COURSE REPORT

On

COASTAL PROCESSES ON NIGERIAN COASTLINE

(Focus: Vulnerability of Niger Delta Coast to Sea Level Rise and Coastal Erosion)

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ABSTRACT

Coastline change is regarded to be one of the most dynamic processes in the coastal area. The change in coastline, caused by physical as well as anthropogenic process, have great environmental significance. Recently, many coasts are experiencing erosion and ecosystem losses resulting of being subjected to the adverse consequences of threats related to climate change and sea-level. Sea-level rise, as one of the impacts of climate change has significantly impacted on low-lying coastal areas of the continents. Major direct impacts of sea-level rise on coastal zones include flooding, inundation, erosion and wetland loss as well as saltwater intrusion. Anthropogenic-induced pressures on the coastal zone seem to worsen these impacts. The Niger Delta coastal region is blessed with abundant biodiversity and natural resources. However, due to developing cities with high population density and industries situated on the coastal zone, the region is high vulnerable to sea-level rise and subsequent coastal erosion. Vulnerability assessment by some researchers has revealed that the coastline line is serious eroding in the eastern part of the Niger Delta with patches of serious erosion menace along the Bonny, Forcados and Escravos river estuary where the major crude oil terminals and tanks farms are located. Since the study of coastline position is of paramount importance for management purposes like developmental planning and hazard zonation as well as determination of erosion and accretion, there is a need to protect this fragile coastal system as well as the coastal infrastructures by adopting effective integrated coastal zone management strategies. This could be achieved through gathering of timely and continuous coastline changes information, in terms of retreat and progradation, as it is essential for the coastal environment monitoring and protection, sustainable coastal development and coastal resources management, particularly in a delta coast like the Niger Delta which is regarded as one of the largest, most significant and strategic deltas in the world owing to its abundant natural and mineral resources. It is therefore recommended that institutional framework be put in place to prevent and mitigate further impacts of coastal erosion on vulnerable communities along the coastline of the region. Though some of the soft-engineering approach including mangrove regeneration is taking place currently in some parts of the Niger Delta coastline, this report also highlights and describe other coastal engineering techniques suitable for managing coastal erosion in the Niger Delta region of Nigeria.

1.0 INTRODUCTION

1.1 Background

Coasts are been subjected to the adverse consequences of hazards linked to climate and sea-level. Sea-level rise poses a serious risk to most lands along the coastline and also major structures and establishments having direct access to the shoreline especially in cities (McGranahan *et al.*, 2007). Most of the world's shorelines retreated during the past century and sea-level rise is one fundamental reason. Before the end of the 21st century, there are reports that the low-lying coastal region of the world would experience frequent rate of land subsidence (Syvitski *et al*., 2009) and increased coastal erosion due to a rise in global sea level. Sea-level rise has significant inertia and will continue beyond 2100 for many centuries. Unalterable breakdown of the West Antarctica and/or Greenland ice sheets, if activated by rising temperatures, would make this long-term rise significantly larger, ultimately questioning the sustainability of many coastal settlements throughout the world. Figure 1 shows the Low-lying areas that are of Africa.

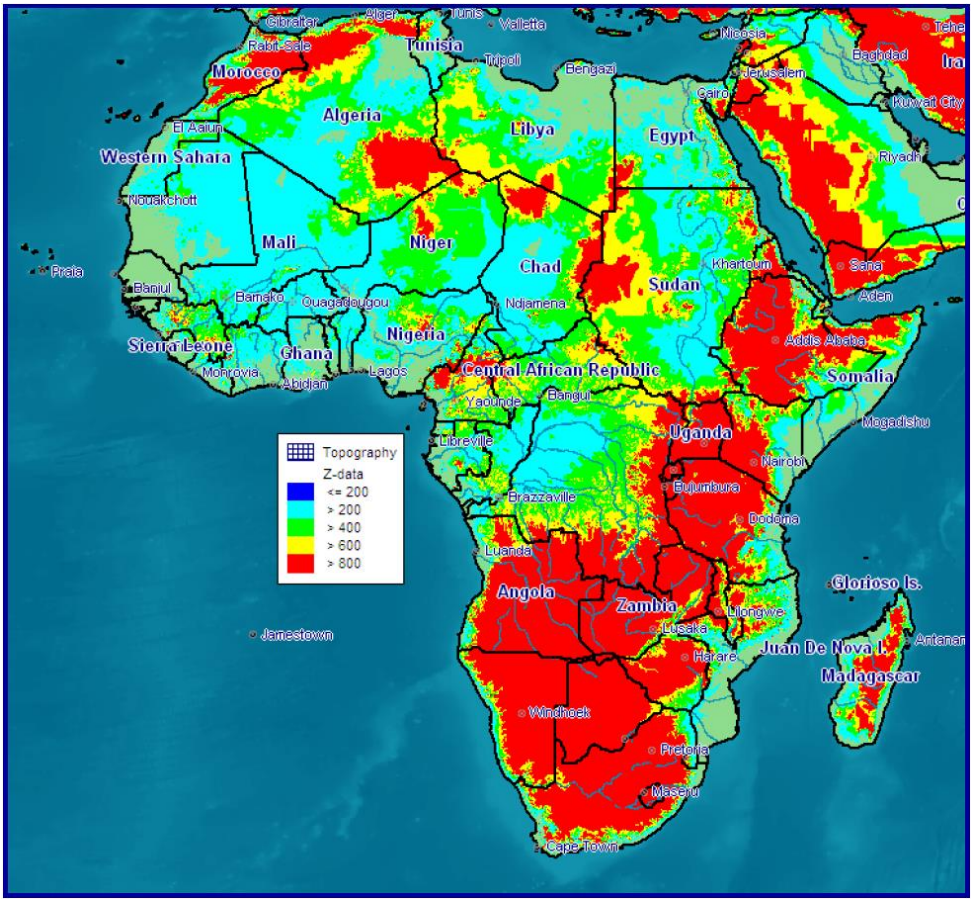

Figure 1: Topographic map of Africa showing general elevation (Data source: the DINASCoast Consortium 2006 database).

