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GRAIN SIZE AND SEDIMENT CHARACTERIZATION OF LAGOON SEDIMENTS IN PULICAT LAKE, NORTH CHENNAI COASTAL REGION, SOUTH EAST COAST OF INDIA

B. Prabhu Dass Batvari[1],* and V.E. Nethaji Mariappan[2]

[1]Center for Earth and Atmospheric Science, Sathyabama University, Jeppiaar Nagar, Rajiv Gandhi Road, Chennai-600119, India

[2]Centre for Remote Sensing and Geoinformatics, Sathyabama University, Jeppiaar Nagar, Rajiv Gandhi Road, Chennai-600119, India

*E-mail: batvarib@gmail.com

ABSTRACT

We presenting the results from a detailed study based on thirty three sediment samples were collected from Pulicat Lake during two seasons. The sand, silt and clay ration varies accordingly during premonsoon and post monsoon with variables at difference stations being observed. The maximum percentage of sand (95.85%) were seen near the bar mouth (Station 1) of Pulicat Lake with the average of 16.07% and 35.91% during post monsoon and premonsoon respectively. Silt percentage (average 14.55%) shows an increasing trend towards middle of the lake with maximum value at station 32. The clay content of sediments varies with the maximum values at station 18, 20 and 21 being minimum at 1, 2, and 3. This implies that the clay content shows an increasing trend towards the middle of the lake. The average value during premonsoon were 1.41% in comparison to post monsoon were 3.01%. The highest value were recorded at station 8 (4.10%), middle of the Lake during premonsoon with a minimum level at station 19 (0.20%).

Keywords: Lagoon, grain size, Sediment, Pulicat Lake

INTRODUCTION

Sediments play a significant role in aquatic systems and act as storage reservoirs for all kinds of pollutants which are introduced in to the aquatic ecosystem either by man or natural processes. Sediment consists of particles of varying sizes, shape and chemical composition, and are transported through different natural agencies and deposited according to their textural properties in different areas such as s and Seas[1].

Sediments (both estuarine and marine) usually act as sinks of river borne metals released through weathering and human activities in terrestrial environments[2-8]. The study of sediments and the distribution of metals in the sediments are more essential from the point of view of environmental pollution because sediment concentrates metals from aquatic systems, and represents an appropriate standard to monitor contamination[9]. The grain size, organic-matter and calcium carbonate content may be serious factors other than pollution that influence metal distributions in sediments[4,10].

Bottom sediments consist of particles have been transported by water, glaciers or air from the sites of their origin in a terrestrial ecosystem and have been deposited on the floor of a lake, river or ocean. In addition to these particles, bottom soil will contain materials precipitated from biological and chemical processes. Natural processes responsible for the formation of bottom sediments can be changed by anthropogenic influence. Many man-made materials have entered bodies of water through runoff from land, atmospheric deposition or direct discharge into the water. Most hydrophobic organic contaminants, metal composites, and nutrients, which enter into the water, become associated with particulate matter. Under certain situation the contaminants in the bottom sediments may be released back into the water or enter the food chain. Therefore, bottom sediments are a sink as well as a source of pollutant in the aquatic

environment. These contaminants may pose a high risk to the ecosystem on a large scale and hence need to be monitored at regular intervals. Environmental monitoring includes sampling and examines of the sediments.

Over the past four decades, there has been increasing interest in the significance of grain size data as an indicator of sedimentary environment and processes[11-14]. Grain size analysis has recently been used in environmental studies, relating fine-grained samples to micro-contaminants in several environments, e.g., marine and transitional[15-20]. Toxic metals are usually bound to marine sediments, including those found in estuaries and lagoons[21-23]. Lagoon sediments usually have high clay concentrations, which increase the particle–particle interface.

Grain size parameters have been used to characterize the sediments in the shelf environment[24]; moreover, the bottom topography of any modern environment is affected by the distribution and transportation processes of the sediments present in the area[25]. According to[26], analyses of textural parameters are indicators of the ecological condition as they are environmental sensitive. A detailed study on San Francisco Bay revealed that temporal fluctuations were noticed in grain size during river discharges[27].

