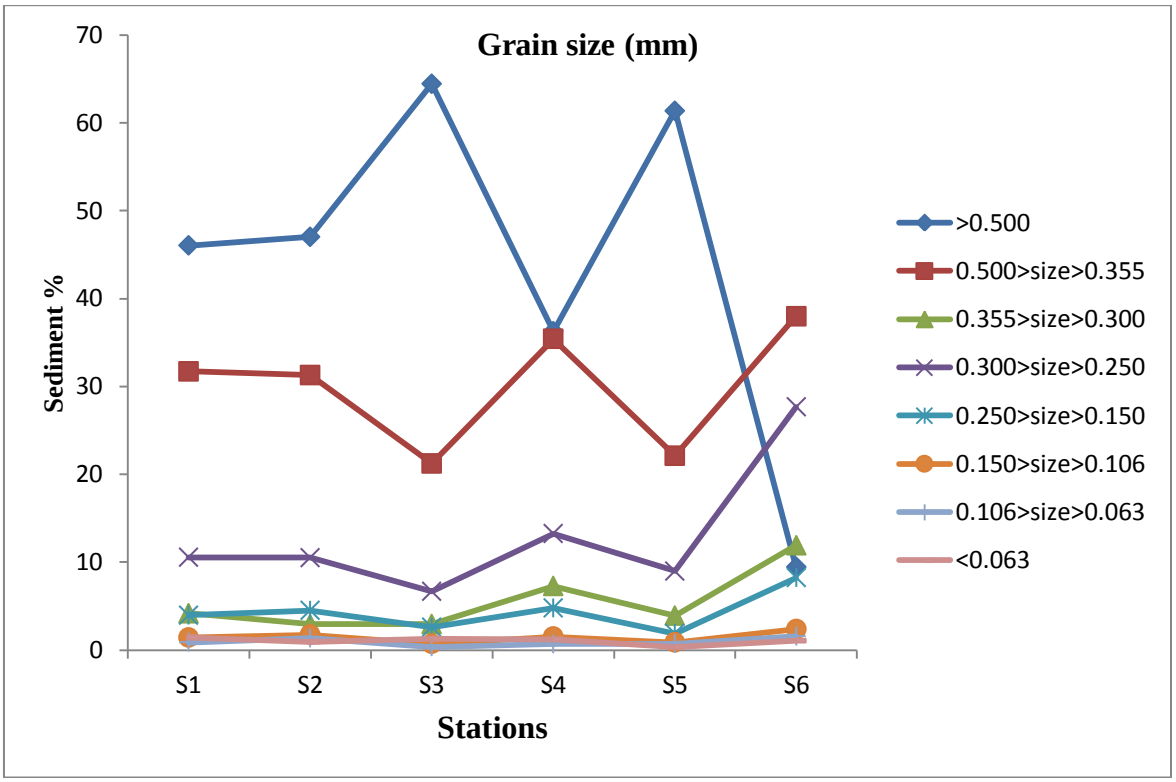

Fig.2 Mean grain size distribution of the Manakudy estuary

IV. Conclusion

The present work provides applicable data for the characteristics of surface sediments in the Manakudy estuary. Based on the results, the parameters such as TP, K, OC, silt, and clay were high in S1 (Starting point of the estuary); The TN were high in S2 (near Mangrove forest); temperature, pH, EC, Na, S were high in S5 (near salt pan); Ca and CaCO3 were high in S6 (mouth of the estuary). This study was used to identify the pollution sources, pollutants distribution and to evaluate the quality of the Manakudy estuary. Pollution control should be enhanced across the river and around the estuary.

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