Numerical Assessment and Analysis of Textural Deposits of Beach Sediment: A case study of Ajah (Okun Mopo) Beach Lagos South West Nigeria.

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ABSTRACT: Grain size distributions and gradation coefficients of sediments are determined and they give the purview of the numerical assessments and textural deposits on Ajah Okun Mopo Beach. During a singular observational period, sediments were collected from the Okun mopo beach on the waterline and berm of each of the established 10 beach profile stations perpendicular to the shoreline. Grain size distribution was assessed by dry sieving and the analysis showed that high current and strong wave energy are responsible for the grain size distribution on the beach. The principal sediment modes ranges from coarse sand on the waterline to medium sand on the berm, and their average grain sizes are recorded as 0.9488Φ and 1.1848Φ respectively. The grains show homogeneity of moderately well sorted sand, mesokurtic and poorly graded (well sorted) sediments on both the waterline and the berm. The grains are finely skewed at the waterline and near symmetrical at the berm with values of 0.1141 on the waterline and 0.0864 on the berm. However, with medium sand reportedly deposited on the berm and coarse sand deposited on the waterline indicate that the beach is influenced by strong wave energy oscillations capable of causing imminent coastal erosion, coastal seawater inundation and flooding, and thus, dangerous to the structural settlements at close proximities to the beach with no appropriate flood or shoreline protections.
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Key words: Textural deposits; Grain size distributions; transport dynamics; gradation coefficients.

1. INTRODUCTION

Textural characteristics of beach sediment is the result of complex interaction between sediment source, wave energy and the general offshore gradient upon which the beach is naturally shaped (Komar, 1998). The grain size distribution of the sediment deposit can be assessed by sieve analysis, and according to Abuodha (2003), the results have been useful for the classification of sedimentary environment and can also helped to elucidate transport dynamics. Being an important component of beach sands, grain sizes are from both abiotic (nonliving) and biotic (living) sources (Carter and Woodroffe, 1994). Beach sediments are sorted according to the energy levels that the beach is exposed, and this infers that beaches exposed to higher wave energy levels are supposed to be composed of coarser sediments, or composed of relatively homogeneous, or similar, grain size distribution, whereas beaches exposed to lower wave energy levels produce surfaces with a more heterogeneous, or mixed, size distribution (Heather, *et al.* 2009; Komar, 1977). However, (Anfuso, 2005) stated that the surface morphology of a beach especially with regard to the steepness affect the intensity of the wave energy, and thus can influence the grain size distribution and sediment transport.

On the other hand, and in the opinion of (Komar, 1977), knowledge of the compositions and grain size distributions of beach sediments can also help to understand the oceanographic processes shaping the coastline in view of the current and wave dynamics. Accordingly, this can help to infer possible coexistence of the beach and the ocean as sediments on the beach surfaces are subject to dynamic oscillations between the beach and the ocean resulting in accretion and or erosion due to high waves and human interruption of coastal processes.

Recently, the Ajah Okun mopo beach is gradually inundated by human settlements and building of housing structures. These structures are sited at very close proximities to the waterline. Considering the plunging waves oscillating the beach and the nearshore current, transporting and depositing sediments, such settlements structures are therefore exposed to high level of danger as there are no shoreline protections against flood situation in the study area yet. Therefore, the numerical assessment and analysis of the textural deposits of sediment on the Okun Mopo beach is imperative to evaluate the grain size distributions so as to elucidate the transport and wave dynamics responsible for the sediment drift. Consequently, this will be utilized to analyse or assess the safety of the exposed settlement structures around the beach in view of imminent erosion and flood, or saltwater inundation.

The quartile measures, phi scale among others have been reported by (Trask, 1932; Inman, 1952; Folk and Ward, 1957; Kane and Hubert, 1962; Folk, 1974; Sawyer, 1977) as the frequently used statistical measures of grain size distribution. According to (Folk, 1974), seven different points on the cumulative-frequency curve are directly selected (at 5, 16, 25, 50, 75, 84, and 95 percentiles) for computation of the parametric statistics such as the mean, standard deviation, Skewness and kurtosis. Similarly associated with the implication of standard deviation are gradation parameters. These parameters are non statistical and they are sorting coefficient, uniformity and curvature coefficients and they are computed from cumulative probability semi-log curve in millimetre scales. Accordingly, two points (at 75 and 25 percentiles) are directly selected for sorting coefficients while three points (at 10, 30 and 60 percentiles) are directly selected for uniformity and curvature coefficients respectively from semi-log graph (Holtz *et al*., 1981).

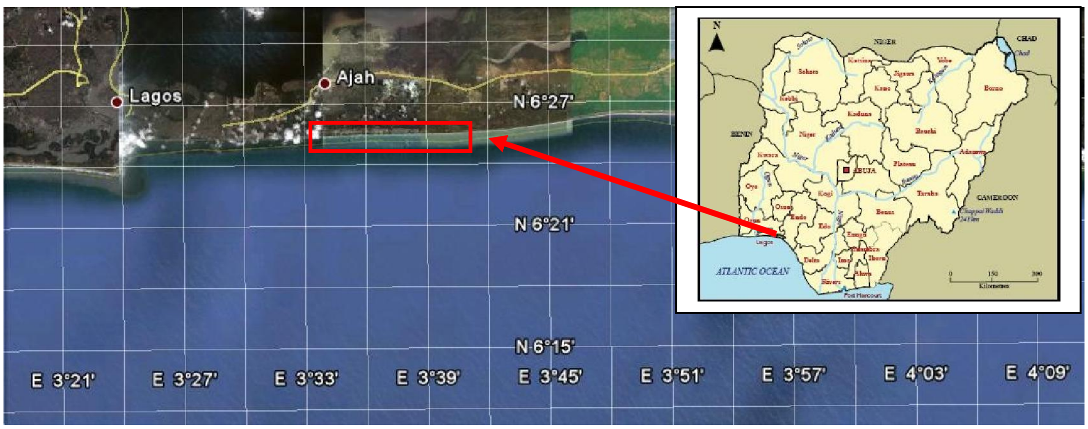

Figure 1. Map of the Study Area showing the showing Lagos State.

