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Research Paper

Studies on grain size characterizatic of surface sediments in Pichavaram mangrove ecosystem, Bay of Bengal, India

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Abstract

Grain size and textural parameters such as phi mean, standard deviation, skewness and kurtosis of Pichavaram mangroves have been studied. There are twenty three sediment samples were collected from different regions namely mangrove, non-mangrove and coastal regions of Pichavaram mangrove ecosystem. The grain size showed that dominance of sand content in coastal areas, silt content in non-mangrove region and mud content in mangrove region. The various bivariate plots between mean, skewness, kurtosis and standard deviation explain the dynamic process operating in the region together with influence the hydrodynamic and depositional nature. The sediments in the coastal region are rolled and deposited by currents and wave refraction, however in the non-mangrove region samples showing silty nature due to weak wave energy condition and in mangrove region samples are mud nature due to aerial root structure of mangrove trees. In present investigation demonstrates the usefulness of selecting several stations in Pichavaram mangrove ecosystem to better understand mangrove, non- mangrove and beach environments of deposition.

Keywords: mangrove, Pichavaram, sedimetology, non-mangroves, skewness

Introduction

Mangroves play an important role in coastal stabilizations[1]. Mangrove plant life consists of salt tolerant trees and shrubs.It can able to tolerate hydrodynamic parameters in intertidal coastlines such as estuaries and lagoons[2]. Mangroves grow in the intertidal parts of sheltered tropical coastlines, facilitating coastal stabilization and wave attention[3]. Mangrove ecosystem holds the sedimentary deposits from erosion. The hydrodynamic regime influences the growth of mangroves[4-7]. Mangrove wetland is highly productive and occupies the intertidal zone in tropical and subtropical regions, which are characterized by small topographic gradients and large tidal amplitude. Mangroves sediments play a vital role in the biogeochemical process by serving a source of nutrients and other materials for mangrove plants. Mangroves directly affect the sediment flux by influencing the hydrodynamics regime through their physical configuration. Various studies have been carried out in order to reveal the tidal circulation and source and dispersal of suspended sediment in Pichavaram mangrove area[8-12]. The present study was undertaken to investigate the textural characteristics of the sediments of Pichavaram mangrove region (three samples) to have proper insight into particle size distribution. Environmental status of basin has been elucidated by studying the energy conditions and transportation pattern of sediments.

Materials and Methods

The study area (Pichavaram mangrove)

Pichavaram mangrove forest is located about 200 km south of Chennai city in the southeast coast of India. This mangrove is actually sandwiched between two prominent estuaries, the Vellar estuary in the north and Coleroon estuary in the south. The Vellar - Coleroon estuarine complex forms the Killai backwater and Pichavaram mangroves. Pichavaram mangrove (figure 1) is present in the higher land of Vellar-Coleroon estuarine complex. The mangrove extends to an area of 1,100 hectares, representing a heterogeneous mixture of mangrove elements. The source of freshwater to this mangrove is from both the estuaries and that of seawater is Bay of Bengal. The whole of the mangrove comprises about 51 small and large islands with their sizes ranging from 10 m^2 to 2 km^2. The mangrove soil usually consists of alluvium derived from the mangrove plants. About 40% of the total area is covered by water ways, 50% by forest and the rest by mud flats, sandy and salty soils. There are numerous creeks, gullies and canals traversing the mangroves with a depth rang irrigation channel is mainly discharging agricultural waste water from the entire upper reaches to this mangrove.