Coastal erosion is one of the major environmental issue of great concern in Africa. It has been confirmed that extensive and significant erosion of coasts, whether due to anthropogenic or natural causes is identified to be one of the most devastating environmental problems of the coastal zone of a number of countries of the Africa including Nigeria, and this has severe implications on the entire national economies. Figure 2 illustrates total sand loss in m^3/year from the African coast due to sea-level rise and coastal erosion with Nigeria being among the country with high sand lost.

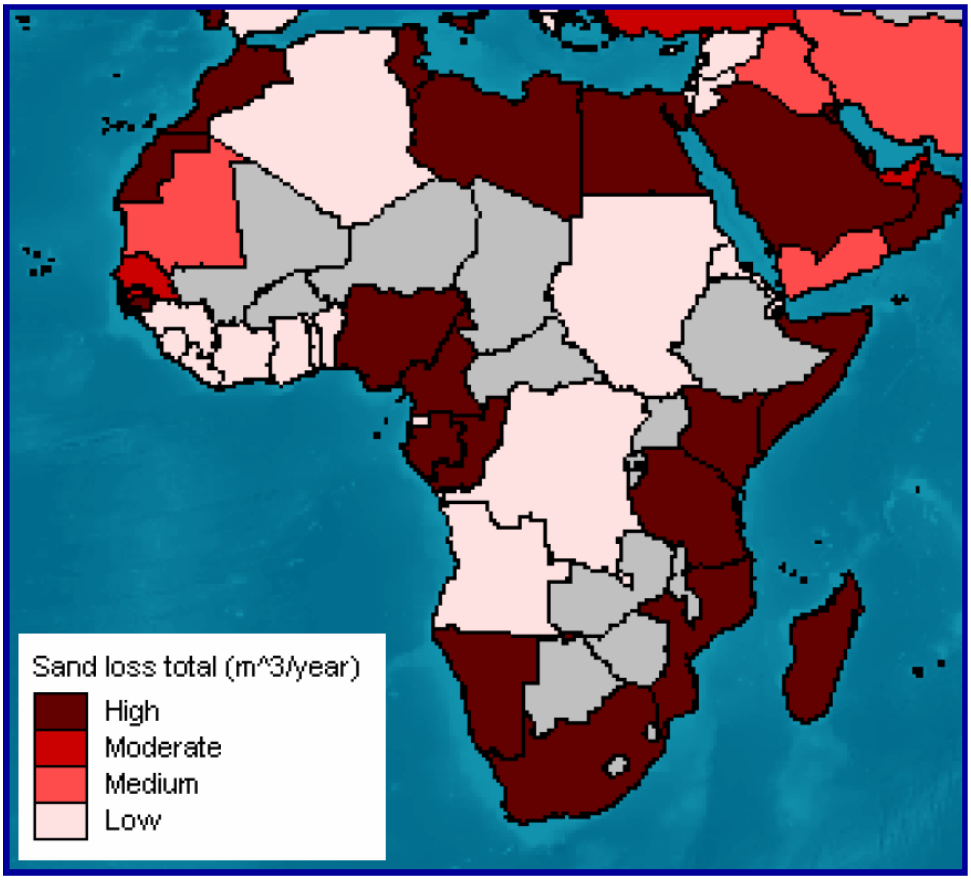

Figure 2: An overview of total sand loss as a result of sea-level rise in Africa. Northern, eastern, southern, and central and parts of western Africa will suffer a high total sand loss (data source: the DINAS-Coast Consortium 2006 database).

The Nigerian coastal environment has a variety of both living and non-living resources, which account for almost 90 % of its economic growth. The mangroves ecosystem which adjoins the Niger delta region of Nigeria is estimated to cover approximately 7000 km^2 contain a significant regional resource, with fishing being the major occupation of the coastal dwellers. Nigeria is one of the major oil producing countries in the world with oil wells spread within the Niger delta and adjacent coastal areas. In some coastal localities, settlements have been uprooted while some oil wells have been lost to the ocean due to erosion.

The Niger Delta region of Nigeria is one of the low-lying delta in the world, with huge coastal plain, rich biodiversity and abundant reserve of hydrocarbon deposit (Akinrotimi, 2012). The region has a network of streams, rivers, creeks and estuaries flowing into the Atlantic Ocean (Mangut and Egbefo, 2010). Its ecosystem supports abundant species of terrestrial and aquatic life. The wetlands, estuaries and lagoons of the Niger Delta are rich nursery grounds for commercial fisheries of the area. Figure 3 is the map of the Niger Delta showing rivers/tidal inlets with distinct morphological units and sector.