However, (Ibe and Awosika, 1988) during their report on the sedimentology of beaches of barrier bar complexes in Nigeria, recorded that beach sediments are coarser in Lagos and finer in East of Lagos which owe their depositions to fluvial, alongshore, offshore-onshore transport dynamics. Again, they also reported that East of Lagos had beaches whose sediments were clean, well sorted and leptokurtic. The Skewness, according to the authors, ranged from finely skewed to near symmetrical without preferred trend across the coast. But during this report, no mention was made to this area of study, and so characterizations of this beach in terms of grain size distribution, sorting coefficients and gradation coefficients were not recorded.

2.0. MATERIALS AND METHODS

2.1. The Study Area

Okun-Mopo beach is located in Ajah, and is one of the beaches situated East of Lagos lagoon, Latitude $6^0$28'0"N Longitude $3^0$34'0"E, along the Lekki Barrier Bar Complex, Lagos (figure1). Past studies by the Nigerian Institute for Oceanography and Marine Research have shown that Lekki barrier bar is inundated by wave actions, longshore and tidal currents, and act as the prevailing physical processes that generate energy for transportation and accumulation of sediments. Owing to the narrowness of the beach and the wave dynamics of the ocean, sediments are continuously oscillated between the beach and the ocean. These dynamic systems therefore yield deposition of sand sediment on the beach face and, perhaps, erosion of same to the ocean. The rectangular strip on the map in figure1, represent the location where sediments were sampled on the Okun Mopo beach. The length of the area sampled was 400m.

In the recent time, the entire stretch of Okun mopo beach is being inundated or encroached by human settlements and building of housing structures and these structures are sited at very close proximities to the waterline. The beach face and the slope are low lying, and the berm is near flat indicating possibility of flooding and inundation of the beach and the coastal environment with seawater. The beach is littered with detritus, plastics materials and sparsely located coconut trees behind the berm. There is however no flood and shoreline protections in the study area yet.

2.2.0. METHOD OF STUDY

Different analytical techniques exist for determination of grain size distribution. Few of these are sieving, settling tube techniques (settling velocity), and method of moment. However, sieving method and analysis was adopted for the investigation of this study.

2.2.1. Fieldwork

In January 2011, a sum of 20 sediments samples were collected from shallow trench along 10 beach profile stations aligned perpendicular to the shoreline, and spaced from each other at intervals of 25m and 50m covering a horizontal length of 400m. Owing to the narrowness of the Ajah Okun Mopo Beach, sediment samples collected per transect was made from the waterline and the berm respectively (figure2). The samples were collected in plastic nylons and labelled accordingly before taking to the laboratory for appropriate sieving and further analysis.

Figure 2. Structural/Satellite Image of the Study Area Berm.

2.2.2. Post-fieldwork/Laboratory Analysis

In Nigeria Institute for Oceanography and marine Research wet laboratory, the samples were dried in the oven at a regulated room temperature to make the grain free from trace moisture or water content and to be unconsolidated. 70g of each sample was passed through a mechanical sieving process, which involves bank of ten sieve meshes in downward decreasing mesh diameters from the top to the bottom. The selection of sieves was from apertures ranging between -1.00Φ and 4.00Φ. In these layers of sieve bank, the 70g of each measured sediment sample was subjected to 15 minutes mechanical agitation or shaking (otherwise called sieving) on Rotap Shaker. The Rotap Shaker (*product name: Endoscott Test Sieve Shaker*) is an electronic device, which operates as a mechanical vibrator. The vibration of this sieve device has an intrinsic time precision frequency and vibrates in an order that grain size greater than a certain micron is retained on that mesh size.

Sample retained on each of the sieves was, completely but carefully, removed and was weighed to the nearest 0.01g on the digital balance (*product name: Scout Pro SP202. SN: 7130430803*) and recorded against the corresponding phi size. This was done for all the twenty (20) sediment samples. Generally, the mass frequency data were subsequently, further, processed using Matlab Software, which was used to plot and calculate the graphical statistical parameters, such as mean, inclusive graphic standard deviation, inclusive graphic Skewness, and kurtosis using the Folk and Ward (1957) showing Sampled Points along the Waterline and formulae, and within accuracy of the Wentworth grade scale, by simply using the conversion factor: $-\log_2$ (mm) for grain size diameters in millimetres. This factor converts grain size diameters in millimetres to diameters in phi.