Pichavaram mangrove did not receive much attention during pre and post-independence periods. A map published by the Cuddalore District authorities in 1882 is the document which was first made available to public. Then, only during the latter part of 20th century[13] explored the Pichavaram mangrove and Venkatesan[14] listed the floral communities in the region in relation to environmental factors. French institute, Pondicherry is one of the pioneering institutes in exploring Pitchavaram and contributed several publications on the wealth of the mangroves[15]. The Centre of Advanced Study in Marine Biology, right from its inception in 1961 has been involved in various research activities in Pichavaram mangrove. Water quality, floral and faunal composition, microflora, ichthyofauna, bioactive substances from mangroves, fishery resources, larval development, heavy metals and organochlorine residues, methanogens, cyanobacteria, wood biodeterioration and UV - radiation are all studied extensively by this Centre. During 90s, M.S. Swaminathan Research Foundation (MSSRF), Chennai, India established a mangrove Genetic Resource Conservation Centre here by adopting 50 ha forest area. In addition, Centre for water Resources, Anna University, Chennai has remotely sensed Pichavaram forest with satellite imageries.

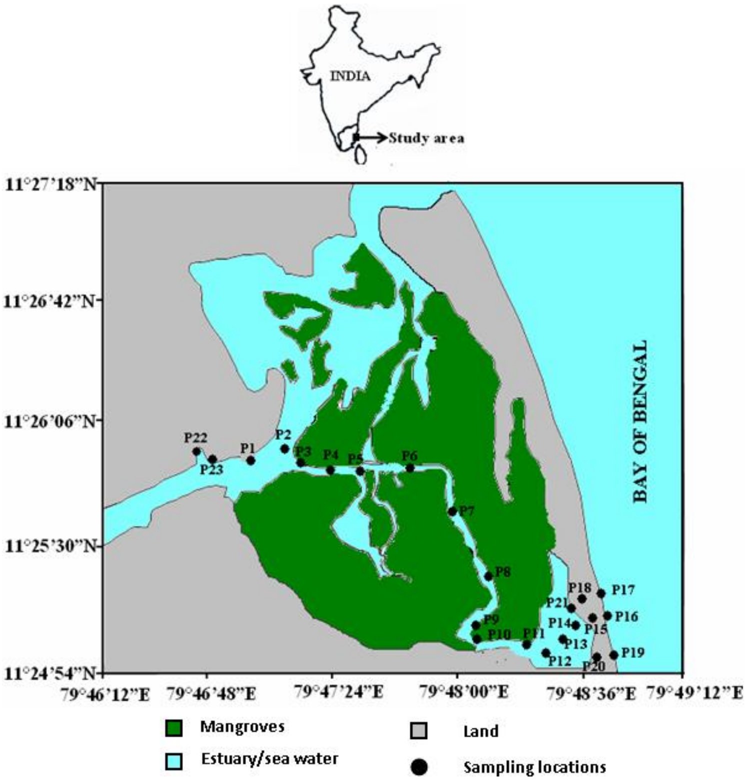

Figure 1: Study area of Pichavaram mangroves

Sampling

The surface sediment samples were collected in twenty three locations (P1 to P23) of the Pichavaram mangroves during July 2009 using Van Veen grab sampler. Global Positioning system (Explorist 200) was used to determine the geographic coordinates of the sampling locations. The collected samples were dried at room temperature in open air for two days and stored in black polythene bags. The sampling locations were classified into three categories such as (1) Non-mangrove region (P1, P2, P12, P13, P14, P22 and P23), (2) Mangrove region (P3 to P11), and (3) Coastal region (P15 to P21).

Results and Discussion

The textural distribution of the collected sediment samples are shown in Figure 2.The comparative study of the histograms of retained fractions of sieve analysis shows most of sediment samples ranged from coarse to fine-grain. Textural attributes of sediments viz. mean (Mz), standard deviation (σ1), skewness (SK) and kurtosis (KG) are widely used to reconstruct the depositional environments of sediments (Table 1). Correlation between size parameters and transport processes/depositional mechanisms of sediments has been established by exhaustive studies from many modern and ancient sedimentary environments[10].

