

FLUVIAL DYNAMIC STUDIES AND DEPOSITIONAL PATTERNS OF COASTAL COMMUNITIES OF GBARAMATU KINGDOM- A SEDIMENTOLOGICAL APPROACH

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ABSTRACT

This research assesses the sedimentological characteristics of coastal sediment within Gbaramatu Kingdom, Warri southwest region of Delta State. A total of 9 samples were collected and analyzed using the sieve analysis method, to determine the spatial trend in their grain size distribution. Grain size values for samples from the Okerenkoko (OK), Kunukunuma (KU), and Kurutie (KT) communities had respective mean averages of 0.22, 1.52, and 1.03.. The standard deviation values were on average 1.63, 1.68, and 1.79, for the three communities respectively. The values for skewness are on respective averages 0.33, 0.22, and 0.06 while the values for kurtosis are 0.99, 0.87, and 0.85 for OK, KU. and KT. On the other hand, the Okerenkoko results characterize them as primarily coarse sand that has been poorly sorted and is almost symmetrical and mesokurtic. According to Kunukunuma's results, they are primarily coarse-skewed, platykurtic, poorly sorted medium sand. Kurutie's results describe them as primarily poorly sorted medium sands that are nearly symmetrical and platykurtic, suggesting the existence of harsh conditions such as tidal variations, wave breaking, and cyclical detrital material supply.

Keywords: grain size distribution, mangrove and coasta sediments, standard deviation, skewness

1.0 INTRODUCTION

Sediment deposited in mangroves and coastal areas are composed of solid materials that are transported by waves, tides and tidal current. Coastal sediments may result from the redistribution or reallocation of material eroded from rocks and supplied by rivers in the coastal area (Ueberman

et al, 1988, Gibb 1978). These are the sediments that are left behind when eroded materials from the uplands are deposited along the shore by river flows (Stephenson 2013). Colin 2002 stated that the coast serves as the transition zone between the land and the sea. The 'shoreline' is the actual margin of the shore, whereas the term 'coast' is much broader and includes areas below and above the water line, such as shoals, dunes and cliffs. The 'coastal zone' is a broad transitional area in which terrestrial environments influence marine environments and vice versa. (Crossland et.al, 2005). Although coastal sedimentary processes are naturally dynamic, significant changes have been linked to human activity in upland regions. Sediments that are captured by hydrodynamics in coastal zones and then deposited form the basis of coastal ecosystems (McLachlan 2016). While coastal sediment is essential to building barriers such as sandbars, dunes and marshes that protect coastal communities from storms and sea level rise (Nicola et.al, 2020). In general, the sediment deposited forms soils that contains clues pointing to the source, mode and medium of transportation, and environment of deposition (Owonaro B. J. *et al.* 2022)

When a stream flows through alluvium, it often deforms the channel as a whole to produce patterns such as meandering or braiding. It also deforms the bed surface to produce ripples, dunes, bars, etc. It is possible to state that a multitude of alluvial shapes emerge as a result of various fluvial processes that an alluvial stream and its deformable barrier endure (Ana Maria and Yalin 2017)

To identify the provenance, paleo-depositional environment, mechanisms, and patterns of sediment deposition in this area, this study analyzes and ascertains the features of the sediment.

2.0 GEOLOGY OF THE STUDY AREA

Okerenkoko, kurutie, and kunukunuma lie within the quantenary mangroves swamps of the alluvial deposits of the Niger Delta (Ewutanure and Binyotubo, 2021). The sediment beneath the Okerenkoko, Kurutie, and Kunukunuma comprised of materials deposited by transitional environments. The remodelling and deposition of sediment are probably routed through River Escravos and possibly by tidal forcing. The sediment has been the product of fluvial environment and deposited through the river current, then transformed via ocean tide and wave (Stephen and Grame 2011). The sediment deposited is of quaternary age and consists of fine-grained clay, silt, and unconsolidated sand. This sediment deposit is said to belong to the sombreiro- warri deltaic plain deposit which consists of sediment whose sizes varies from medium through fine to silt and clay (Ewutanure and Binyotubo, 2021). The sombreiro- warri deltaic plain deposit is underlain by the Benin formation.