The data of this study were presented in plots as histogram, where the frequency by weight percent of each sampled data was plotted against the grain size in phi and as Cumulative Arithmetic Curve, where the cumulative frequency weight percent of each sample data was plotted against grain sizes in phi. The statistical parameters were computed directly from the Cumulative Arithmetic Curve, according to (Folk, 1974), by selecting seven different points at 5, 16, 25, 50, 75, 84, and 95 percentiles and the results were presented in table 1 and 2. A total average value of each parameter was computed so as to reveal the overall trend of grain size distributions on the Okun mopo beach. For each of the beach profile station the histogram and cumulative arithmetic curve for the waterline and berm data were plotted together as subplots for convenient overview picture of events on the beach.

On the logarithmic papers, the cumulative probability logarithmic curve and Cumulative Probability semi-log curve of the entire waterline and berm data were plotted respectively using matlab logarithmic intrinsic commands to show the relationship between percentage finer or passing and the grain size in millimetres. The cumulative probability curve would straighten out the S-shaped tails of the cumulative curve if the frequency distribution is normal (Gaussian) distribution, or show a deviation from straight line if the frequency distribution is not a normal distribution. Again, the steeper the slope of cumulative probability line, the better sorted the grain distribution is interpreted. The cumulative Probability semi-log curve predicts the range of gradation or sorting of the grains, and also showcases the dynamic range of distribution of the grains between the soil classifications (fine (silt), sand and gravel). So, the semi-log graph was segmented into three parts, with demarcation at 0.074mm boundary for fine (silt) and sand and another demarcation at 4.75mm boundary for sand and gravel. The distribution of the sediments between fine (silt) and sand was also computed in percentages according to USCS scheme, each for waterline and berm, and presented in table1.

2.2.3. Gradation Coefficients

Gradation coefficients such as sorting coefficient, uniformity coefficient and curvature coefficient are geologic and engineering measures of how graded (or sorted) a soil is (U.S. Army, 1997). These coefficients are associated with this study with regard to the statistical analysis of the standard deviation, whose implication is based on sortedness of the grains. While the sorting coefficient is a geologic application, the uniformity and curvature coefficients are engineering applications, and they were considered to view sorting of the grain size of this study from both perspectives.

These coefficients are defined as follow:

Sorting Coefficient (S_o)

$$S_o = (D75/D25)^{1/2} \qquad (1)$$

Uniformity Coefficient (Cu)

$$Cu = D_{60}/D_{10} \qquad (2)$$

Curvature Coefficient (Cc)

$$Cc = (D_{30})^2/D_{60}*D_{10} \qquad (3)$$

Where S_o = sorting coefficient; Cu = uniformity coefficient; Cc = curvature coefficient; D_{10} is Hazen's effective size or diameter for which 10% of the sample is finer than D_{10}; D_{25} is the diameter for which 25% of the sample is finer than D25; D30 is the diameter for which 30% of the sample is finer than D_{30}; D_{60} is the diameter for which 60% of the sample is finer than D_{60}; and D_{75} is the diameter for which 75% of the sample is finer than D_{75}.

Accordingly, the larger the S_o, the more well graded the soil, and sand whose Cu is greater than or equal to 6 and Cc lies between 1 and 3 is said to be well-graded. The sediments not meeting these conditions are regarded as poorly graded. Poorly graded sediments are uniformly sorted, with all grains having uniform or equal size if Cu =1. Poorly graded soils are designated by "SP" under the USCS system. Apparently, according to (Holtz, R. and Kovacs, W. 1981), a well-graded soil is poorly-sorted, while a poorly-graded soil is well-sorted.

3.0. RESULTS

The numerical assessments of the Okun Mopo Beach sediment characteristics, computed according to Folk and Ward (1957b), were summarized in table 1 and 2; and consequently represented in graphics in figures 3 to 8. The textural analysis and descriptions of the Okun mopo beach grain size distributions were accounted for horizontally, parallel to the beach, along the waterline and berm respectively to ascertain consistency of the grain size distributions due to longshore drift of sediment, and vertically across the beach, to ascertain cross-shore variations in grain size distributions, due to the beach profile transect perpendicular to the shoreline.

Cross-shore variations of the grain population contained along the waterline and berm for each station were presented in histogram (figure3a-j) plotted together as well as their cumulative arithmetic frequency curves. They present a quick picture and overview of the grain abundance and sortedness of the data respectively. Figure4 is frequency curves showing the skewness of grain size along the waterline and the berm, while figure5 is a longshore (horizontal) analysis and gives overview of the cumulative frequency curve, each for the waterline and berm. They reveal the general trends or total average longshore variation of grain size distributions along the waterline and along the berm so as to associate current of deposition, energy and waves of the grain dynamics.

Figure 6 is cumulative probability curve, plotted to reveal sediments with "normal" frequency or size distribution, or show deviation from straight line to indicate sediments with non-normal frequency distribution. Sorting can also easily be interpreted from the cumulative probability curve. The steeper the slope of the line, the better the sorting of the grains size. Figure7 is a semi-log graph, plotted to envisage the sediments whose grain sizes are uniformly and well sorted (i.e. poorly graded); poorly sorted (i.e. well graded) or whose grain sizes are bimodal (i.e. gap-graded soil). Figure 8 is an integral evaluation of the statistical parameters of the waterline and the berm and it gives a graphical elucidation of the statistical parameters; which shows the variability trends of the grain size distributions on the beach.

Table1. Results of the Grain Size Analysis for Waterline and Berm in phi (Φ).