EXPERIMENITAL

Study Area

The study area is restricted to the lake waters of Pulicat, which is the second largest brackish water lagoon in India running parallel to the Bay of Bengal, bordering the east coast of Andhra Pradesh with a portion of it extending into the northern part of Tamil Nadu (Figure. 1). The lake extends to about 59 km from north to south direction with maximum width of 19 km in east–west direction in the northern sector of the lake. The narrowest part of the lake is near Pazhaverkadu Village measuring about 250 meters with a narrow channel part. In the northern part of Lake, there are two larger islands Veynadu and Irakkam and a much smaller one called Kuruvithittu, all of which have deposits of sub follilised calm shells. On the eastern side, the Sriharikota Island extends north to south all along, as a narrow strip of sand bar between the Lake and Bay of Bengal with an approximate width of around 2km.

Sampling

Sixty Six surface sediment samples have been collected (33 during premonsoon and 33 during post monsoon) using Peterson grab sampler. Collected sediment samples have been transferred to sterile polyethylene bags, which were cleaned by detergents, stored in an icebox and then transported to the laboratory for further analysis. Sample locations are shown in sample location map (Figure 1)

Grain size analysis

Sand, silt and clay percentage were computed from a combination of sieving and pipette procedures[28]. Five grame of oven dried sediment sample was treated with 0.025 N sodium hexametaphosphate solution in order to facilitate deflocculation. The disaggregated sample was then washed through a 230 mesh ASTM sieve (mesh opening = 0.063 mm) until clear water passed through, and care was taken during washing, so that the amount of water for washing did not exceed 1000mL. The portion of the sample retained on the sieve was dried and weighed and weight of the sand obtained. The fine fraction (silt + clay) in the washings was analyzed by the pipette method, in accordance with the procedure adopted by[28], collected in a 1 liter graduated measuring cylinder. The suspension in the measuring cylinder was agitated well with the help of a stirrer in order to have uniform distribution of the particles in suspension, as soon as the agitation was stopped, the time was noted, and exactly after 2 hours and 3 minutes, a 20 mL pipette was slowly inserted up to a depth of 10 cm in the solution and the sample was sucked uniformly in order to avoid turbulence. The sample pipetted out was transferred to a preweighed 50 mL beaker and fried in an oven. After drying, the weight of the residue was determined from which the weight of the clay fraction was calculated. The weight of the silt fraction was determined by subtracting the combined weight of the sand and clay fractions from the known sample weight. The individual weights of the sand, silt and clay fractions were converted into weight percentages and plotted on a trilinear diagram. Trefethen's[29] textural nomenclature has been used to described the sediments in the present study.

RESULTS AND DISCUSSION

The estimated results of the sand, silt and clay during pre-monsoon are present in the Table 1. The sand percentages are found to vary between 95.85 and 6.20, while the average of the sand percentage for overall the stations is 35.91%. The maximum sand percentage (95.85%) was in station 1, which is the mouth region of the , the minimum sand percentages (6.20%) was recorded in station 20, which represent the Northern part of the study area. The sand content of the sediments of the Lake show a decreasing trend towards the middle part of the Lake (Table .1) and then showing a slight increasing trend.

The silt percentages are varies from 30.00 % to 2.50% (Table.1) whereas, the average of the Pulicat Lake sediments is 16.14%. The maximum of silt percentage was found at station 32 and the minimum at stations 1, 2 and 3 representing the mouth of the Pulicat Lake. In general, silt percentages show an increasing trend towards middle of the Lake. The clay content of the sediments of the estuary varies from 83.8 to 1.65% and the maximum percentages of clay found in 18 and 20 the minimum is in stations 1, 2 and 3.

Sand, silt and clay percentages post-monsoon, the sand content of the samples shows an average content of 46.07%, ranging between 96.80% (station 1) and 6% (station 30). It has been found that the sand content shows a decreasing trend towards the middle of the Lake and then there is a similar trend in the remaining samples (Figure-2).