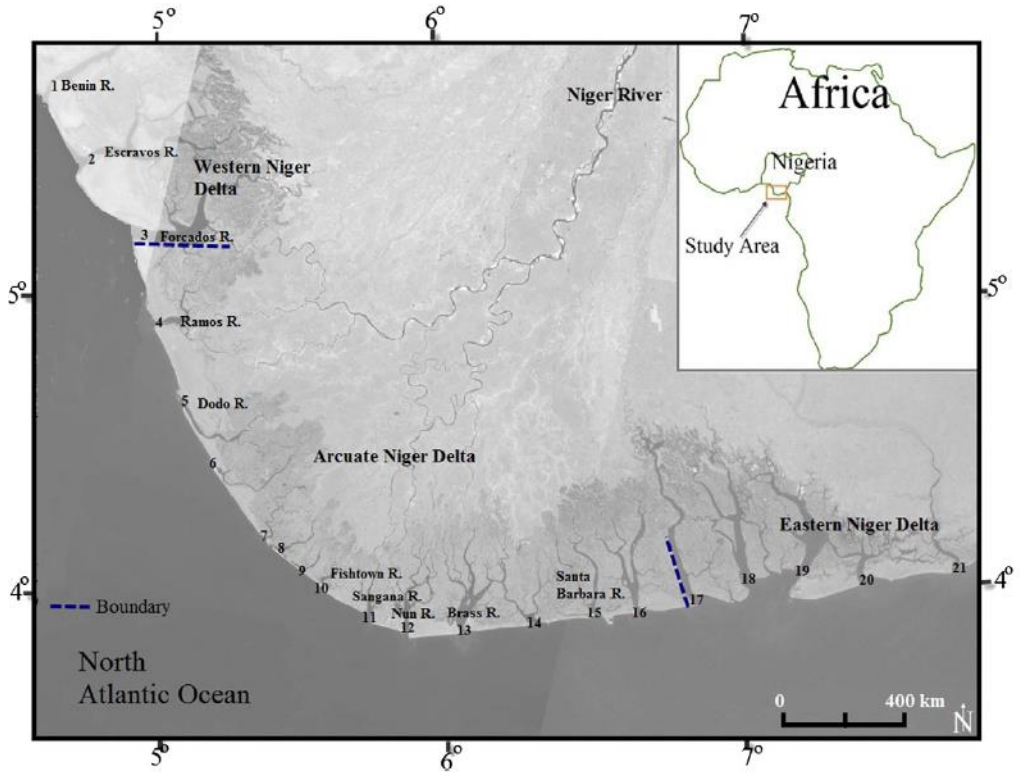

Figure 3: Map of the Niger Delta showing rivers/tidal inlets with distinct morphological units and sectors used in this study. Inset: map of Africa showing Nigeria and Niger Delta (Source: Dada et al., 2015)

World Bank ranked stated that coastal erosion is an issue of great concern in the Niger Delta (Agbola and Olurin, 2003) while the Nigerian Environmental Study Team (NEST, 2004) later indicated that sea-level rise and frequent ocean surges will aggravate the threat of coastal erosion that is already a menace in the Niger Delta coastal zone. The Niger Delta is highly prone to adverse environmental condition caused by sea-level rise due to the fact that it is found in the coastal region. Being the home of most of the major multinational oil companies in Nigeria, the region is also faced with environmental degradation resulting from oil exploration and exploitation activities. Odunuga *et al.* (2014) indicated that the vulnerability of the Lagos coastline to Sea-level Rise is above all exacerbated by its low-lying, densely populated nature,

a high concentration of GDP generating industries and infrastructures especially along the barrier lagoon Coast of Lagos-Badagry-Seme border of the southwestern part of Nigeria. This report aims at reviewing the vulnerability of the Niger Delta region to coastal erosion resulting from sea-level rise. In order to manage the incidence of coastal erosion in the region, appropriate coastal engineering techniques are also highlighted and discussed in this report.

1.2 Characteristics of Niger Delta Coastal Area

The Niger Delta, which is among the world's largest arcuate fan-shaped deltas (Figure 4), is located in the southern part of Nigeria, along Gulf of Guinea coast of the Atlantic Ocean (Dada *et al.,* 2016). The Niger Delta being among of the most dynamic deltas in the world, also supports one of the most extensive wetlands in the world (Figure 5). Due to proximity, the delta experiences a combination of wave, tide and current action from the waters of the Atlantic Ocean (Obuwu and Abam, 2014). Spanning a geographical area covering about 70,000km^2, the delta represents about 7.5% of Nigeria's landmass. The entire region is interlinked by dense networks of brooks, streams, rivers, creeks, estuaries and comprises of several ecological zones including the sandy coastal ridge barrier, brackish and saline mangrove, seasonal and permanent fresh water swamp forest and low land rain forest (Tami and Moses, 2015). The geology of the Niger Delta (ND) has already been described by Short and Stauble (1967), Burke (1972), Weber and Daukoru (1975), Evamy et al. (1978), Ejedawe (1981), Ejedawe et al. (1984), Petters (1984), Knox and Omatsola (1987), Stacher (1995), Reijers et al. (1997), and Reijers (2011). Its evolution is basically controlled by pre- and syn-sedimentary tectonics (Dada *et al*., 2015).