WATERLINE

ST.ID	MEAN	STD	SKEW	KURT	Cu	Cc	So	%Sand	%Fine
1FE	0.592	0.534	0.015	1.042	1.765	1.003	0.503	87	13
2FE	1.002	0.537	0.068	1.001	1.708	0.958	0.687	96	4
3FE	0.759	0.577	0.006	0.992	1.864	0.995	0.562	90	10
4FE	0.959	0.573	0.266	1.036	1.64	0.903	0.592	90	10
5FW	1.226	0.578	0.09	0.907	1.818	0.902	0.7	98	2
6FE	0.831	0.533	0.025	1.055	1.751	1.017	0.644	93	7
7BW	1.139	0.576	0.124	0.948	1.741	0.942	0.694	97	3
8EW	0.975	0.503	0.165	0.996	1.605	0.953	0.697	95	5
9EW	1.03	0.533	0.217	0.946	1.583	0.929	0.688	96	4
10FW	0.975	0.503	0.165	0.996	1.605	0.953	0.697	95	5
Average	**0.9488**	**0.5447**	**0.1141**	**0.9919**	**1.708**	**0.9555**	**0.6464**		

BERM

ST.ID	MEAN	STD	SKEW	KURT	Cu	Cc	So	%Sand	%Fine
1FE	1.418	0.522	0.144	1.004	1.65	0.961	0.775	100	0
2FE	1.297	0.555	0.199	0.944	1.681	0.912	0.732	98	2
3FE	0.865	0.676	-0.06	0.744	2.198	0.804	0.465	90	10
4FE	1.09	0.469	0.016	0.944	1.637	0.944	0.732	99	1
5FW	1.243	0.566	0.072	0.886	1.815	0.91	0.706	99	1
6FE	1.094	0.633	0.103	0.833	1.909	0.801	0.625	95	5
7BW	1.413	0.469	0.129	1.027	1.581	0.969	0.799	99	1
8EW	0.815	0.553	0.092	0.889	1.776	0.927	0.577	92	8
9EW	1.284	0.678	0.033	1.072	1.989	0.981	0.696	97	3
10FW	1.329	0.476	0.136	0.973	1.587	0.94	0.776	99	1
Average	**1.1848**	**0.5597**	**0.0864**	**0.9316**	**1.7823**	**0.9149**	**0.6883**		

Table2. Result Descriptions of the Grain Size Analysis.

Waterline Result Descriptions

Stations	Descriptions
1FE	Coarse sand, moderately well sorted, near symmetrical, mesokurtic. SP.
2FE	Medium sand, moderately well sorted, near symmetrical, mesokurtic. SP.
3FE	Coarse sand, moderately well sorted, near symmetrical, mesokurtic. SP.
4FE	Coarse sand, moderately well sorted, fine skewed, mesokurtic. SP.
5FW	Medium sand, moderately well sorted, near symmetrical, mesokurtic. SP.
6FE	Coarse sand, moderately well sorted, near symmetrical, mesokurtic. SP.
7BW	Medium sand, moderately well sorted, fine skewed mesokurtic. SP.
8EW	Coarse sand, moderately well sorted, fine skewed, mesokurtic. SP.
9EW	Medium sand, moderately well sorted, fine skewed mesokurtic. SP.
10FW	Coarse sand, moderately well sorted, fine skewed, mesokurtic. SP.
Average	**Coarse sand, moderately well sorted, Fine skewed, Mesokurtic. SP.**

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Berm Result Descriptions

Stations	Descriptions
1FE	Medium sand, moderately well sorted, fine skewed mesokurtic. SP.
2FE	Medium sand, moderately well sorted, fine skewed mesokurtic. SP.
3FE	Coarse sand, moderately well sorted, near symmetrical, platykurtic. SP.
4FE	Medium sand, well sorted, near symmetrical, mesokurtic. SP.
5FW	Medium sand, moderately well sorted, near symmetrical, platykurtic. SP.
6FE	Medium sand, moderately well sorted, fine skewed platykurtic. SP.
7BW	Medium sand, well sorted, Fine skewed, mesokurtic. SP.
8EW	Coarse sand, moderately well sorted, near symmetrical, platykurtic. SP.
9EW	Medium sand, moderately well sorted, near symmetrical, mesokurtic. SP.
10FW	Medium sand, well sorted, Fine skewed, mesokurtic. SP.
Average	**Medium sand, moderately well sorted, near symmetrical, Mesokurtic. SP.**

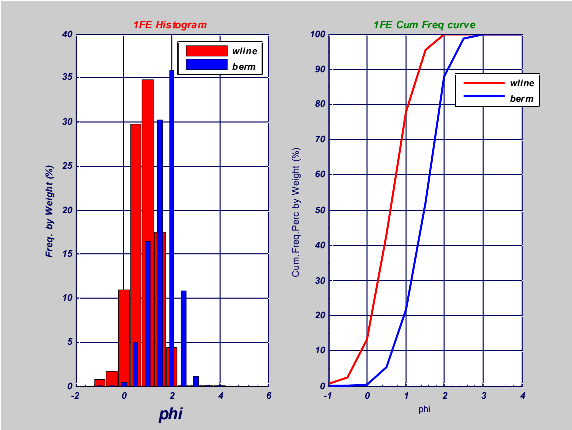

Figure 3a. Histogram and Frequency Cumulative Curve of Waterline and Berm of Station 1FE.