Table-1: Sand, Silt and Clay percentages of Pulicat lake sediments during Pre-monsoon and Post-monsoon

Station No.	Premonsoon				Post monsoon			
	Sand (%)	Silt (%)	Clay (%)	Sediment type	Sand (%)	Silt (%)	Clay (%)	Sediment type
1	95.85	2.5	1.65	Sand	96.8	2.50	0.7	Sand
2	95.05	2.5	2.45	Sand	96.35	2.50	1.15	Sand
3	91.9	2.5	5.60	Sand	25.20	10.0	64.8	Sandy clay
4	91.4	5	3.60	Sand	55.40	20.0	24.6	Clayey silty sand
5	10.4	20.0	69.6	Silty clay	30.60	10.0	59.4	Sandy clay
6	24.2	10.0	65.8	Sandy clay	96.50	2.50	1.0	Sand
7	23	10.0	67.0	Sandy clay	43.60	30.0	26.4	Clayey silty sand
8	24.4	20.0	55.6	Sandy silty clay	52.80	10.0	37.2	Clayey sand
9	28	20.0	52.0	Sandy silty clay	63.40	10.0	26.6	Clayey sand
10	68.6	10.0	21.4	Clayey sand	66.80	10.0	23.2	Clayey sand
11	66.2	20.0	13.8	Silty sand	81.60	10.0	8.4	Sand
12	67.2	20.0	12.8	Silty sand	14.60	10.0	75.4	Sandy clay
13	31.8	10.0	58.2	Sandy clay	77.20	20.0	2.8	Silty sand
14	70	20.0	10	Silty sand	93.6	2.50	3.9	Sand
15	8.4	10.0	81.6	Clay	88.0	10.0	2.0	Sand
16	20.4	10.0	69.6	Sandy clay	53.40	20.0	26.6	Clayey silty sand
17	7.6	20.0	72.4	Silty sand	13.20	10.0	76.8	Sandy clay
18	6.2	10.0	83.8	Clay	31.40	30.0	38.6	Sandy silty clay
19	11.2	10.0	78.8	Sandy clay	36.40	10.0	53.6	Sandy clay
20	6.2	10.0	83.8	Clay	13.40	10.0	76.6	Sandy clay
21	14.2	20.0	65.8	Silty clay	10.80	10.0	79.2	Sandy clay
22	36	20.0	44.0	Sandy silty clay	39.40	20.0	40.6	Sandy silty clay
23	22.6	20.0	57.4	Sandy silty clay	14.80	20.0	65.2	Silty clay
24	10	20.0	70.0	Silty clay	7.20	20	72.8	Silty clay
25	24.2	20.0	55.8	Sandy silty clay	67.20	20.0	12.8	Silty sand

26	68.6	20.0	11.4	Silty sand	54.60	10.0	35.4	Clayey sand
27	13	30.0	57.0	Silty clay	58.40	30.0	11.6	Silty sand
28	62.8	20.0	17.2	Sity sand	34.0	10.0	56.0	Sandy clay
29	14.2	20.0	65.8	Silty clay	27.20	10.0	62.8	Sandy clay
30	7.6	20.0	72.4	Clay	6.0	30.0	64.0	Silty clay
31	9.6	30.0	60.4	Silty clay	10.20	20.0	69.8	Silty clay
32	8.8	30.0	61.2	Silty clay	34.60	10.0	55.4	Sandy clay
33	45.4	20.0	34.6	Clayey sand	25.80	30.0	44.2	Sandy silty clay
MIN	6.2	2.50	1.65		6	2.50	0.7	
MAX	95.85	30.0	83.8		96.8	30.0	79.2	
MEAN	35.91	16.14	47.95		46.07	14.55	39.38	

