Available online at www.elixirpublishers.com (Elixir International Journal)

Geoscience

Elixir Geoscience 65 (2013) 19787-19793

ISSN: 2229-712X

Textural characteristic variation of beach sediments from Mandapam to Valinokkam, Ramanathapuram District, South East Coast of India

Tamilselvi.M[1], Mukesh, M.V[1], Jeyavel Raja Kumar.T[1], Muthukumarasamy.R[1], Chandrasekaran.A[1] and Sabeen H.M[2]

[1]Department of Earth Sciences, Annamalai University, Annamalainagar, Tamilnadu-608002

[2]Department of Geology, Government College, Kariavattam, Thiruvananthapuram, Kerala-695581

ARTICLE INFO

Article history:

Received: 9 October 2013;
Received in revised form:
25 November 2013;
Accepted: 5 December 2013;

Keywords

Mandapam,
Valinokkam,
Grain size,
Beach sediments,
Depositional processes,
Shore face.

ABSTRACT

The aim of the study is to determine the morphodynamic changes based on beach profile, and grain size distribution of sediments along the beaches between Mandapam to Valinokkam of Ramanathapuram district southern Tamilnadu. Morphodynamic condition and changes along the coastal length of 50km were recorded, and the granulometric study was done by dry sieving methods. Two seasonal, both summer and winter sediment samples were collected from the four main geomorphologic units (water level, slope, berm, and dune) during field observation periods. Grain characteristics were estimated by using GRADISTAT software and the results are revealed. The sediments were mainly of coarse to fine grained, moderately sorted to poorly sorted, nearly-symmetrical skewed to find skewed, and leptokurtic to mesokurtic in nature. The majority of the sediment showed the bimodal nature of the interrelation ship of various parameters in sediment having the dominance of coarse to fine sand. Grain size characteristics varied with beach orientation foreshore, slope and wave action. The study area showed that sediment environment with high wave energy between Mandapam to Valinokkam beaches of Ramanathapuram district were under erosion or deposition with a strong winnowing process.

Introduction

The study of textural characteristics of beach sediments is used to categorize the sedimentary environments. The foreshore sediment is generally influenced by coastal processes, especially wave action and beach morphology (beach face, slope and shoreline orientation). A statistical analysis of beach sediment is relevant to identify the sedimentary environments. Mean size, Sorting and Skewness and Kurtosis are most useful parameters to distinguish the sediments (Carranza-Edwards, 2001; Friedman, 1961). The composition of littoral sediments and their textural composition depend on wave, wind, long shore currents and source of composition (Komar, 1976). The grain size statistics are used to differentiate between high and moderate energy environments (Nords, 1977). The textural characteristics of beach sediments have been studied in the past by a number of researchers.

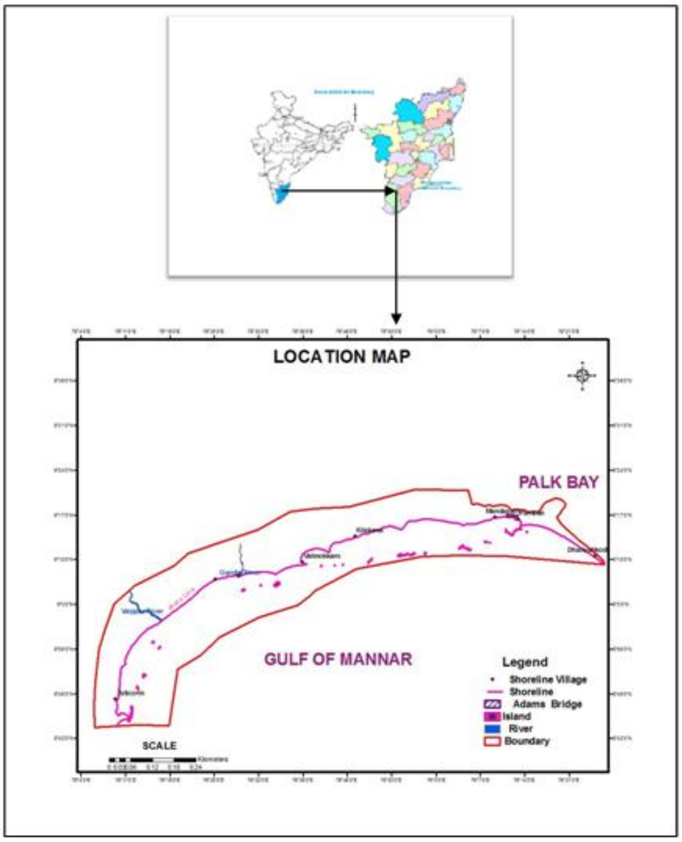
The seasonal changes of beach sand due to long shore transport were analysed to understand the near shore sediment's characteristics. The grain size characteristics in intertidal shore are changing with sediment transport, especially depositional and removal of fine sediments. During falling of sea level, the primary focus of erosion centres around the wave based reworking of self-sediment. The zone of wave activity moves sea wards, supplies the near shore, beach, dunes and results in the progressive procreation of the coastline. Sediment transport is closely coupled with sediment sorting and depositional processes. Coastal environment often appears to experience little net erosion or accumulation, but they can be highly transient environment resulting from a delicate balance between sediment influx storage and loss (Morton, 1979, Gioson et. al, 1999, Walarce et. al, 2009). Grain size is the most fundamental property of sediment particles affecting their entrainment, transport and deposition. Grain size analysis therefore, gives clues to the sediment provenance, transport history and depositional conditions. (e.g. Folk and Ward 1957; Friedman 1979; Bui et. al., 1990). The various techniques employed in grain size determination include direct measurement, dry and wet sieving and sedimentation. All techniques involve the division of the sediment sample into a number of size fractions, enabling a grain size distribution to be constructed from the weight or volume percentage of sediment in each size fraction. Long shore variation in mean particle size, features local discontinuities in the beach slope and the lateral wave energy (Van Hijum and Pilarczyk 1982., Kamphuis, 1991). If the wave crest approaches the shore with an angle, long shore sorting takes places and finer sand grains are transported from up drift to down drift section. The knowledge of the coastal sediment transport rates is generally considered as the component in the study of long shore and cross shore sediment transportation. In this study, a series of experiments is carried out to investigate the long shore grain sorting processes.