Figure 4: View of the Niger Delta from space (Source: NASA Space Shuttle Photo, 2010)

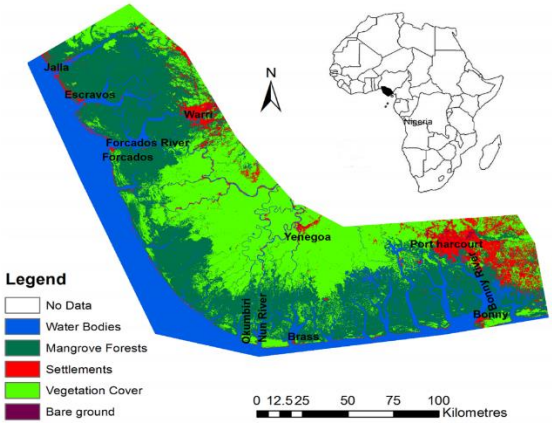

Figure 5: The Niger Delta land cover map. (Source: Musa et al., 2014)

The Niger Delta is a wave-dominated delta and its morphology is largely influenced by the Atlantic wave action (Figure 6). These waves are driven by winds that are major and most prevalent during the summer season. Wave heights generated at the front edge of the fetch area are between 0.3 and 2 m, with the period ranging between 5 and 15 s. Longshore current is the major forcing controlling sediments dispersal along the Niger Delta coast (Dada *et al.*, 2016).

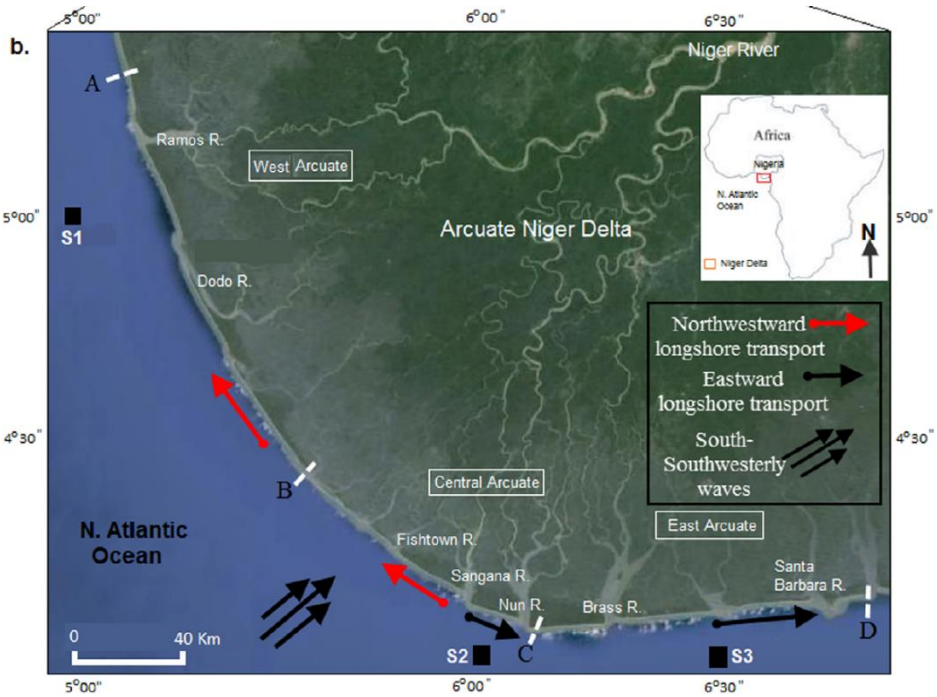

Figure 6: Map of the arcuate Niger Delta showing rivers/ tidal inlets. Inset: map of Africa showing Nigeria and Niger Delta (modified from Google Earth).

Characterised by a semi-diurnal tide, the coastal geomorphology and sediment characteristics of the Niger Delta coast comprise of three different morphological units including the arcuate delta, the western delta and the eastern delta. Dada *et al.* (2015) reported that the arcuate delta composed of fine to medium-grained well sorted sand and has a beach slope of 1:15 to 1:20 while the western and eastern delta flanks composed of fine- to very-fine grained, moderately well-sorted sand and has beach slopes on the intertidal portion of the profiles ranging from 1:50 to 1:90. Dada *et al*. (2016) indicated that the coastal swells are typically less than 2 m in height with the possibility of swell height exceeding 2 m in summer. They added that these waves are generally erosive in nature. The abundant natural resources of the Niger Delta region accounts for over 90% of the Nation's total export earnings. The region is also home to the largest adjoining Mangrove forest in Africa and third largest in the world, after Indonesia and Brazil (James *et al.*, 2007).

2.0 COASTAL EROSION IN NIGER DELTA

2.1 Recent Scientific Research Reports

Coastal erosion is observed on many shorelines around the world. In recent times, scientific researchers have affirmed that there is a serious shoreline change in the Niger Delta coastal area resulting from coastal erosion. Adegoke *et al.* (2010) conducted an assessment of Recent Changes in the Niger Delta Coastline Using Satellite Imagery. Their results revealed that coastal erosion was dominant over accretion of sediment deposition in the area. They reported 46,535 km^2 as the total area of coastline changes, with erosion (27.65 km^2, 59.43%) exceeding accretion (18.88 km^2, 40.57%). Olorunlana (2013) attributed the huge land loss along Niger Delta shoreline to the activities of tide and wave which topple over the coastal plain leading to a sheet wash processes with large scale surface sediments removal. Obowu and Abam (2014) conducted a spatial and multi-temporal change analysis of the Niger Delta coastline using remote sensing and geographic information system. Their result showed that for most of the coastline sections there have been period of erosion and accretion over the 36 year study period with just very few sections showing consistent erosion or accretion over the years.