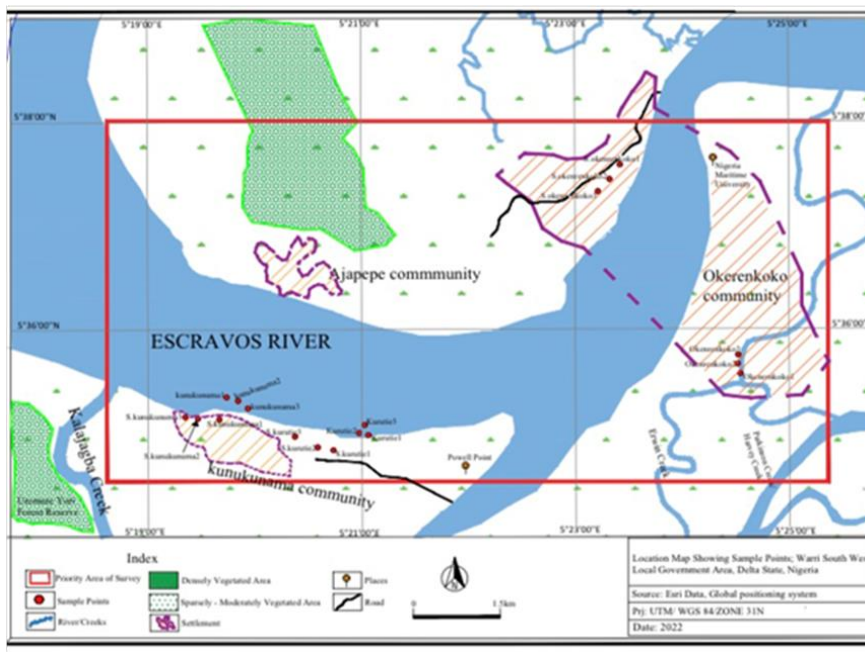


Fig. 1: Map of the study area showing sample locations

3.0 METHODOLOGY

A total of 9 samples were collected from 3 sample stations (Fig. 1) and analyzed to determine the spatial trend in their grain size distribution. 700grams of each sample collected was heated to remove the moisture content before grain size analysis. The dried samples were disaggregated, kept in carefully labelled polythene bags before they were taken to the laboratory for sieve analysis. At the laboratory, the samples were weighed to obtain 500grams of each before sample analysis and sieves were gently brushed of all materials using a fine sieve brush. This was done to avoid errors that may result from external materials influencing the result of the sieve analysis. The dried and weighed samples were transferred carefully to the uppermost sieve of a stacked series of graded sand sieves which were arranged in ascending order of increasing diameter. A pan was placed below the finest sieve to catch the last of any fine material that was not retained by the sieves. Arranged column of sieves was now transferred to a mechanical sieve shaker (Humboldt) for a period of 10-15minutes. When sieving was achieved, the fraction of the samples retained on each sieve was emptied at different turns on different sheets of paper and grains remaining on each sieve were removed with a fine sieve brush. A pan which has been cleansed of external materials that may influence the results of the instrument was placed on an electronically weighing instrument (Virgo V200). Samples were poured from the sheet of the paper into the pan and weighed, the process of weighing starts from the sample fraction retained on the uppermost sieve of the stacked series and right after results are obtained from the weighing instrument. The

instrument is tarred again to neglect the weight of the pan and initial sample fraction weighed for the first sieve. This process continues for every sieve through the series until finally, the material passing through the last 0.075mm sieve, and that retained in the pan were recorded and the same process continues for the next sample to be sieved. A graph of cumulative weight percentage against sieve phi size was plotted. From the cumulative frequency curve, data on grain size parameters such as average size (mean), spread of the size about the average (standard deviation), symmetry of preferential spread to one size of the average (skewness) and kurtosis or degree of concentration of the grains to the central size were determined. These parameters were necessary for the construction of plots needed for environmental interpretation because frequency distribution of grain sizes may sometimes correlate with their various origin and terminal environment of deposition (Boggs, 1987).

4.0 RESULTS AND DISCUSSION

Result of grain size analysis for samples from Okerenkoko community show cumulative percentile mean values of 0.22 describing them as very coarse sand. Result of grain size analysis for samples from Kunukunuma showed mean values 1.52 describing them as ranging coarse to medium sands, while, results of grain size analysis for samples from Kurutie showed mean values of 1.03, describing them as medium sand to coarse sand (Table 2).