Study area

Coastal segment from Mandapam to Valinokkam of Ramanathapuram District is selected for the study, which stretches to a distance of about 50 kms and is located between 9° 05' and 9° 50' North of Latitude and between 78° 10' and 79° 27' East of Longitude.(Fig.1) It covers the geographical area of 4175.00 Sq.km. Geology of the area is covered by the unconsolidated sediments of Quaternary age except in the north-western part, where isolated patches of Archaen Crystallines and Tertiary sandstone are exposed. A major part of the district is covered

Tele:
E-mail addresses: mukeshearthsciences@gmail.com

with the fluvial, fluvio-marine, aeolian and marine sediments of Quaternary age. The geomorphology of the study area is classified as gently sloping plain except for remnant hills in the western area. Quaternary studies have brought out various erosional and depositional landforms of fluvial and marine regimes. The fluvial landforms comprise flood plains of Vaigai, Varshalei, Pambar, Kottakkarai and Gundar rivers. The marine landforms comprise sand mounds (Teri's) and barrier dunes along the present coast. The erosional processes are manifested in the form of pediments and pedipalin around Kamuthi.



Methodology

The samples were collected from the hinterland to the breaker zone along the coastal region between Mandapam to Valinokkam. Nearly 24 stations were located for sampling, each station with 400m space interval and based on different morphological characteristic showing different features (Coral fragment, shelf fragment, beach rock, fine grain). In each location, four sampling spots were fixed based on geomorphologic units like water level, slope, berm and dune with 4m space interval perpendicular to the coast. Totally, 142 sediment samples were collected during the summer season (March 2011) and Winter Season (October 2011) from Mandapam to Valinokkam coastal tracts. In the laboratory, the dried samples were divided into sub samples and weighted and treated with HCL to remove shell and organic content, washed with fresh water and rinsed with distilled water and dried. Dry sieving analysis was performed by using a series of sieves ranging in the mesh size from 25 to 325 sieve intervals and grain size analysis. The sediment distribution is presented graphically as a cumulative percentage curves with Phi scale and the statistical parameters, Such as Central tendency Mean, Standard deviation (sorting), Skewness, and Kurtosis were calculated by Folk and Ward 1957. Grain size distribution pattern of sieve data along the coastal stretch is done by Graindist Software version 1.07 (Koldijk, 1968; Davis and Ehrlich, 1970; Jaquet and Vernet, 1976; Swan *et al.*, 1978, Simon, 2001). However, the study of morphodynamics state of beaches helps in forecasting coastal erosion, marine flooding, siltation etc.

Results

The grain size distributions along the sampling stations were analyzed and differentiated on the basis of two seasons during summer and winter to understand the grain size characterization and categorize the depositional environment (Table 1).

Summer season:

The mean grain size characteristics of the beach sediments, during summer season ranges from 0.62Φ to 3.20Φ, which is classified as fine sand. Sediment sorting range from 0.42Φ to 1.97Φ, which is defined as poorly sorted to very well sorted. Skewness values range from -0.64Φ to 0.96Φ, which are given as fine-skewed to course skewed. The minimum and maximum Kurtosis values are from 0.59Φ to 3.19Φ respectively and are classified as very leptokurtic to very platykurtic in nature. The overall average grain size distribution during summer season is collectively summarized as mean grain size of 2.22Φ, sorting of 0.92Φ, skewness of -0.02Φ and Kurtosis value of 1.2Φ Based on the above value of classification, it is given as Fine sand, moderately sorted, nearly symmetrical and leptokurtic in nature.

Winter season:

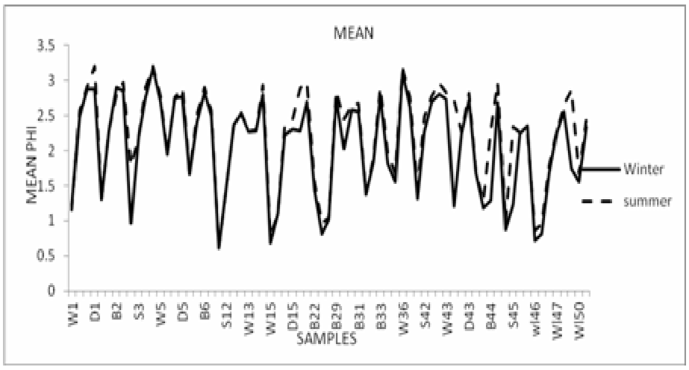
During winter season, the analytical values of the beach sand were represented as mean grain size ranging from 0.61Φ to 3.18Φ as fine sand. Sediment sorting ranges from 0.32Φ to 1.29Φ, which is given as poorly sorted to well sorted. Skewness values range from -0.53Φ to 0.77Φ, which vary from fine-skewed to course skewed. The kurtosis values range between 0.59Φ to 2.13Φ respectively and classified as very leptokurtic to Very platykurtic. The average mean grain size 2.07Φ an average sorting by 0.76 Φ, skewness average as -0.008 Φ and an average Kurtosis value as 1.095Φ. All collective interpretations of winter samples represent Fine sand, Moderately well sorted, Nearly Symmetrical, and Mesokurtic.