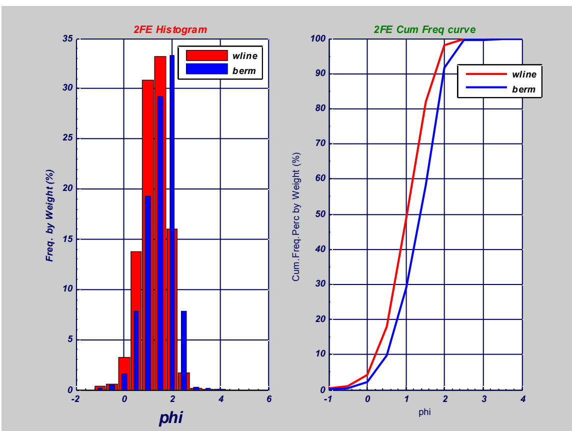

Figure 3b. Histogram and Frequency Cumulative Curve of Waterline and Berm of Station 2FE.

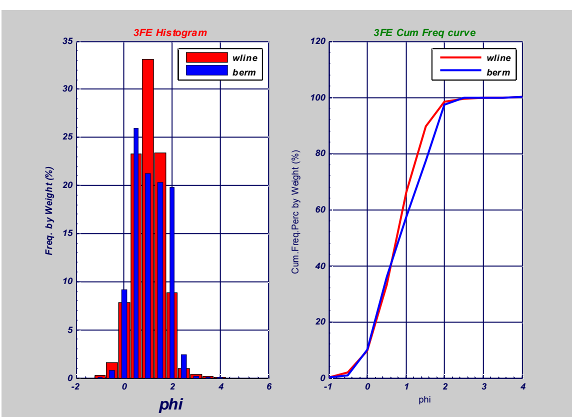

Figure 3c. Histogram and frequency Cumulative Curve of Waterline and Berm of Station 3FE.

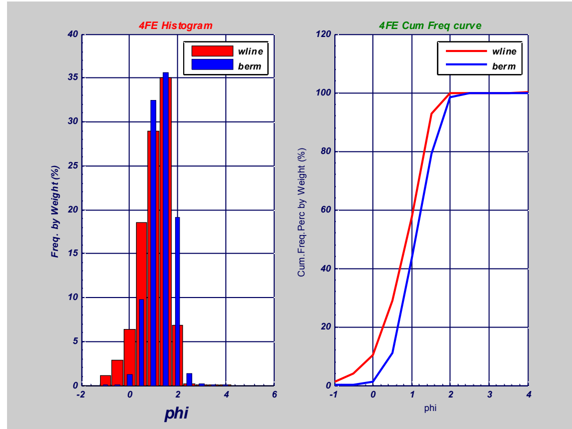

Figure 3d. Histogram and Frequency Cumulative Curve of Waterline and Berm of Station 4FE.

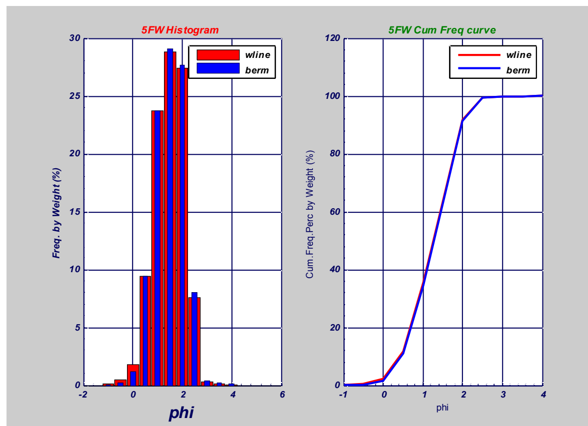

Figure 3e. Histogram and frequency Cumulative Curve of Waterline and Berm of Station 5FW.

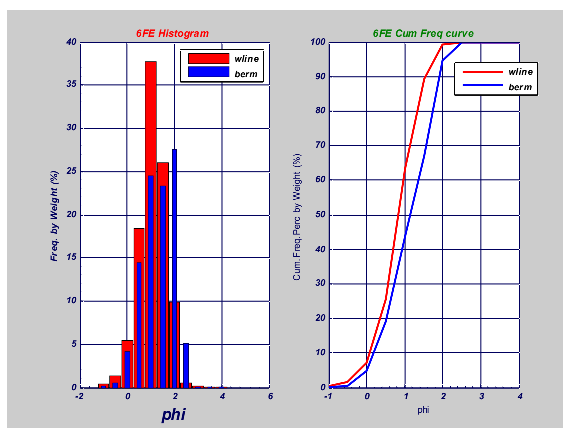

Figure 3f. Histogram and Frequency Cumulative Curve of Waterline and Berm of Station 6FE.

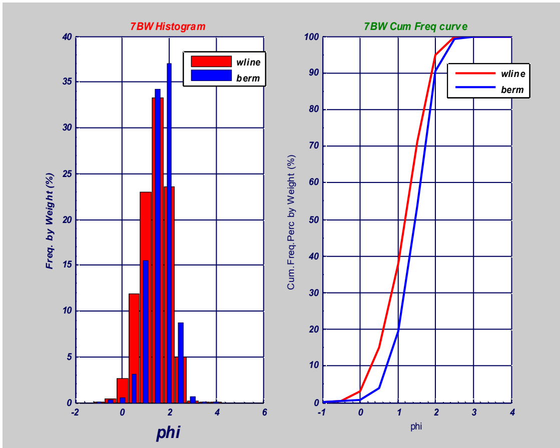

Figure 3g. Histogram and Frequency Cumulative Curve of Waterline and Berm of Station 7BW.