Recently, Musa *et al*. (2014) conducted an assessment using geographic information systems (GIS) techniques to examine the indicators and the index of Niger Delta coastal vulnerability. They reported that 42.6% of the Niger Delta is highly vulnerable to sea level rise, such areas as characterized by low slopes, low topography, high mean wave heights, and unconfined aquifers. Figure 7 shows Niger Delta topography classification while Figure 8 shows Niger Delta slope classification. Dada *et al.* (2015) examined the evolutionary trend of Niger Delta shoreline within a period of 100 years. They realised that the shoreline is characterized by long-term erosion and short-term accretion. Oyegun *et al.,* (2016) realised that though there is shoreline advancement in some sections of the coastline, erosion has been simultaneously very destructive in other sections of the Niger Delta. Olorunlana (2013) proposed that coastal erosion and subsidence in the Niger Delta could be accelerated by the withdrawal of oil and gas from subsurface of the region and this was affirmed by the local people who link the incidence of accelerated coastal erosion with the commencement of oil and gas exploration and exploitation in the region. Maiti & Bhatta, (2009) earlier generalised coastal erosion and shoreline changes is majorly caused by sea level rise.

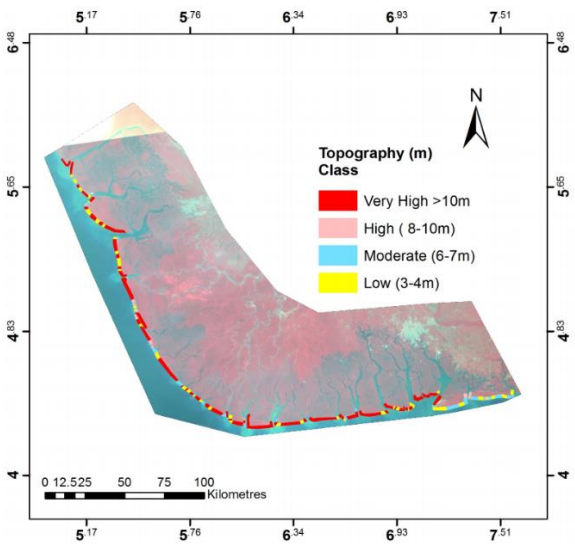

Fig. 7. Niger Delta topography classification. (Source: Musa et al., 2014)

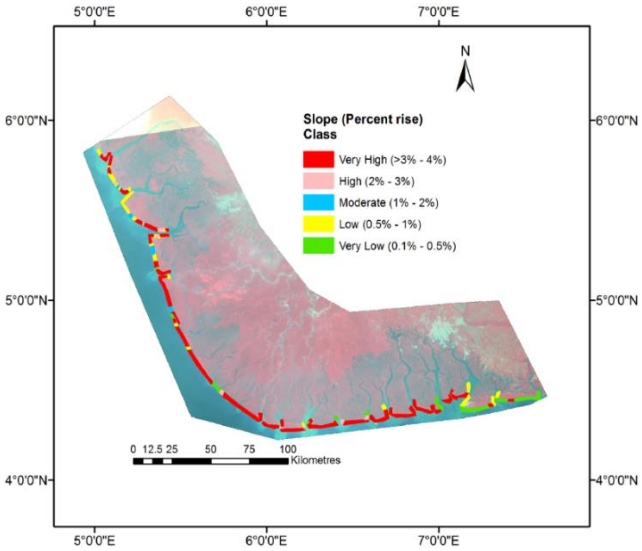

Fig 8. Niger Delta coastal slope classification (Source: Musa et al., 2014)

2.2 Vulnerability Studies

Vulnerability signifies potential damage, and it is uncertain upon the risk of a hazard. (Balica *et al.* (2013) explained that a system is regarded as being vulnerable when it has a high susceptibility to the impacts of a hazard, and is not capable to cope, recover or adapt to the hazard impact. Fashae and Onafeso (2001) examined the historical trend in the coastal extent of Lagos coastal city and projects the potential impact on coastline change using geographic information system (GIS) techniques coupled with scenario-based climate change predictions from three different general circulation models (GCMs). The satellite imagery of the Lagos coastline revealed that while the total area of the coast in 1999 was about 1.64 km^2 of beach, by 2009 the extent had reduced to about 0.89 km^2, thereby indicating the total loss of a 0.75 km^2 of beach land within a period of ten years. Fashae and Onafeso (2001) projected that before 2029 the rate of inundation would have entered a negative figure, which is suggestive of the complete loss of the beach and a consistent loss of developed land area into the ocean.

There are few studies carried out by scientific researchers on the vulnerability of Niger Delta coastline to sea level rise. However, for the purpose of this report, one of the studies will be used as a case study for in-depth analysis. Oyegun *et al* (2016) conducted a research on the dynamic nature of Niger Delta coastline. In the result, they presented the pattern of change in shoreline retreat or advance over the time steps of 1986 and 2010. In Figure 9 below, the red polyline and the medium apple polyline indicate shoreline retreat and shoreline advancement respectively in the study area. The blue polygon indicates the water bodies in the study area.