STATISTICAL PARAMETERS

Positive correlation usually exists between kurtosis and grain roundness; that is as grain roundness increases, kurtosis also tends to increase. This is due to the fact that a more peaked grain size distribution is produced when rounder grains are transported and sorted more frequently. Lee and Schwab (2005), in their study, found that the kurtosis of grain size distributions increased with increasing grain roundness in diverse sedimentary environments. This relationship was attributed, by the authors, to the fact that rounder grains are more easily transported and sorted by currents

Standard deviation (σ_ϕ), measures the sorting or uniformity of the grains, pointing to the energy conditions that prevailed during transport and deposition of sediment (Ahmad et al., 2019) In this investigation, the Okerenkoko standard deviation values are 1.49, 2.03, and 1.39 (refer to Table 2), with an average of 1.63 characterizing them as extremely poorly sorted to poorly sorted; the skewness values are 0.53, 0.33, 0.13 with an average of 0.33 characterizing them as near symmetrical to finely skewed; and the kurtosis values are 1.18, 0.88, 0.96, and with an average of

0.99 characterizing them as leptokurtic, platykurtic, to mesokurtic. These results indicate that the coarse sand is primarily poorly sorted, with a corresponding platykurtic and predominantly symmetrical characteristics. Okerenkoko mangroves experiences direct impact of the water currents from the Atlantic Ocean resulting in a lot of turbulence which is reflected in the sediment sorting and grain size.

The Kurutie standard deviation values are 1.36, 1.98, 1.70), with an average of 1.68, indicating poor sorting. The skewness values are -0.53, -0.05, -0.09, with an average of -0.22, indicating near symmetry, and the kurtosis values are 1.42, 0.59, 0.63, with an average of 0.87, indicating leptokurtic, platykurtic, to very platykurtic, indicating primarily poorly sorted medium sand that are coarsely skewe. Due to Kurutie's proximity to the Escravos River T-junction (Fig. 1), which transports water and sediments from the Atlantic Ocean into the estuaries, there is typically a lot of turbulence during the day. As a result, the energy of transportation and deposition is high to medium during the day and moderate to quiet at night, particularly in the area around the mangroves, which serve as speed breakers.

While the skewness values from Kunukunuma are -0.49, 0.35, 0.33 averaging 0.06 describing them as strongly coarse skewed to strongly fine skewed, the standard deviation values from Kunukunuma are 1.54,1.88,1.97 averaging 1.79 describing them as poorly sorted to moderately sorted, and the kurtosis values are 1.13,0.72, 0.85 describing them as leptokurtic to platykurtic, averaging 0.85. Hence, they can be described as primarily poorly sorted to medium-sized sand that is almost symmetrical and platykurtic, suggesting the existence of extreme circumstances such as wave breaking, tidal variation, and a steady supply of detrital materials.

Table 1: Calculated Percentiles from the cumulative frequency curve

Sample representation	5 Φ	16 Φ	25 Φ	50 Φ	75 Φ	84 Φ	95 Φ
OK 1	-1.6	-1.4	-1.0	-0.6	0.7	1.6	3.3
OK 2	-1.8	-1.3	-1.0	0.2	1.9	3.2	4.2
OK3	-1.7	-1.2	-0.9	0.1	1.2	1.4	3.2
KU 1	-1.2	1.2	1.8	2.9	3.3	3.5	4.0
KU 2	-1.7	-1.2	-0.8	1.2	3.2	3.4	3.8
KU 3	-1.2	-0.8	-0.5	0.6	2.6	3.1	3.6