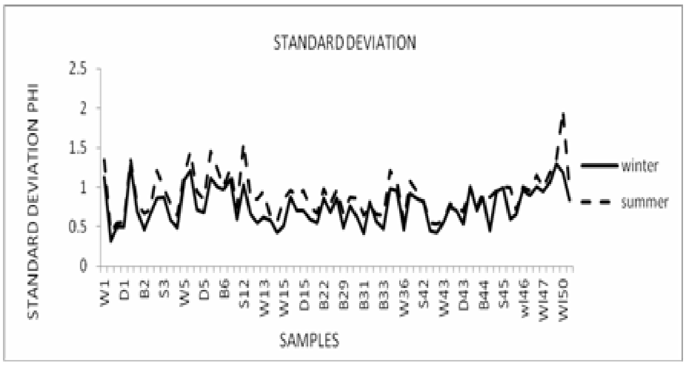
Discussion

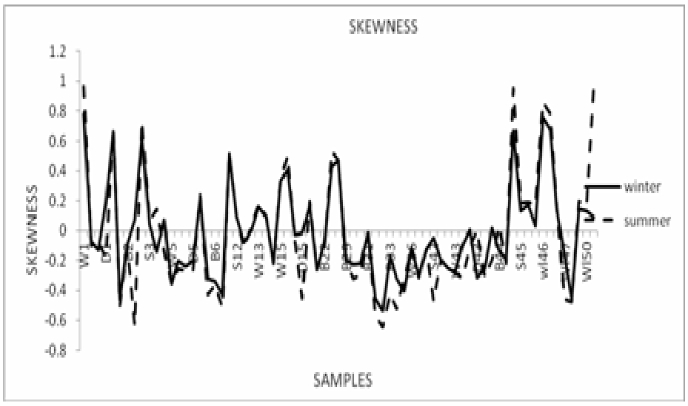
The beach sediment of both summer and winter season is and the significance for better depositional environment is highlighted. The normal mean value of the sediment is medium to fine sand (90%) and coarse sand (10%) during summer, during winter nearly 64% come under fine sand, 27% medium sand and 6% coarse. This noted variation of the grain size with respect to the monsoon is due to the changing wave activity occurring along the coast. In general, the beach sediment of east coast of India falls in a medium to fine sand, because of the nature of the source sediments, wave energy level and the general trend of offshore slope (Komar, 1976, Chauhan et. al. 1988).

During summer season, the fine grain is observed with low wave energy condition, which prevails a broad beach width and coarse grains. The beach width is medium during the high wave energy condition. The near shore wave's energy is same along the beach, but the wave energy at breaking zone is altering with beach slope and has influenced on the grain size and shape. In winter, season the sediments are transported and fine grained materials are deposited in the bed (Drake and Cacchione, 1985). In this pattern, the ripple reworking and re-suspension winnows find sand sediment from the bed throughout the winter storm seasons. (Wiberg et al., 1994). During the summer season, the higher-energy levels permit a deposition of coarser sediments as well as transportation of wide range of fine sediments (Bryant, 1982).

The standard deviation of sediments indicates the fluctuation in the kinetic energy or velocity condition of the depositing agent (Sahu, 1964). The standard deviation values reveal that the beach sediments are well sorted to poorly sorted. Along the study area during summer 51% of the total samples are moderately sorted, 20% moderately well sorted, 1 % samples are well sorted and 28% poorly sorted. In winter, 34% of the samples represent moderately sorted; 30% moderately well sorted, 19% are poorly sorted, and 16% are well sorted. It is observed that moderately sorted sands are pre dominant on the beaches of the east coast of India respectively (Chakrabarti, 1977 and Chandhri et.al 1981). The beaches are identified as moderately sorted and moderately well sorted with the influence of relatively high wave energy condition, and the few samples are founds well sorted and poorly sorted along the beaches (Fig. 2).







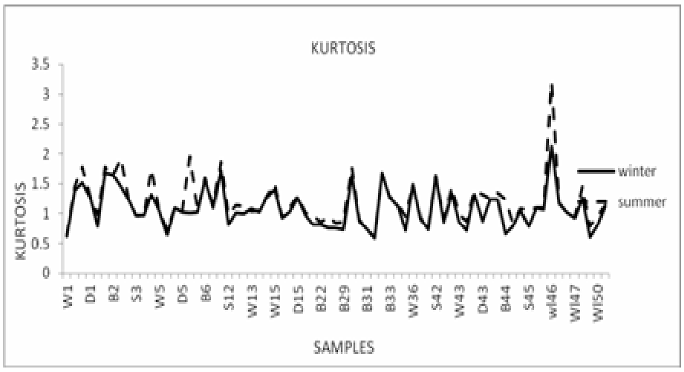


Figure: 2 Line graph showing grain size distribution in water level, slope, berm and dune during summer and winter seasons

Coarse grain size in the foreshore sub environment decreases both landward and seaward shore face is transitional with offshore sediments. Both are composed of fine to medium sand, moderately sorted to poorly sorted and shore face sands are slightly coarser. In summer, there is an increase in mean percentage of fine sand in the landward part of the profile and a decrease of the profile and percentage of the fine sand in the offshore part of the profile, and vice versa in winter season. It is a clear evidence of poor sorting in the plunge position (Fox et al. 1960) and according to Inman (1953) it's the poorest sorting in the breaker and surf zone and the best sorting in the region of the swash zone sands. Bascom(1951) found a decrease in sorting in the offshore direction and on the other hand, Miller and Zeigler (1958) found the high degree of sorting in the breaker sorting both seaward and shoreward. These results obtained from different beaches highlight how the existing sand has different source.