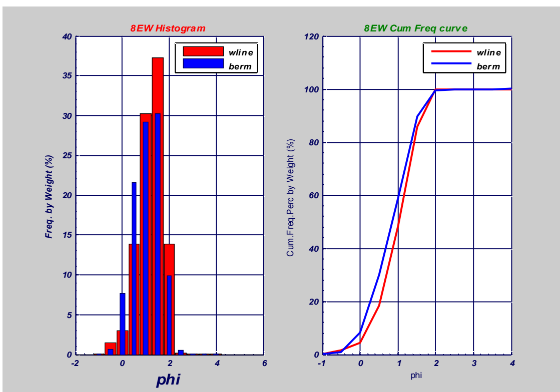

Figure 3h. Histogram and Frequency Cumulative Curve of Waterline and Berm of Station 8EW.

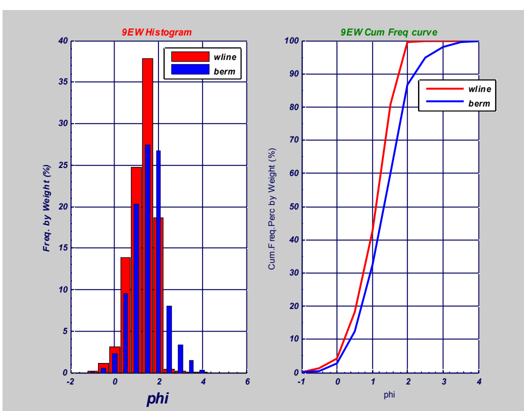

Figure 3i. Histogram and Frequency cumulative Curve of Waterline and Berm of Station 9EW.

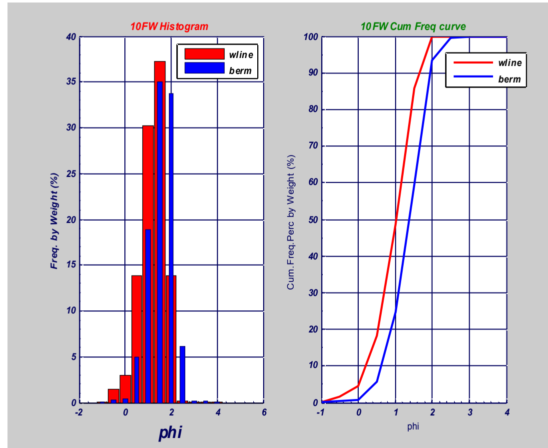

Figure 3j. Histogram and Frequency Cumulative Curve of Waterline and Berm of Station 10FW.

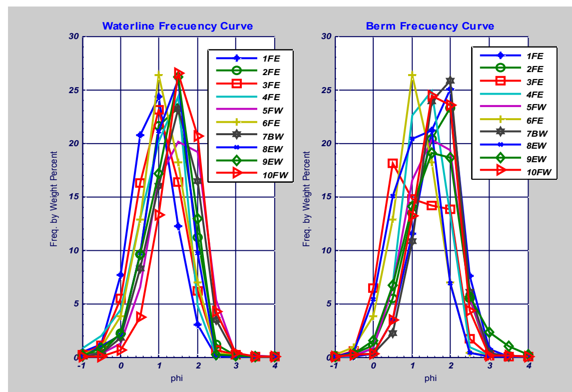

Figure 4. Frequency Curve, depicting the Skewness of the Grain Size Distributions.

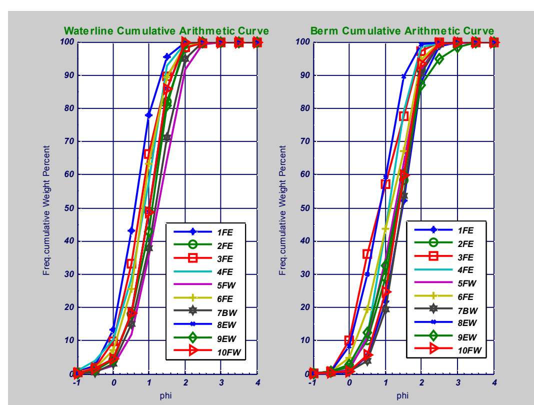

Figure 5. Frequency Cumulative Arithmetic Curve, showing total average Longshore Variation of Grain Size Distributions along the Waterline and the Berm.