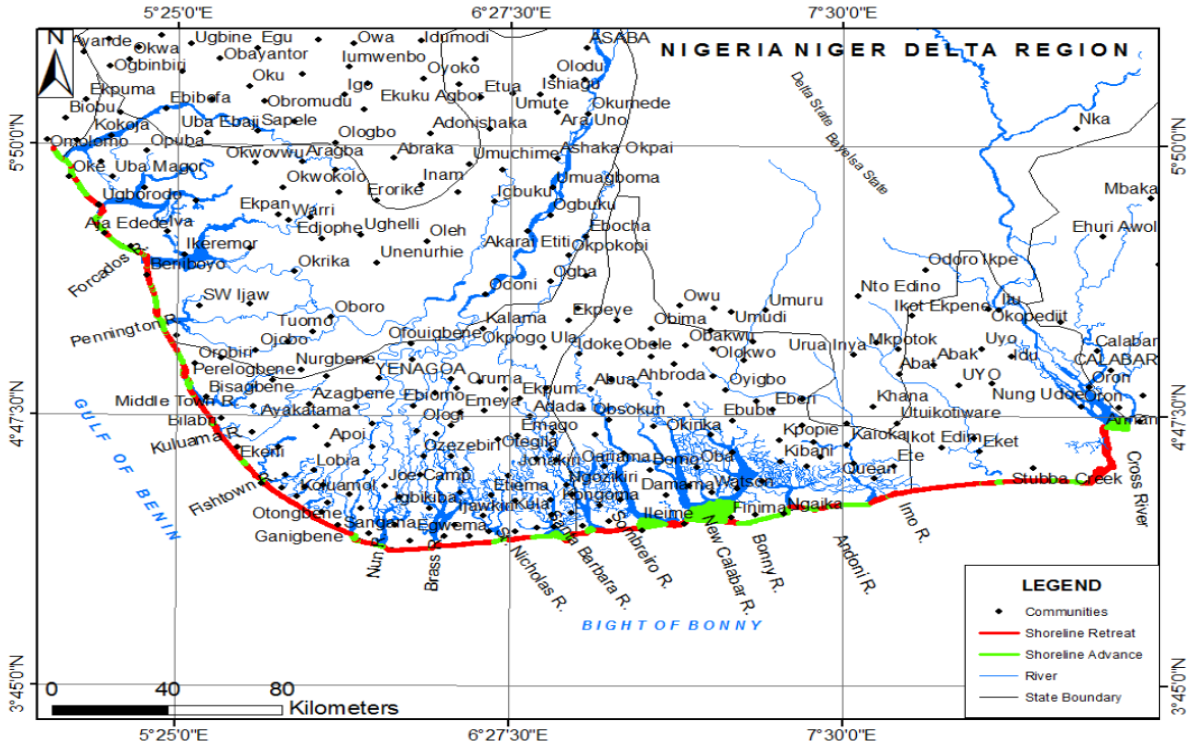

Figure 9: Pattern of Shoreline Change in the Niger Delta (Source: Oyegun et al., 2016)

From figure 9 above, it can de deduced that most of the shoreline were retreating. Apart from community settlement, most of the onshore oil installations are at risk of being eroded away with the shoreline. This calls for urgent attention to salvage the situation.

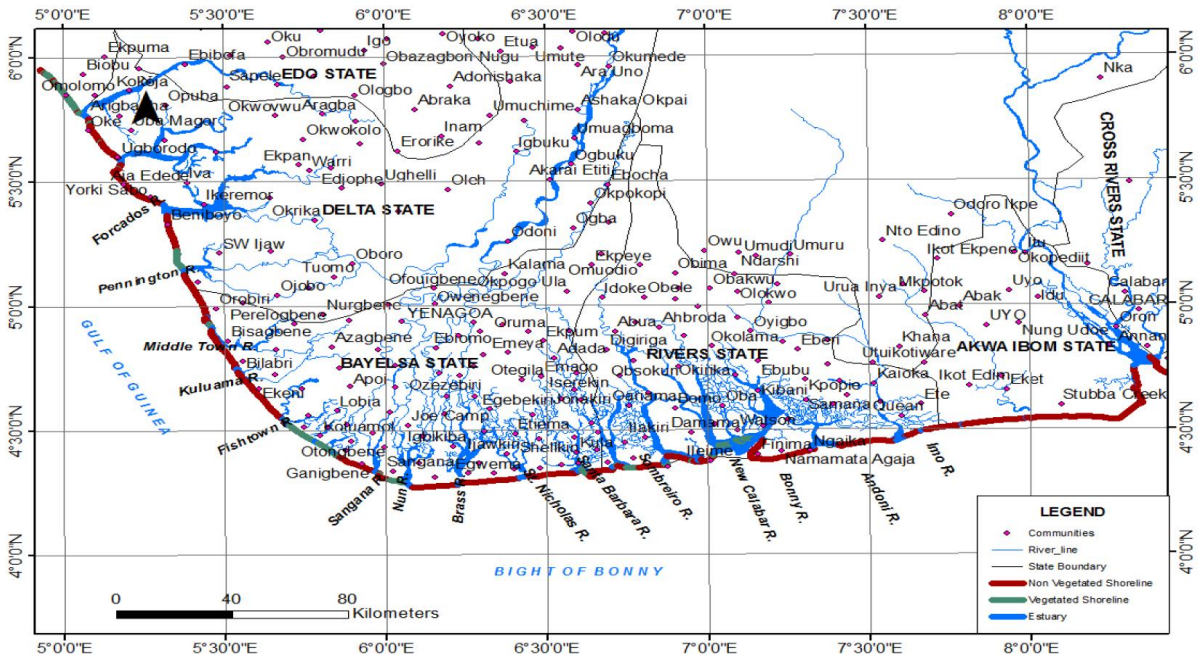

Fig. 10: Vegetated and Non-Vegetated Sections of the Coastline (Source Oyegun et al., 2016)

Assessing the relationship between shoreline retreats with non-vegetated/vegetated sections of the shoreline (Figure 10), they realised that 19.7% of shoreline retreat took place along the vegetated section of the shoreline while 80.3% of shoreline retreat occurred in the non-vegetated section of the shoreline. Comparing Figure 9 and Figure 10 revealed that shoreline retreat was more established along non-vegetated section as compared to the vegetated sections. This indicates that Niger Delta community with mangrove vegetation adjoining its shoreline is less vulnerable to shoreline recession than communities with mere coastal sand beach.