KT 1	-0.5	-1.2	1.3	2.0	2.6	2.8	3.1
KT 2	-1.0	-0.7	-0.5	0.7	2.5	3.6	4.3
KT3	-1.7	-1.3	-1.0	0.2	2.2	3.2	3.9

Table 2: Calculated Grain Size Parameters and Description

Sample Representation	Mean Grain Size	Sorting	Skewness	Kurtosis	Sample Description
OK 1	-0.3	1.49	0.53	1.18	Very coarse sand, poorly sorted, near symmetrical leptokurtic
OK 2	0.7	2.03	0.33	0.85	Coarse sand, moderately sorted, near symmetrical, platykurtic
OK 3	0.1	1.39	0.13	0.96	Coarse sand, moderately sorted, near symmetrical, mesokurtic
AVERAGE	0.22	1.63	0.33	0.99	Coarse sand, moderately sorted near symmetrical mesokurtic
Sample Representation	Mean Grain Size	Sorting	Skewness	Kurtosis	Sample Description
KU 1	2.5	1.36	-0.53	1.42	Fine sand, poorly sorted, near symmetrical leptokurtic
KU 2	1.1	1.98	-0.05	0.56	Medium grains, poorly sorted, near symmetrical, very platykurtic
KU 3	0.97	1.70	-0.09	0.63	Coarse sand, moderately well sorted, near

					symmetrical, platykurtic
AVERAGE	1.52	1.68	-0.22	0.87	Medium sand, moderately sorted, coarse skewed, platykurtic
Sample Representation	Mean Grain Size	Sorting	Skewness	Kurtosis	Sample Description
KT 1	1.2	1.54	-0.49	1.13	Medium sand. Poorly sorted, near symmetrical, leptokurtic.
KT 2	1.2	1.88	0.35	0.72	Medium sand, moderately sorted, strongly fine skewed, platykurtic
KT 3	0.7	1.97	0.33	0.71	Coarse sand, moderately sorted, strongly fine skewed, platykurtic
AVERAGE	1.03	1.79	0.06	0.85	Medium sand, moderately sorted, near symmetrical, platykurtic

- OK- Okerenkoko, KU- Kunukunuma, KT- Kurutie

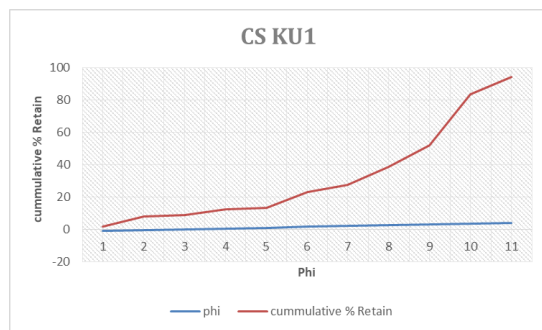


Fig 2: Grain size cumulative curve for KU

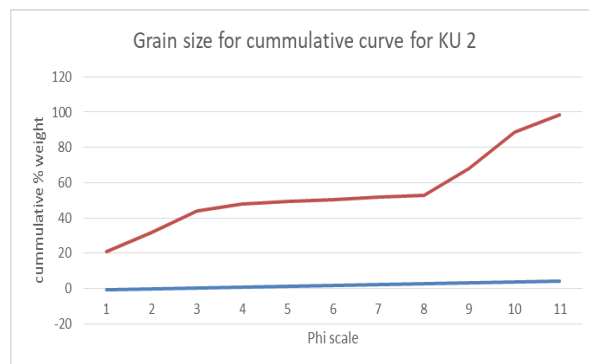


Fig 3 Grain size cumulative curve for KU 2

Fig 4:

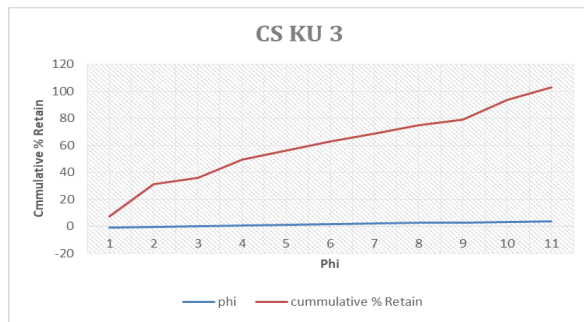


Fig 4: Grain size cumulative curve for KU 3

PIPETTE ANALYSIS

	CS OK1	CS OK2	CS OK3	CS KT1	CS KT2	CS KT3	CS KU1	CS KU2	CS KU3
Clay	85.1	88.5	79.1	84.2	86.3	87.8	94.2	91.3	93.3
Silt	11.2	7.6	18	12	10.3	9.1	3.7	5.9	4.1
Sand	3.7	3.9	2.9	3.8	3.4	3.1	2.1	2.8	2.6