Inter relationship of size parameters

The inter-relationship of specific size-parameters is significant to interpret various aspects of depositional environment, as the textural parameters of the sediment are often environmentally sensitive[16-18]. The mean versus standard deviation plot (Figure 3) of the present samples, shows the nature of the sediments are dominantly sand in coastal region, mud in mangrove region and silt in non-mangrove region. The mean versus skewness showed that the skewness of coastal region mostly falling in the negative skewed zone of the graph (Figure 4), while the non-mangrove sediments are falling in the low positive skewed zone, whereas the mangrove region sediments are falling in high positive skewed zone. It is clearly indicates the nature of sediments with varying percentage of sediment texture. The relation between mean size and kurtosis is complex and theoretical. The plot (Figure 5) denotes the mixing of two or more size classes of sediments, which basically affect the sorting in peak and tails i.e. index of kurtosis. It shows that the sediment admixture is dominated by coarse sand to fine grain mud. Similarly, the plot between skewness and standard deviation produce a scattered trend that very platykurtic to platykurtic sorted because of the dominance of sand in coastal region, mud in mangrove region and silt in non-mangrove region.

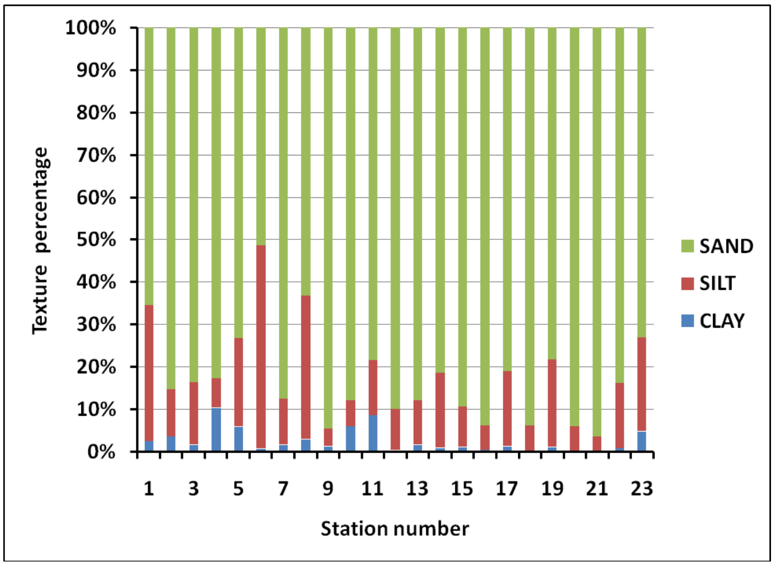

Figure 2: Sediment texture of Pichavaram mangrove sediments

The higher energy levels permit deposition of coarser sediments as well as transportation of a much wider range of finer sediments[12]. The plot (Figure 6) describing relation between skewness and standard deviation produces a scattered trend, which shows the increase in standard deviation leads to decrease in skewness. This may be due to the variations under the influence of littoral currents, high wave energy and wave refraction in coastal region, weak wave energy prevailing in non-mangrove region whereas mangrove region fine particles are accumulating due to aerial their root structure.