The beach sediments vary in between very fine skewed to very coarse skewed as 21% of the total samples are coarse skewed and 11% were fine skewed, 22%very fine skewed, 21% are coarse skewed and 26% very coarse skewed. In winter, season the beach sediments vary in between very fine skewed to very coarse skewed, 17% of samples are coarse skewed and 16% fine skewed, 11% very fine skewed, 17% very coarse skewed and 27% of symmetrical skewed. The results show that most of the samples vary in between coarse skewed to fine skewed. The excess of coarse skewed (negatively skewed distribution) depicts the running down of the fine sediments and suggests the dominants of the erosion process Hedge et al. (2006). At beach, where erosion processes are dominant, sediments are generally negatively skewed indicating selective winnowing of the fine sediments. The positively skewed distribution indicates the depositional tendencies (Duane, 1964). The sand of all season ranges from negatively skewed to nearly symmetrical and selective removal of fine by back wash, truncating the fine end of the population. This is generally considered as the mechanism by which foreshore sediments become negatively skewed (Friedman, 1961; Martins, 1965). The skewness of this type of sediments is dominated by symmetrical (the most common), and positively skewed. The grain size distribution due to bed load transport components and suspended transport components can be identified (Visher,1969).This is due to the presence of dual-directional tidal current and waves within the sub-environment, where the sediments are deposited.

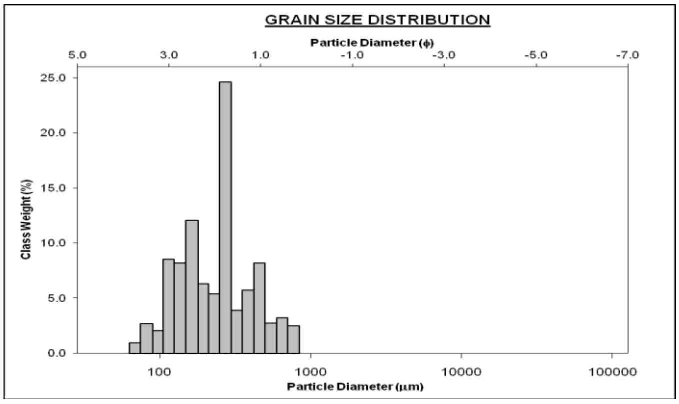
The kurtosis classification in summer season, shows that all samples are differ in between very platy kurtic to very leptokurtic. Most of the samples were shown as platykurtic

(9%), Meso-kurtic (43%), and lepto kurtic 27% and very Platykurtic 3% and leptokurtic 17%, extremely leptokurtic 1%. During winter season the samples mixed in between very platykurtic to vey leptokurtic. Most of the samples are shown as platykurtic 26%, leptokurtic 22%, mesokurtic 30%, very platykurtic 7%, very leptokurtic 14%, extremely leptokurtic 1%. The dominated mesokurtic and platykurtic extreme high or low values of kurtosis imply that part of the sediment achieved its sorting elsewhere in a high-energy environment Friedman (1962). The above result shows that skewness was slightly influenced by wave action. Their kurtosis is normally in the range of very platykurtic to platykurtic. Probability cumulative of grain size is composed of four sets of segments with two saltation components and two suspension components respectively (Visher, 1969). The kurtosis of this type of sediment is leptokurtic to platykurtic and most of them are suspension segment (cf.visher, 1969). The Kurtosis indicates that the most of the sample fall under mesokurtic category and the influence of sediment supply and wave energy on the mean grain size of the beach sediments is further evocated in the present study (Fig. 3)

A: Sample Statistics-Summer Season

	μm	φ	GRAIN SIZE DISTRIBUTION	
MODE 1:	275.0	1.868	GRAVEL: 0.0%	COARSE SAND: 8.8%
MODE 2:	165.0	2.605	SAND: 100.0%	MEDIUM SAND: 44.1%
MODE 3:	115.5	3.119	MUD: 0.0%	FINE SAND: 33.0%
D_{10}:	115.2	1.036		V FINE SAND: 14.1%
MEDIAN or D_{50}:	255.1	1.971	V COARSE GRAVEL: 0.0%	V COARSE SILT: 0.0%
D_{90}:	487.6	3.118	COARSE GRAVEL: 0.0%	COARSE SILT: 0.0%
(D_{90} / D_{10}):	4.234	3.009	MEDIUM GRAVEL: 0.0%	MEDIUM SILT: 0.0%
$(D_{90} - D_{10})$:	372.5	2.082	FINE GRAVEL: 0.0%	FINE SILT: 0.0%
(D_{75} / D_{25}):	2.079	1.644	V FINE GRAVEL: 0.0%	V FINE SILT: 0.0%
$(D_{75} - D_{25})$:	166.7	1.056	V COARSE SAND: 0.0%	CLAY: 0.0%

	METHOD OF MOMENTS			FOLK & WARD METHOD		
	Arithmetic μm	Geometric μm	Logarithmic φ	Geometric μm	Logarithmic φ	Description
MEAN ($\bar{x}$):	274.7	235.2	2.088	242.6	2.044	Fine Sand
SORTING (σ):	158.7	1.732	0.793	1.785	0.836	Moderately Sorted
SKEWNESS (Sk):	1.314	0.091	-0.091	-0.076	0.076	Symmetrical
KURTOSIS (K):	4.508	2.471	2.471	1.035	1.035	Mesokurtic