The vulnerability of the Niger Delta coastal region to sea level rise and the relative vulnerability of the study area were interpreted following Coastal Vulnerability Index (CVI) formulation by Oyegun *et al.* (20116).

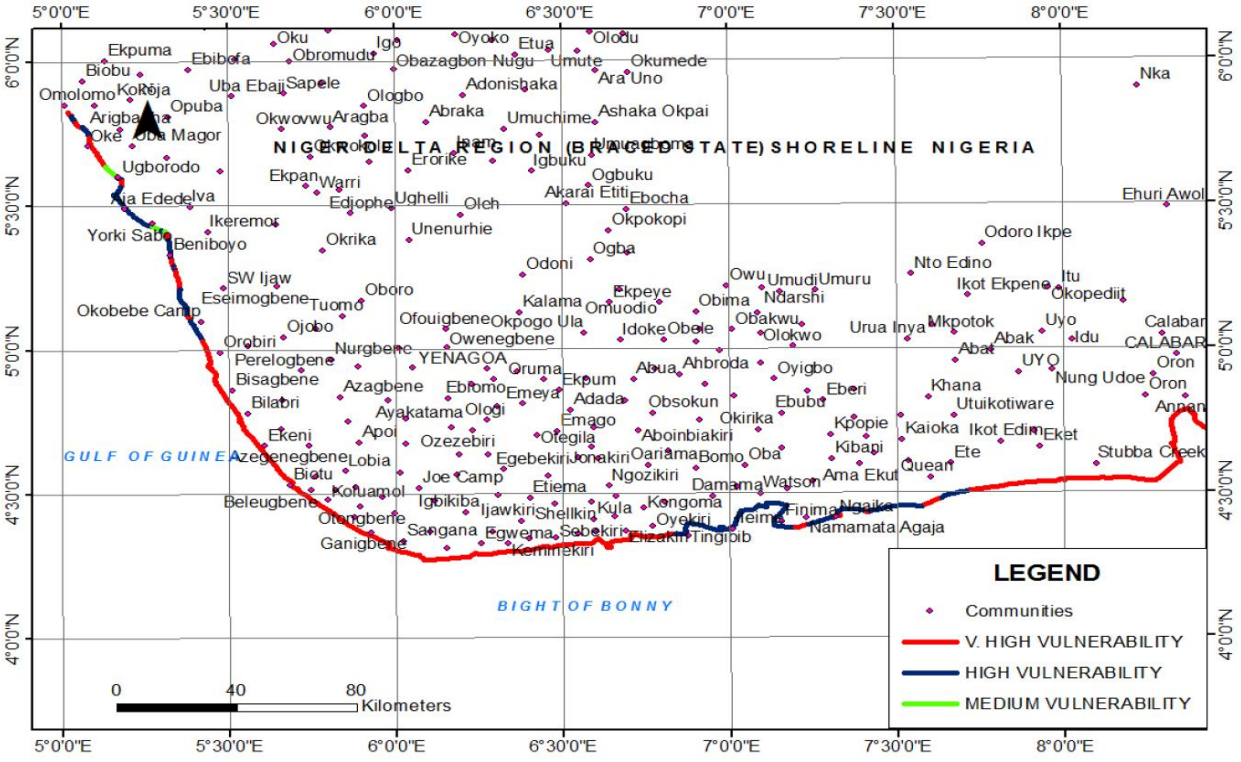

Figure 11: Vulnerability Index map of the Niger Delta Shoreline (Source Oyegun et al., 2016)

Vulnerability assessment was also carried out by Oyegun *et al*. (2016) to examine areas of the shoreline that are delicate to erosion (Figure 11). Their results revealed that vulnerability of the shoreline is highest in the eastern part of the Niger Delta with patches of high vulnerability rating along the Bonny, Forcados and Escravos river estuary where the major crude oil terminals and tanks farms are located. This calls for urgent attention in the shoreline of the areas linked with high and very high vulnerability.

3.0 DISCUSSION

The coasts is one of the most dynamic parts of the earth surface, continuously undergoing both gradual and sudden changes with many physical processes including coastal erosion. Sea level rise is one of the effects of global warming which has a direct role in coastal erosion. The satellite imagery of the Lagos coastline revealed that while the total area of the coast in 1999 was about 1.64 km^2 of beach, by 2009 the extent had reduced to about 0.89 km^2, thereby indicating the total loss of a 0.75 km^2 of beach land within a period of ten years. The projection of coastal extent shows the possibility complete loss of the beach area into the ocean.

Coastal erosion is also a major challenge in Niger Delta, and further rise in sea level will worsen the situation. Human settlements have already been uprooted and some onshore oil wells have also been lost to the ocean as a result of coastal erosion. Agriculture and aquaculture activities are seriously at risk. Even coastal vegetation like the mangroves have also been destroyed due to coastal erosion. Scientific research reports have affirmed that a greater percentage of the Niger Delta coast is highly vulnerable and prone to coastal erosion, there is a need for timely and continuous intervention in order to promote sustainable coastal development and coastal resources management.