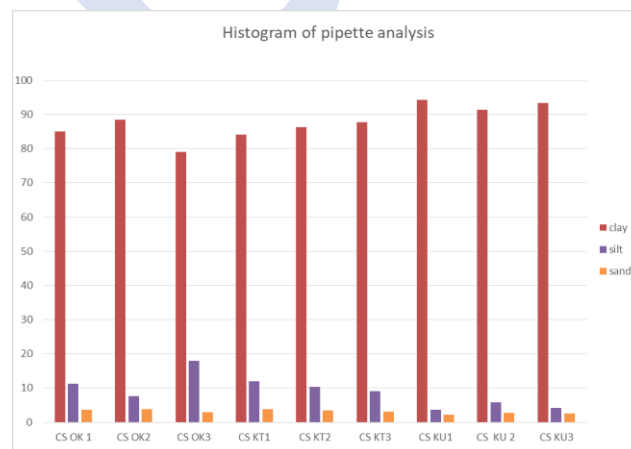


Fig. 5: Histogram of pipette analysis

BIVARIATE ANALYSIS

Bivariate analysis is a statistical analysis that involves the analysis of two variables for the purpose of determining the empirical relationship between them (Earl 2009). Bivariate analysis can be

helpful in testing simple hypotheses of association. The bivariate plot or scattered plot of some of the locations are given.

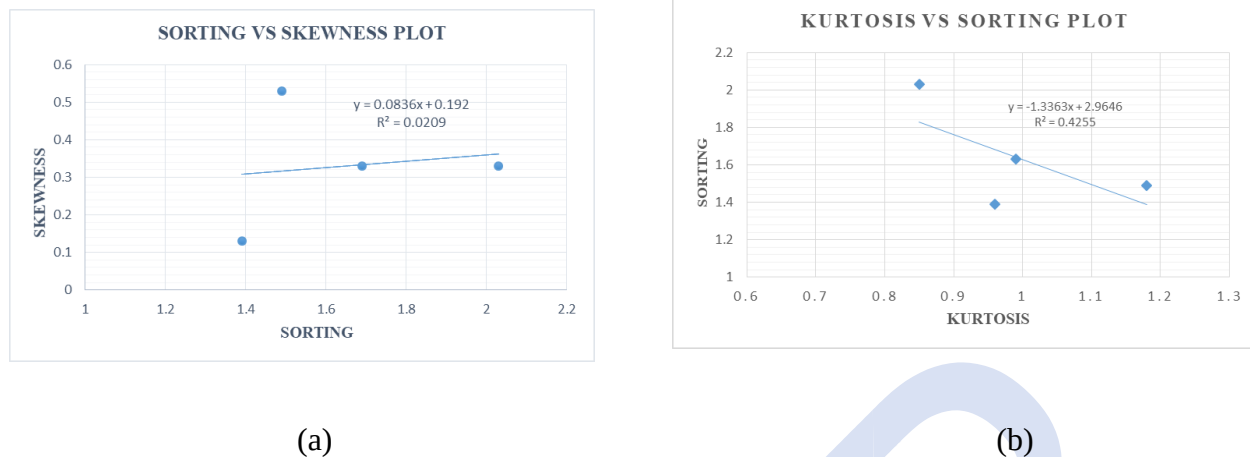


Fig. 4: Bivariate plots of (a) sorting vs skewness and (b) kurtosis vs sorting

Plot (a) shows the plot of sorting against skewness of Okerenkoko data and it reveals a positive linear relationship exists between the variables showing that the symmetry of the grains contributed to the poor sorting of the grains. The square of Pearson Product moment correlation coefficient (R^2) is 0.0209, indicating that both variables are not correlated. While plot (b) shows kurtosis against sorting, which indicates a negative linear relationship exist between the variables. However, the R^2 is 0.4255, indicating that both variables are moderately positively correlated lending credence to the fact that positive relationship exist between kurtosis and grain roundness. This is because the rounder the grains, the more likely they are to be well sorted due to long distance of transportation,

5.0 CONCLUSION

This study reveals that the fluvial dynamics and structural layout of this area have profound effect on the grain size and sorting of these sediments. The sediments were mostly fine to medium grained, and moderate to poorly sorted. This reveals that the energy of deposition was majorly medium to high with intermittent episodes of water turbulence. The study also revealed that the mangroves in this area act as wave and current breakers thereby protecting the shorelines.

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