B: Sample Statistics-Winter Season

	μm	φ	GRAIN SIZE DISTRIBUTION	
MODE 1:	115.0	3.126	GRAVEL: 0.0%	COARSE SAND: 0.1%
MODE 2:	193.5	2.375	SAND: 98.2%	MEDIUM SAND: 1.1%
MODE 3:			MUD: 1.8%	FINE SAND: 48.8%
D_{10}:	86.06	2.327		V FINE SAND: 48.2%
MEDIAN or D_{50}:	125.0	3.000	V COARSE GRAVEL: 0.0%	V COARSE SILT: 1.8%
D_{90}:	199.3	3.538	COARSE GRAVEL: 0.0%	COARSE SILT: 0.0%
(D_{90} / D_{10}):	2.315	1.520	MEDIUM GRAVEL: 0.0%	MEDIUM SILT: 0.0%
$(D_{90} - D_{10})$:	113.2	1.211	FINE GRAVEL: 0.0%	FINE SILT: 0.0%
(D_{75} / D_{25}):	1.686	1.305	V FINE GRAVEL: 0.0%	V FINE SILT: 0.0%
$(D_{75} - D_{25})$:	73.61	0.753	V COARSE SAND: 0.0%	CLAY: 0.0%

	METHOD OF MOMENTS			FOLK & WARD METHOD		
	Arithmetic μm	Geometric μm	Logarithmic φ	Geometric μm	Logarithmic φ	Description
MEAN ($\bar{x}$):	140.8	132.8	2.912	131.9	2.922	Fine Sand
SORTING (σ):	49.46	1.391	0.476	1.380	0.465	Well Sorted
SKEWNESS (Sk):	3.156	-0.067	0.067	0.125	-0.125	Coarse Skewed
KURTOSIS (K):	43.30	3.297	3.297	0.770	0.770	Platykurtic

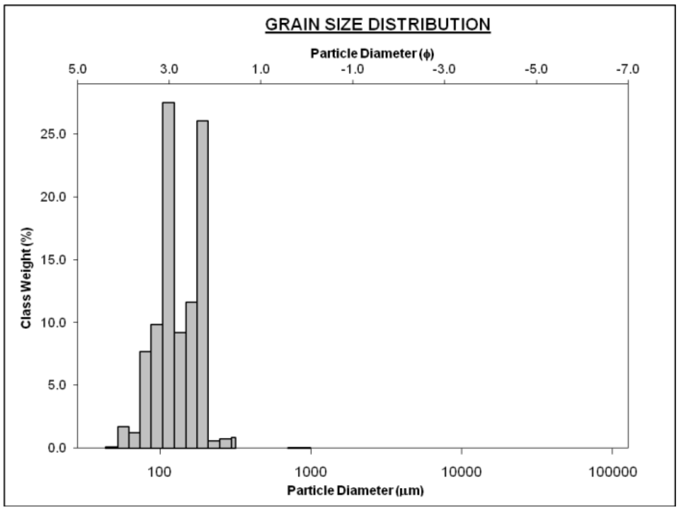


Figure 3. Showing statistical analytical results in summer and winter season

The interrelationship between grain size and frequency distribution has been widely used to discriminate the depositional environments and also to recognize the various operative processes of sedimentation. From the bivariate plots of phi, mean, standard deviation, skewness and kurtosis, it is seen that sorting decreases in winter season and increase in summer season. Majority of the sample of summer season is coarse sand 9%, medium sand 44%, fine sand 33%and very fine sand 14% with polymodal, moderately sorted, medium sand. It is respectively 100% in summer season which indicates suspension and rolling, and in winter season medium sand 1%, fine sand 49%, and very fine sand 48%, and coarse sand 0.1% with bimodal, well sorted fine sand which represents 98.2%.The summer season indicates the fine-grained material in the bed. This pattern is consistent with the ripple reworking, and re-suspension which winnows fine sediments from the bed throughout the winter storm season. Similarly, from the phi values it can be seen that the sorting becomes dominant with the addition of finer particles in the winter season. During winter and summer season reverse process takes place. (Fig.4 & 4.1).