Table 1: Statistical analysis of grain of Pichavaram mangrove sediments

Station	Mean	Standard deviation	Skewness	Kurtosis	Mean	Skewness	Kurtosis
P1	1.1	0.77	0.05	1.15	poorly sorted	symmetrical	Very platkurtic
P2	1.34	0.87	0.08	1.18	poorly sorted	symmetrical	Very platkurtic
P3	0.92	0.64	0.25	0.78	moderately sorted	symmetrical	Very platkurtic
P4	0.77	0.62	0.23	0.85	moderately sorted	symmetrical	Very platkurtic
P5	0.63	0.55	0.19	0.62	moderately sorted	symmetrical	Very platkurtic
P6	0.7	0.53	0.28	0.66	moderately well sorted	symmetrical	Very platkurtic
P7	0.8	0.54	0.26	0.67	moderately sorted	symmetrical	Very platkurtic
P8	0.77	0.53	0.18	0.65	moderately sorted	symmetrical	Very platkurtic
P9	0.62	0.54	0.29	0.59	moderately well sorted	symmetrical	Very platkurtic
P10	0.77	0.62	0.21	0.62	moderately sorted	symmetrical	Very platkurtic
P11	0.67	0.57	0.17	0.64	moderately sorted	symmetrical	Very platkurtic
P12	1.2	0.74	0.08	1.08	poorly sorted	symmetrical	Very platkurtic
P13	1.35	0.78	0.06	1.11	poorly sorted	symmetrical	Very platkurtic
P14	1.14	0.83	0.04	1.18	poorly sorted	symmetrical	Very platkurtic
P15	2.4	1.03	0.15	2.02	very poorly sorted	symmetrical	platkurtic
P16	2.5	1.14	-0.11	1.95	very poorly sorted	symmetrical	platkurtic
P17	2.3	1.24	-0.18	1.91	very poorly sorted	symmetrical	platkurtic
P18	2.1	1.26	-0.13	1.88	very poorly sorted	symmetrical	platkurtic
P19	2.22	1.18	-0.17	1.92	very poorly sorted	symmetrical	platkurtic
P20	2.3	1.15	-0.08	1.98	very poorly sorted	symmetrical	platkurtic
P21	2.25	1.2	-0.14	1.93	very poorly sorted	symmetrical	platkurtic
P22	1.2	0.88	0.07	1.09	poorly sorted	symmetrical	Very platkurtic
P23	1.15	0.77	0.05	1.11	poorly sorted	symmetrical	Very platkurtic