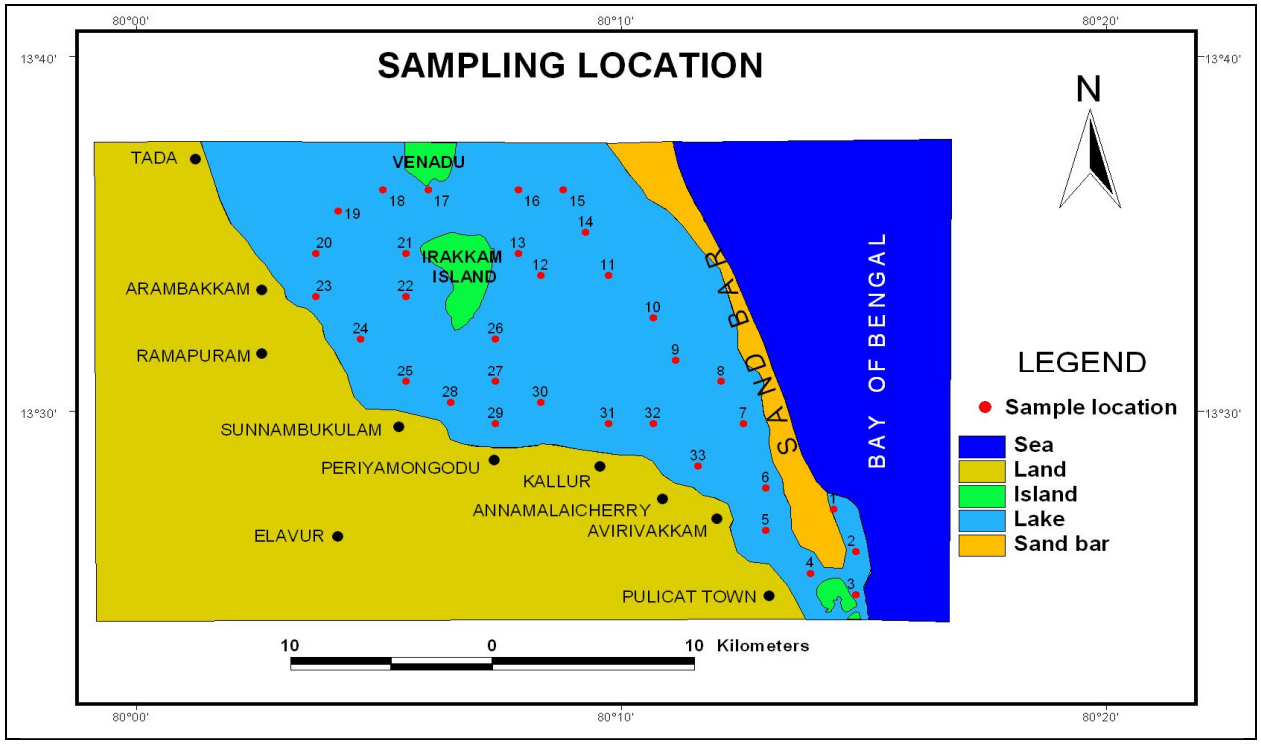


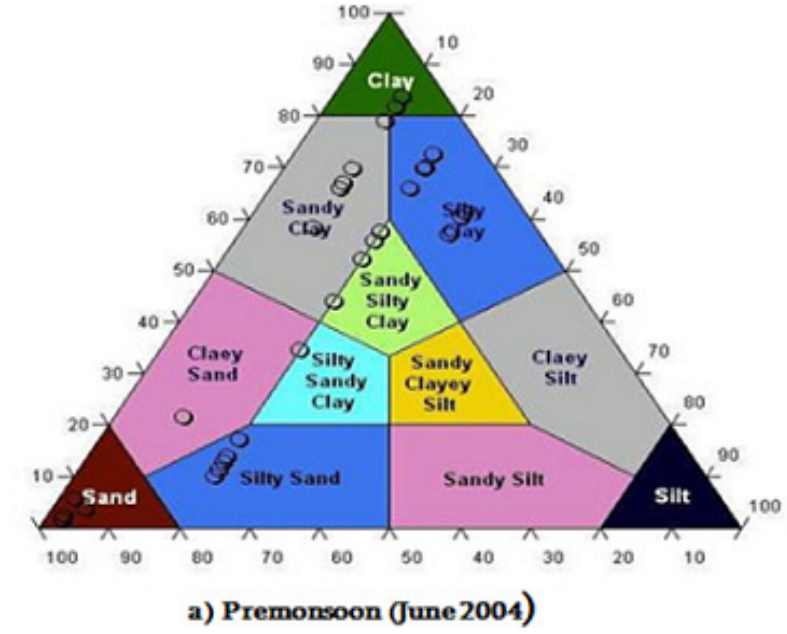
Fig.-1: Study area and Sampling location

The silt contents of the samples shows an increasing trend towards the middle of the Lake, which is in contrast with that of sand content as shown in figure 2. The silt content ranges from 30.0% to 1.14%, and has an average content of 14.55%. The clay content generally shows an increasing trend in the samples collected in the middle of the Lake (21, 12). The maximum content of clay is found in the sample in (21) middle of the Pulicat Lake.