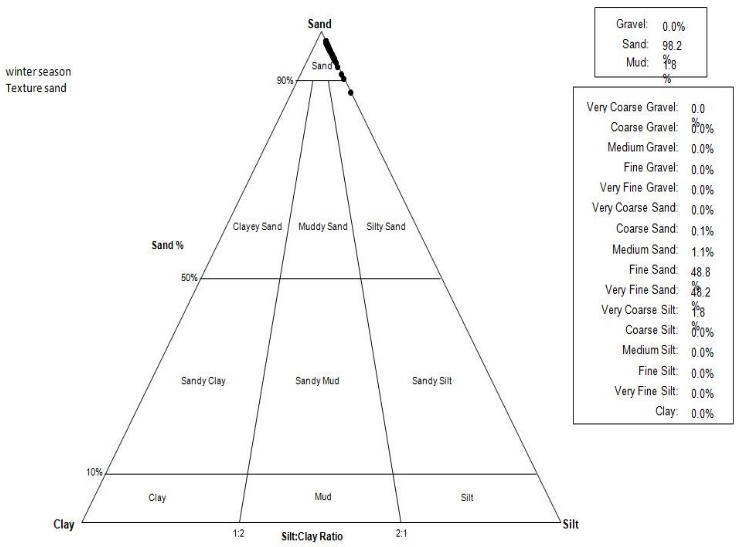


Figure 4. Triangular diagram showing distribution of sediment in winter season

Table 1. Showing statistical parameters of winter and summer season

Winter	Mean	Standard Deviation	Skewness	Kurtosis		Summer	Mean	Standard Deviation	Skewness	Kurtosis
W1	1.223	1.12	0.779	0.619		W1	1.165	1.341	0.967	0.64
S1	2.48	0.321	-0.07	1.392		S1	2.567	0.421	-0.098	1.456
B1	2.882	0.492	-0.13	1.52		B1	2.913	0.552	-0.078	1.784
D1	2.882	0.492	0.187	1.272		D1	3.201	0.562	-0.18	1.289
W2	1.306	1.28	0.664	0.782		W2	1.32	1.352	0.69	0.983
S2	2.284	0.691	-0.465	1.678		S2	2.298	0.772	-0.505	1.784
B2	2.898	0.459	-0.091	1.653		B2	2.789	0.662	-0.115	1.644
D2	2.852	0.654	0.071	1.452		D2	2.967	0.721	-0.634	1.919
W3	0.966	0.856	0.625	1.229		W3	1.789	1.21	0.734	1.245
S3	2.195	0.871	0.043	0.972		S3	2.198	0.978	0.065	0.965
B3	2.76	0.58	-0.142	0.971		B3	2.897	0.782	0.145	0.955
D3	3.181	0.48	0.071	1.322		D3	3.194	0.642	-0.135	1.754
W5	2.698	1.089	-0.354	1.072		W5	2.781	1.156	-0.356	1.098
S5	1.949	1.216	-0.199	0.654		S5	1.959	1.452	-0.256	0.723
B5	2.74	0.714	-0.238	1.092		B5	2.76	0.946	-0.269	1.112
D5	2.773	0.676	-0.201	1.026		D5	2.892	0.854	-0.265	1.034
W6	1.659	1.118	0.22	1.018		W6	1.686	1.452	0.24	1.945
S6	2.408	1.007	-0.321	1.023		S6	2.523	1.231	-0.431	1.034
B6	2.834	0.971	-0.339	1.568		B6	2.897	1.009	-0.36	1.606
D6	2.499	1.098	-0.428	1.1		D6	2.562	1.231	-0.512	1.143
W12	0.615	0.598	0.511	1.722		W12	0.627	0.745	0.521	1.867
S12	1.479	1.032	0.097	0.818		S12	1.467	1.562	0.099	0.987
B12	2.36	0.654	-0.078	1.014		B12	2.367	0.852	-0.113	1.134
D12	2.53	0.548	0.045	0.996		D12	2.54	0.852	0.033	1.123
W13	2.27	0.615	0.162	1.081		W13	2.278	0.945	0.178	1.034
S13	2.283	0.581	0.092	1.02		S13	2.291	0.645	0.097	1.055
B13	2.804	0.42	-0.218	1.281		B13	2.941	0.562	-0.222	1.293
W15	0.678	0.514	0.335	1.403		W15	0.783	0.845	0.349	1.503
S15	1.102	0.877	0.404	0.927		S15	1.113	0.956	0.503	0.945
B15	2.221	0.704	-0.028	1.031		B15	2.341	0.895	-0.066	1.096
D15	2.3	0.701	-0.015	1.261		D15	2.452	0.956	-0.452	1.289
W22	2.276	0.594	0.166	0.97		W22	2.892	0.756	0.198	1.012
S22	2.701	0.543	-0.259	0.821		S22	2.978	0.672	-0.264	0.967
B22	1.446	0.859	-0.083	0.817		B22	1.567	0.976	-0.098	0.856
W29	0.818	0.677	0.431	0.753		W29	0.971	0.782	0.534	0.945
S29	1.022	0.865	0.469	0.761		S29	1.045	0.967	0.473	0.845
B29	2.744	0.489	-0.197	0.734		B29	2.856	0.672	-0.2	0.856
W31	2.036	0.76	-0.223	1.646		W31	2.453	0.867	-0.321	1.782
S31	2.578	0.615	-0.218	0.869		S31	2.645	0.862	-0.297	0.894
B31	2.549	0.417	-0.009	0.739		B31	2.678	0.642	-0.016	0.745
W32	1.371	0.806	-0.451	0.591		W32	1.378	0.764	-0.563	0.597
S33	1.841	0.564	-0.536	1.676		S33	1.896	0.654	-0.645	1.688
B33	2.777	0.471	-0.166	1.281		B33	2.897	0.642	-0.423	1.298
W35	1.812	0.985	-0.323	1.12		W35	1.967	1.21	-0.523	1.145
S35	1.551	0.955	-0.405	0.711		S35	1.678	1.067	-0.324	0.956
W36	3.121	0.456	-0.112	1.484		W36	3.178	0.564	-0.116	1.489
S36	2.61	0.917	-0.304	0.915		S36	2.756	1.078	-0.314	0.922
W42	1.313	0.862	-0.124	0.733		W42	1.452	0.954	-0.126	0.756
S42	2.27	0.811	-0.048	1.631		S42	2.489	0.825	-0.471	1.648
B42	2.694	0.449	-0.196	0.864		B42	2.783	0.541	-0.198	0.896
D42	2.804	0.431	-0.249	1.34		D42	2.956	0.531	-0.257	1.452
W43	2.731	0.548	-0.278	0.861		W43	2.829	0.567	-0.288	0.978
S43	1.204	0.754	-0.103	0.717		S43	2.72	0.789	-0.317	0.87
B43	2.243	0.701	0.006	1.317		B43	2.259	0.754	-0.104	1.378
D43	2.721	0.54	-0.316	0.87		D43	2.812	0.697	0.001	1.318
W44	1.69	1.001	-0.256	1.241		W44	1.711	1.009	-0.311	1.244
S44	1.189	0.706	0.018	1.24		S44	1.278	0.734	-0.196	1.345
B44	1.285	0.873	-0.135	0.665		B44	2.295	0.934	0.032	1.233
D44	2.685	0.449	-0.188	0.794		D44	2.967	0.869	-0.217	0.845
W45	0.869	0.945	0.669	1.058		W45	0.967	0.956	0.956	1.078
S45	1.231	0.999	0.133	0.793		S45	2.345	1.004	0.187	1.071
B45	2.25	0.593	0.176	1.089		B45	2.26	0.997	0.189	1.098
D45	2.35	0.652	0.029	1.07		D45	2.272	0.698	0.173	1.089
wl46	0.722	0.967	0.759	2.139		wl46	0.856	1.008	0.859	3.191
S46	0.813	0.899	0.672	1.17	s	S46	0.956	0.956	0.781	1.173
B46	1.685	1.01	0.136	1.021		B46	1.789	1.156	0.156	1.022
Wl47	2.265	0.945	-0.162	0.934		Wl47	2.286	0.987	-0.456	0.945
Wl48	2.551	1.061	-0.46	1.265		Wl48	2.645	1.189	-0.478	1.453
Wl49	1.739	1.294	0.143	0.606		Wl49	2.867	1.345	0.197	0.784
Wl50	1.557	1.185	0.134	0.801		Wl50	1.678	1.972	0.167	0.956
S50	2.345	0.839	0.09	1.124		S50	2.456	0.956	0.967	1.134
Max	3.181	1.294	0.779	2.139		**Max**	3.201	1.972	0.967	3.191
Min	0.615	0.321	-0.536	0.591		**Min**	0.627	0.421	-0.645	0.597
Avg.	2.060	0.761	-0.008	1.095		**Avg.**	2.221	0.920	-0.024	1.222