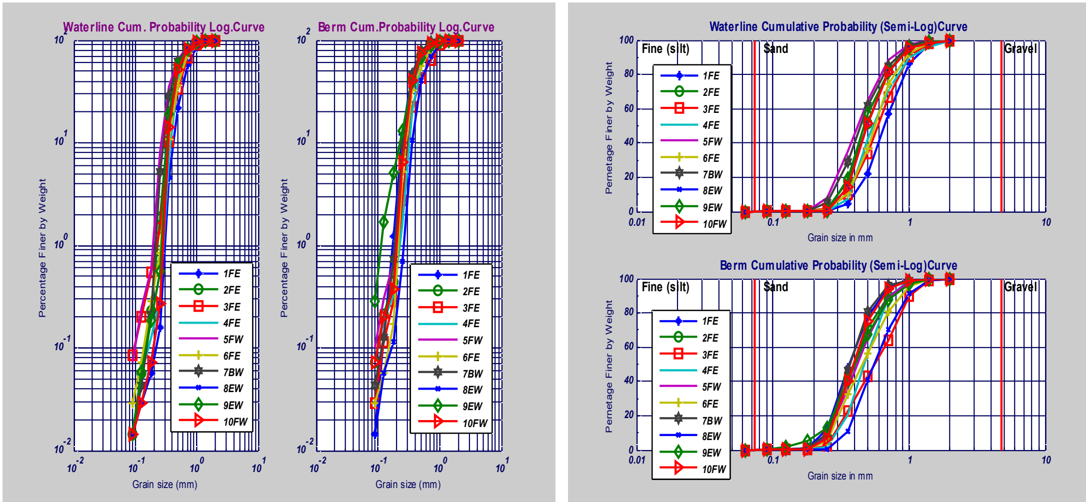

Figure 6. Cumulative Probability Logarithmic Plot showing Longshore Variation of Sorting.

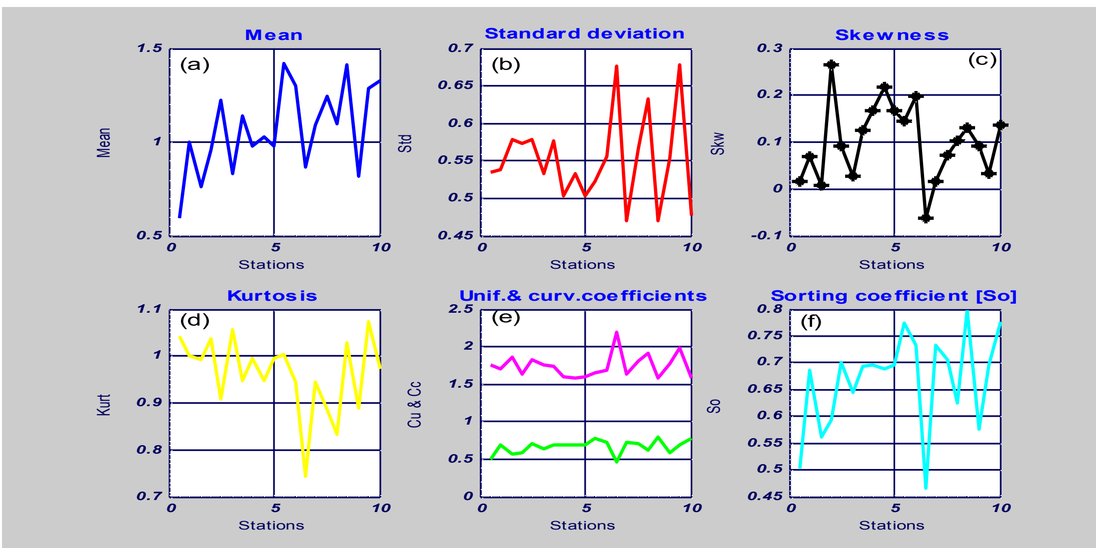

Figure 7. Semi-log Plot of Waterline and Berm Sediment Data showing the Distributions and how Sorted (or graded) the Sediments are variability with stations on the Beach)Above). Figure 8. The Statistical Parameters and their (Below).

4.0. DISCUSSIONS

As the environmentally sensitive indicators, the mean, standard deviation, Skewness and kurtosis, coupled with the gradation coefficients such as sorting, uniformity and curvature coefficients revealed the overall reflection of competence of the drift dynamic system, and so have improved the general knowledge of the current and wave dynamics interacting with the beach (figure8).

Generally, from the total average data (table1 and 2), analysis of the sediments showed that the grain size distributions ranged from coarse sand on the waterline to medium sand on the berm, with grains showing homogeneity of moderately well sorted sand, mesokurtic and poorly graded sediments respectively. The Skewness revealed a dissimilar trend at the waterline and berm respectively. The grains are fine skewed at the waterline and near symmetrical at the berm.

At each station along the waterline, parallel to the beach, sediments are seen to be coarse at stations 1FE, 3FE, 4FE, 6FE, 8EW, and 10FW, and have medium sized sand range at stations 2FE, 5FW, 7BW, and 9EW. While along the berm, parallel to the beach, the sediments are seen to be medium sand at stations 1FE, 2FE, 4FE, 5FW, 6FE, 7BW, 9EW, 10FW, and have coarse sized sand at stations 3FE and 8EW. However, the total average mean values indicated that sediment on the waterline is coarse sand and on the berm is medium sand (figure 8(a)). The principal sediment modes are therefore coarse sand of average of 0.9488Φ diameter and a medium sand of about 1.1848Φ average diameter. The different locations on the profile transects are represented by varying proportions of those two modes. The coarseness of the sediment reflects the local intensity of turbulence and wave energy dissipation. Hence, the mean grain size is greatest within the wave plunge point at the base of the beach face, decreasing up the fore-shore slope, and the mean grain size closely reflect the energy level of the wave processes. Intensity of the swash decreases up the beach face, and this produces a parallel decrease in grain size. The abundance of the grains, both along waterline and along the berm, from figure3a-j, is unimodal with greater percentage of sands.