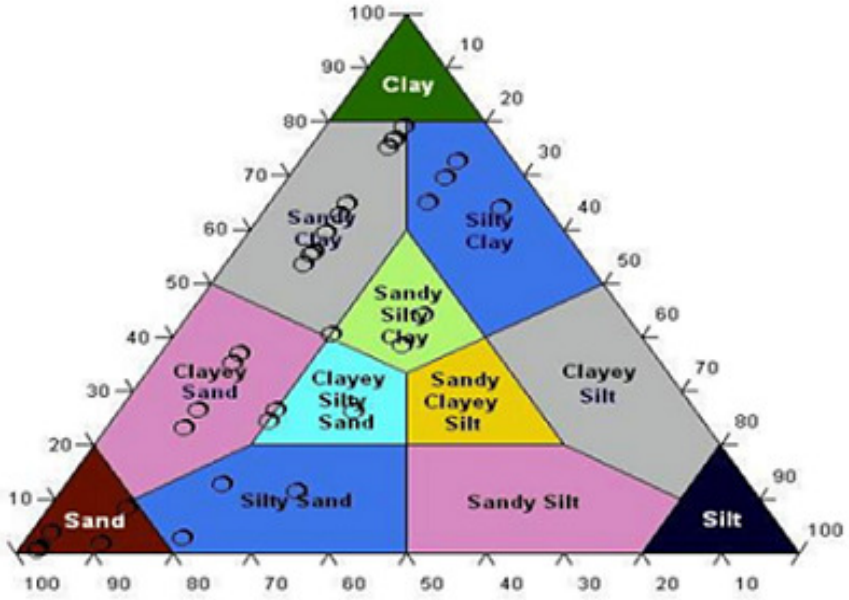
Plotting of the sand, silt and clay percentages in the Trefethen nomenclature (1950) diagram falls in three categories. viz., sand, silt sand and sandy silt (Fig. 2). High percentage (>95%) of sand has been recorded very close to the sea mouth (Station 1) for both the seasons. This might be due to the occurrence of a sandy bed, about 2 km wide, along the eastern margin of the[30]. The minimum values of silt (premonsoon 2.50%: post monsoon 2.50%) have also been recorded from the same location as that of sand during both the seasons. Low (1.65%) and high (83.8%) percentages of clay are recorded from the Western Central

part (Kalangi River mixing area) during premonsoon. Low percentage of sand (premonsoon 7.6%; post monsoon 6%) is also recorded from the same part during both the seasons. The average percentage of sand is found to be more during post monsoon (46.07) when compared to premonsoon (35.91). Silt and clay percentages have decreased from (16.14%) to (14.55%) and from 47.95% to 39.38%, respectively. Low percentage of silt and clay has been observed mainly in the western central part during post monsoon.

Human activities also play a major role in concentrating the fine particles in the middle of the Lake. The higher concentration of coarse sediments at the mouth of the lake is due to tidal effects, which remove the finer fractions. The fluvial input made the coarse nature of the sediments at the end of the lagoon.



a) Premonsoon (June 2004)



b) Premonsoon (June 2004)

Fig.-2: Trilinear plots of Sand- Slit- Clay percentage of Pulicat Lake sediments

CONCLUSION

The sand silt and clay ratio viz, sand average during premonsoon was 35.91% and the ranging between 95.85% and 6.20% the maximum percentage of sand is 95.85% is observed in station 1 which is located near bar mouth of the Pulicat Lake. The silt percentage was varied from 30% to 2.5% whereas the average of the sediments is 16.14%. The maximum of silt percentage was found at station 32 which is located near land side. In general, silt percentages show an increasing trend towards middle of the Lake. The clay content of the sediments were varied from 83.8 to 1.65% and the maximum percentages of clay found in stations 18 and 20, the minimum is in stations 1, 2 and 3. During the post monsoon the sand content of the samples shows an average content of 46.07%, ranging between 96.80% (station 1) and 6% (station 30). It has been found that the sand content shows a decreasing trend towards the middle of the Pulicat Lake and then there is a similar trend in the remaining samples. The silt contents of the samples shows an increasing trend towards the middle of the Pulicat Lake. The silt content ranges from 30.0% to 1.14%, and has an average content of 14.55%. The clay content generally shows an increasing trend in the samples collected in the middle of the Pulicat Lake (21, 12). The maximum content of clay is recorded in the sample location 21.

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