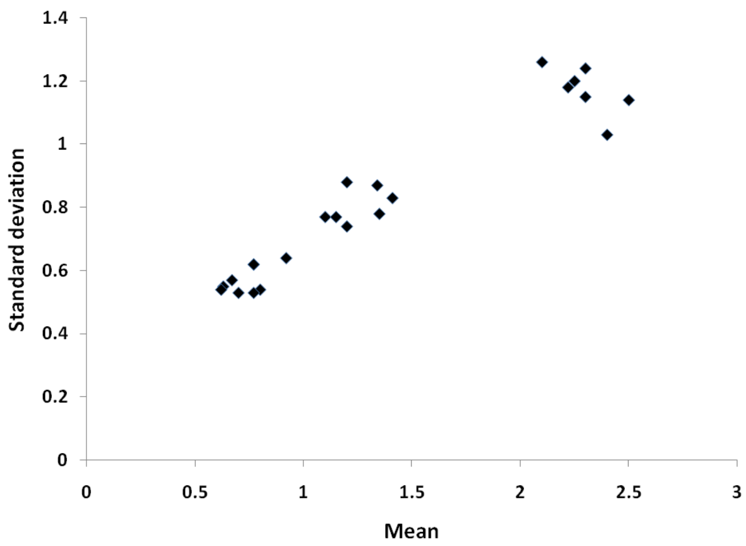

Figure 3: Interrelation plot of Mean versus standard deviation

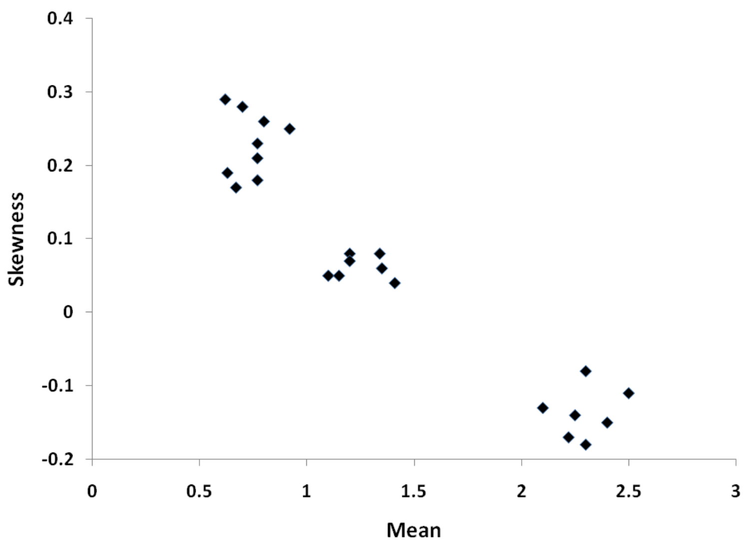

Figure 4: Interrelation plot of Mean versus skewness

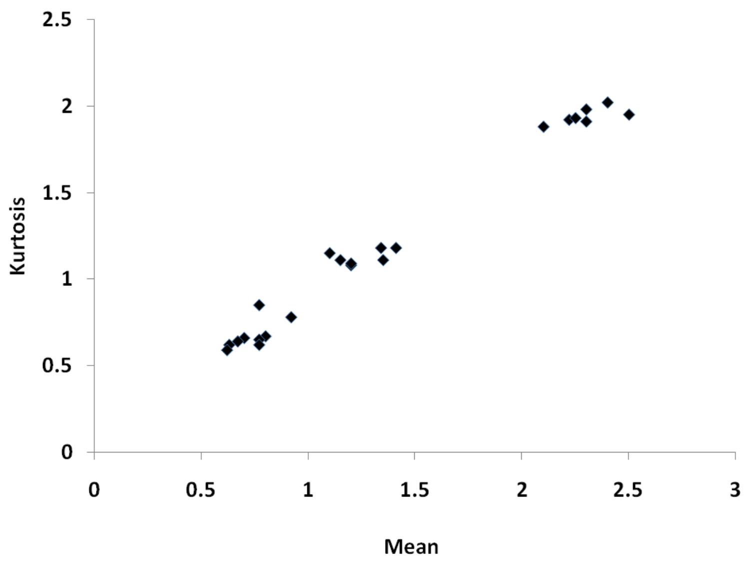

Figure 5: Interrelation plot of Mean versus kurtosis

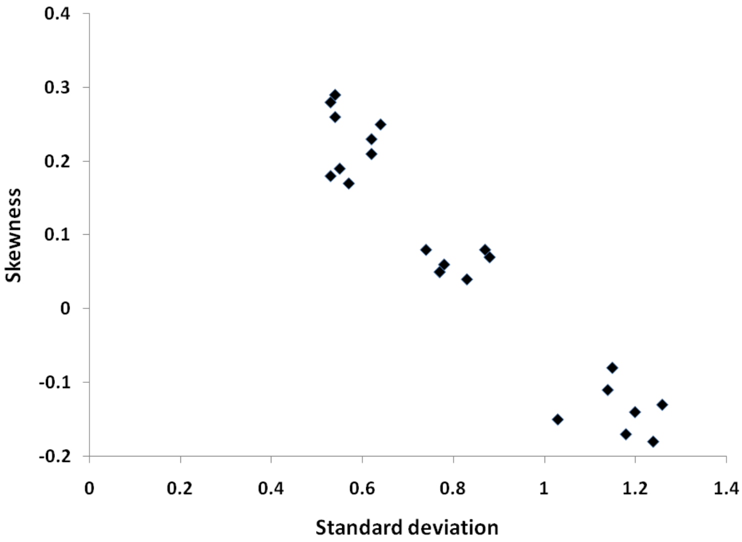

Figure 6: Interrelation plot of Standard deviation versus skewness

Conclusion

The various bivariate plots between mean, skewness, kurtosis and standard deviation explain the dynamic process operating in the region together with the influence hydrodynamic and depositional nature. The sediments in the coastal region are rolled and deposited by currents and wave refraction, however in the non-mangorve region samples showing silty nature due to and weak wave energy condition, whereas in mangrove region samples are mud nature due to aerial root structure of mangrove trees. This study demonstrates the usefulness of selecting several stations in Pichavaram mangrove ecosystem to better understand mangrove, non-mangrove and beach environments of deposition.

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