Sorting of sediments along the beach profile produces cross-shore variations in sediment grain size that are readily apparent. Generally, sorting on the waterline and berm are 0.5447 and 0.5597 respectively. Along the waterline and berm (table 1 and 2), sorting however, maintained a consistent range, of moderately well sorted, except at stations 4FE, 7BW, and 10FW of the berm where the standard deviation indicated the grain sands to be well sorted. This is also evident in figure3a-j of the cumulative frequency curves, where the curve lines exhibited gentle slopes, signifying moderately well sorted grain sands, while in figure3d, figure3g, and figure3j, the cumulative frequency curve lines of the berm showed abrupt slopes, signifying well sorted grain sands. Figure 8(b) apparently unveiled the grains sorting variation between well sorted and moderately sorted on the entire beach. Sorting is also evident in figure7, where all the grains plotted on semi-log paper indicated that they are uniformly sorted along the waterline and berm respectively with values of uniformity coefficient (Cu), curvature coefficient (Cc) and sorting coefficient (So) as shown in table 1. From the steep slopes in figure6, it showed that the sediments are better sorted on the waterline and on the berm too. Again, deviation of the curve lines in figure6 from straight line further indicated that sediments on the Okun mopo beach do not have a normal frequency distribution.

The frequency curves in figure4 revealed that the skewness of the waterline and berm regime ranged between fine Skewed and near symmetrical respectively. Similarly, from table2, the total average computations of the skewness revealed that fine skewed sands (0.1141) dominate along the waterline, while the near symmetrical (0.0864) dominate along the berm. These suggest that the waterline is negatively skewed and the sands have larger or coarse grain sizes, while the berm has medium sized grain sands.

Waterline stations had uniform range of mesokurtic kurtosis. For stations along the berm, kurtosis ranged between mesokurtic and platykurtic. This revealed that the sediments are either sorted everywhere or sorted at the peaks. But from table 1, the total average computations of kurtosis on the waterline and berm (0.9919 and 0.9316) respectively, revealed a homogeneously ranged result that is mesokurtic. Figure 8(d) clearly indicates the dynamic variations of kurtosis ranging between mesokurtic and platykurtic.

The gradation coefficients (equations 1, 2 and 3 above) analysed alongshore revealed that uniformity and curvature coefficients are 1.708 and 0.9555 respectively on the waterline and 1.7823 and 0.9149 respectively on the berm, while the sorting coefficient is 0.6464 on the waterline and 0.6883 on the berm. These results revealed that the grains are poorly graded sands with the designation “SP” according to USCS system in table 2. See also figure8 (e and f). Actually, poorly graded sand is said to be well sorted sand. The uniformity and curvature coefficients showed that the grains are well sorted since Cu is not greater than or equal to 6 and Cc does not lie between 1 and 3.

5.0. CONCLUSION

The Okun Mopo Beach is dominated by clastic sediments whose sizes basically ranged from coarse to medium grain sized sand. In general, the beach is homogeneous in sorting, kurtosis and gradation coefficients. That is, it is moderately well sorted, mesokurtic and poorly graded respectively. The Skewness revealed a dissimilar trend across the beach. The grains are fine skewed at the waterline and near symmetrical at the berm.

With regard to the energy of deposition which helps to elucidate the sediment transport dynamics from the sea, significant trends of mean and sortedness exist along the waterline and berm respectively. Owing to close proximity of the waterline to the sea, coarse sized sands are deposited on the waterline due to strong current and high wave energy. The coarseness of the sediment reflects the local intensity of turbulence and wave energy dissipation. The existence of moderately well sorted and well sorted medium sized sands along the berm of the beach is an indication that there is strong wave and qualitative consistency of flow of high energy of deposition, strong enough to transport the medium sized sands, to the beach berm.

With coarse sized sands dominating the grain size distributions along the waterline and medium sized sands dominating the grain size distributions along the berm, it is evident that the grain sands were reworked and fractured as they drifted through the waterline to the berm. Recall that the longer grain sands are actively transported the smaller they become, but for the close proximity between the waterline and the berm, medium sized sands thus characterized the berm regime.

The beach is dominated by poorly graded sands whose source is unimodal. Medium sands on the berm with near symmetrical skewness is an indication that different level of beach water or nearshore current carried different grain sizes and transcend the berm, depositing constituents of medium sands. The kurtosis (mesokurtic) also shows an indication that the grain distributions on both the waterline and berm are sorted normally.

From the analysis and record of gradation coefficients, the grain sands are poorly graded. This implies that the grain sands were uniformly graded, meaning the sediments are well sorted, because they contain only uniformly or similar sized grains. Hence, uniformity, curvature and sorting coefficients have made the expected verification and contributions to the statistical analysis of standard deviation of sediments from this study.

The ocean waves, energy of deposition and water or nearshore current transcending the beach, even up to the berm, is convenient indication that housing structures built at close proximity to the waterline is actually exposed to flood-out due to imminent inundation of seawater and, perhaps, coastal erosion and flooding. There is therefore need for adequate flood and shoreline protection measures in this area of study to protect the recent structural settlements.

6.0. RECOMMENDATION

Owing to strong current, high waves and strong energy of deposition sediments, Ajah Okun mopo Beach is said to be highly exposed to imminent flooding, erosion and coastal inundation of seawater. Hence, it is imperative that adequate flood or shoreline protection measures are promptly provided to secure the lives and property gradually encroaching the beach.

Sediment samples for wet season should be collected from the study area and analysed for possible results correlation.

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