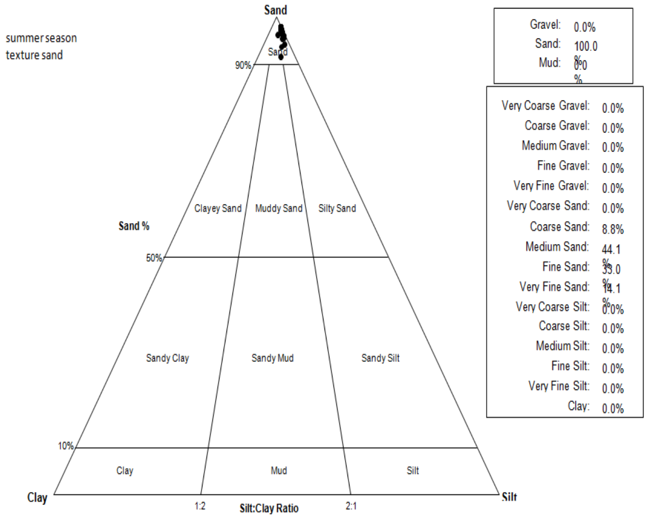


Figure 4.1. Triangular diagram showing distribution of sediments in summer season

Conclusion

The grain size analysis of 142 sediment samples during summer and winter seasons shows a drastic change due to the effect of wave activity. Bivariate modal for mean, standard deviation, skewness, kurtosis shows the dynamic process operating in the region together with the influence of the climatic season. The central tendency of mean collected sediment samples shows that the beaches along the study area are dominated by fine sand with bimodal characteristics. The standard deviation highlights coarse sand with moderately well sorted and moderately sorted during high wave energy. The skewness shows that the negative coarse skewed and positive fine skewed samples indicating strong winnowing and erosion in the study region. The dominant kurtosis, mesokurtic and platykurtic values reveal that the sediments achieved its sorting in high energy environment. The study conducted along the beaches from Mandapam to Valinokkam, highlight the fact that the sedimentary environment is influenced by relatively high wave energy and winnowing process that supports erosion or non deposition environment.

Acknowledgement

The authors are thankful to the University authorities for permitting us to work on this research project. We also thank CSIR-EMR for funding this research project work. We acknowledge all well-wishers for their encouragement and suggestion given for the completion of this research work.

Reference:

1. Bascom, W.N., The relationship between sand-size and beach face slope. Transactions of the American Geophysical Union 32, 866–874. **(1951)**
2. Bird, E.C.F., Coasts: an Introduction to Coastal Geomorphology, third ed. Australia National Univ. Press, Canberra. **(1984)**
3. Bryant E., Behaviour of grain size characteristics on reflective and dissipative foreshores, Broken Bay, Australia. Journal of Sedimentary Petrology, Vol. (52,) No. 2, pp. 431– 450. **(1982)**
4. Bui EN, Manzullo J, Wilding LP. Using quartz grain size and shape analysis to distinguish Between Aeolian and fluvial deposits in the Dallol Bosso of Niger (West Africa). Earth Surface Processes and Landforms 14: 157–166 **(1990)**
5. Carranza-Edwards A., Grain size and sorting in modern beach sands. *Journal of Coastal* Research, Vol. (17) No. 1, pp. 38–52 **(2001)**
6. Chakrabarti A.**,** Polymodal composition of beach sands from the east coast of India. Journal of Sedimentary Petrology, Vol. (47) No. 2, pp. 634–641**(1977)**
7. Chaudhri R. S., Khan H. M. M., and Kaur S., Sedimentology of beach sediments of the West coast of India. Sedimentary Geology, Vol. (30) No 1-2, pp. 79–94 **(1981)**
8. Chauhan, O.S. and Chaubey, A.K.,. Correlation between moment, graphic and phi Measure of the sediments of east coast of India in Sedimentary Geology **(1988)**
9. Davis MW, Ehrlich R. Relationships between measures of sediment-size-frequency Distributions and the nature of sediments. Geological Society of America Bulletin 81: 3537–354 **(1970)**
10. Drake D. E. and D. A. Cacchione Seasonal variation in sediment transport on the Russian River shelf, California. Continental Shelf Research, 4, 495—514 **(1985)**
11. Duane D. B.**,** Significance of skewness in recent sediments, Western Pamlico Sound. North Carolina. Journal of Sedimentary Petrology, Vol. (34) No. 4, pp. 864–874 **(1964)**
12. Fox, W.T., Ladd, J.W. and Martin, M.K., A profile of the four moment measures Perpendicular to a shore line, South Haven, Michigan. J. Sediment. Petrol., 36:1126 113 **(1960)**
13. Friedman G. M.**,** Distinction between dune, beach and river sands from their textural Characteristics. Journal of Sedimentary Petrology, Vol. 931) No. 4, pp. 514–529 **(1961)**
14. Friedman G. M., on sorting, sorting coefficients and the log normality of the grain-size Distribution of sandstones. Journal of Geology, Vol. (70) No. 6, pp. 737–753 **(1962)**
15. Friedman, G.M., Difference in size distributions of populations of particles among Sands of various origins. Sedimentology, 26, 1-30 **(1979)**
16. Friedman, G.M., and Difference in size distribution of population of particles among the sand of various origins: address of the retiring president of the International Association of Sedimentologist. Sedimentology, 26(1), 3-32 **(1979)**
17. Folk, R.L. and Ward, R.C., Brazos River Bar-a study in the significance of grain size Parameters. Journal of Sedimentary Petrology, 27 (1), 3-27 **(1957)**
18. Giosan, L., Bokuniewicz, H., panin, N., Postolache, I., Longshore sediment transport Pattern along the Romanian Danube delta coast. Journal of Coastal Research 15, 859–871**(1999)**
19. Hegde V. S., Shalini G., and Kanchanagouri D. G., Provinence of heavy minerals with Special reference to ilmenite of the Honnavar beach, central west coast of India. Current Science, Vol. (91)No. 5, pp. 644–648 **(2006)**
20. Inman, D. L. and Guza, R. T. The origin of swash cusps on beaches. Mar. Geol. 49,133-1489 **(1982)**
21. Jaquet JM, Vernet JP. Moment and graphic size parameters in sediments of Lake Geneva (Switzerland). Journal of Sedimentary Petrology 46: 305–312 **(1976)**

22. Kamphuis, J.W., Alongshore sediment transport rate. J. Waterway Port Coastal Ocean Eng.ASCE 117 (6) **(1991)**
23. Komar P. D., Beach Processes and Sedimentation, New Jersey, Prentice-Hall, pp. 1–429 **(1976)**
24. Koldijk WC. On- Environment -Sensitive grain, Size parameters. Sedimentology 10:57–69 **(1968)**
25. Martins, L., Significance of skewness and kurtosis in environmental interpretation. Journal of Sedimentary Petrology, 35, 768-770 **(1965)**
26. Morton, R.A., Temporal and spatial variations in shoreline changes and their implications, examples from the Texas Gulf coast. Journal of Sedimentary Petrology 49, 1101–112 **(1979)**
27. [Nordstrom K. F. the use of grain size statistics to distinguish between high- and moderate-energy beach environments. Journal of Sedimentary Petrology, Vol. (47) No. 3, pp. 1287– 1294 **(1977)**
28. Miller, R.L. and Zeigler, J.M.,**.** A model relating sediment pattern in the region of shoaling waves, breaker zone, and foreshore. J. Geol., 66: 417-441**(1958)**.
29. Sahu B. K**.,** Depositional mechanisms from the size analysis of clastic sediments. *Journal of* Sedimentary Petrology, Vol. (34) No. 1, pp. 73–83 **(1964)**
30. Simon J, Gradistat: A grain size distribution and statistics package for the analysis of unconsolidated sediments earth surface process. Landforms 26, 1237-1248 **(2001).**
31. Swan D, Clague JJ, Luternauer JL. Grain size statistics I: evaluation of the Folk and Ward graphic measures. Journal of Sedimentary Petrology 48: 863–878 **(1978).**
32. Tanaka, H., Suzuki, M., Prediction of shoreline change and grain size sorting at the Sendai Coast. In: Belorgey, M., Rajaona, R.D., Sleath, J.F.E. (Eds.), Euromech 93—Sediment Transport Mechanisms in Coastal Environments and Rivers. World Scientific, London **(1994).**
33. Van Hijum, E., Pilarczyk, K.W., Equilibrium Profile and Longshore Transport of Coarse Material under Regular and Irregular Wave Attack Delft Hydr., Lab. Publication vol. 274 **(1982)**
34. Visher G. S**.,** Grain size distributions and depositional processes. Journal of Sedimentary Petrology, Vol. 39, pp. 1074–1106 **(1969)**
35. Wallace, D.J., Anderson, J.B., Rodriguez, A.B.,. Natural versus anthropogenic mechanisms of erosion along the upper Texas coast. GSA Special Papers 460, 137–147**(2009)**.
36. Wiberg, P.L., Drake, D.E., Cacchione, D.A., Sediment re-suspension and bed armoring during high bottom stress events on the northern California inner continental shelf: Measurements and predictions. Continental Shelf Research 14 (10–11), 1191–1219**(1994).**