The Niger Delta coastal region is blessed with abundant natural resources and biodiversity. However, due to increased coastal erosion resulting from high population growth, storm events, wave action and sea-level rise amongst other factors, the coastal area is undergoing environmental constraint. Overall, there are many management strategies used by coastal engineers in tackling the problem of coastal erosion. It is worth nothing that their usage differs among regions depending on the environmental condition, socio-economics of the coastal dwellers, technological disposition of the regions, as well as political will of the national government

Currently, the available management strategies can be grouped under protection strategy, adaptation strategy, planned retreat and abandonment. For the reason that none of these individual approaches is considered to be most effective, integrated coastal zone management is usually preferable, which incorporates multiple approaches. In the integrated coastal zone management, most of the engineering approach would be too expensive for Nigeria being a developing nation. Nevertheless, In the case of Niger Delta region of Nigeria, coastal adaptation through resilience building and vulnerability reduction is very much recommended.

4.0 COASTAL ENGINEERING TECHNIQUES

In other coastal areas of the world with eroding coastlines, coastal engineers tackle erosion problem by studying the processes at the shoreline and applying either soft engineering or hard engineering approach to manage or mitigate the coastal erosion. The following are some of the coastal engineering approach that could be applied to manage the problem of coastal erosion in the Niger Delta region of Nigeria.

4.1 SOFT ENGINEERING APPROACH

Soft Engineering approach is all about stabilising the soft shoreline against erosion. This technique has been lauded to be environmentally friendly because it considers the need for protecting the shoreline against erosion while simultaneously maintaining and promoting the shoreline functions. Soft engineering approach aims at maintaining gently slope which allows for gradual dissipation of wave energy across a longer distance. Some of the soft engineering techniques that could be effective in managing Niger Delta coastal erosion include:

4.1.1 Soil Bio-Engineering Technique

This technique involves hybrid approaches that is commonly used where the ecological concern of the area is taken into consideration. Bio-engineering measures for shallow landslide stabilization, erosion prevention and/or control are widely used in engineering practice (Morgan and Rickson, 2004; Norris *et al.*, 2008). Soil bioengineering technique has a simple geotechnical advantage of providing reinforcement to the soil while adjusting the drainage patterns of the soil. When the soil is stabilised, bushy vegetation can grow thereby preventing erosion. In the Niger Delta region, various species of woody plants like the mangroves with excellent rooting ability could be used in soil bioengineering.

Figure 12: Soil Bio-Engineering Technique for coastal sediment stabilization

4.1.2 Geosynthetics Techniques – Geotubes.

Geosynthetics technique involve the use of Geotubes filled with indigenous material dug from the remaining storm-damaged dune system. Since the first use of Geosynthetics in more than four decades ago, several researchers have conducted studies to ascertain the performance and efficiency of these engineered geo-materials under loading conditions and in relation to the effects of installation damage (Rosete *et al.*, 2013; Carlos *et al*., 2016, 2015). After filling the tubes with the materials, the top is covered with a top layer of soil and vegetated to add soil stability. Over time, wind-blown sand from the beach accumulates at the seaward flank of the dune system and organizes into smaller dunes, where additional vegetation growth takes place and provides additional protection from waves and storm surges approaching the coast. The use of geosynthetic materials in soil and coastal engineering is increasing and improving due to improvements in its engineering properties and fabrication techniques. This method of coastal management could also be used in Niger Delta coast along the Ibeno beach in Nigeria

Figure 13: Geosynthetics Techniques – Geotubes.

With regards to ecological point of view, soft engineering approaches offer many benefits over typical hard stabilization structures. Some merits of soft engineering approaches include sustaining the normal shoreline dynamics and healthy sand movement across a coastal, sediment trapping to restore the eroded shorelines, providing or preserving important coastal habitat, filtering debris from the water as well as creating a carbon sink. It is worth noting that, soft engineering approaches will only be appropriate for sections of the Niger Delta coast with low energy. The section of the coastline suitable for soft engineering approach will be known after the vulnerability studies.

4.2 HARD ENGINEERING APPROACH

Coastal protections against extreme marine events are essential for the safety of coastal infrastructures, properties and populations. Hard engineering approach involves the construction of coastal structures to prevent erosion of coastal sites. These coastal or hard structures are usually built with armour stone, steel, or timber and are mostly permanently fixed within dynamic coastal zone. Zhang *et al.* (2017) stated that seventy percent of China's coastlines are protected by artificial sea dikes, seawalls, breakwaters, and groynes and the performance of protection structures basically depends on both their construction characteristics and the hydrodynamic condition. Some of important hard structure that could be used to control coastal erosion in high energy sections of Niger Delta coast include sea dikes, seawalls revetment and jetties.

4.2.1 Sea Dikes

In the low-lying coastal regions of the world, sea dikes designed with the goal of managing coastal erosion and preventing coastal flooding (Murphy *et al.*, 2002), are usually the most common and important coastal defenses structures. Wave breaking on a sea dike slope seem to be one of the most important problems for the coastal engineers to be investigated. Sea dikes are onshore structures with the principal function of protecting low-lying areas against flooding. Sea dikes are usually built as a mound of fine materials like sand and clay with a gentle seaward slope in order to reduce the wave run up and the erodible effect of the waves. The surface of the dike is armoured with either grass, asphalt, stones, or concrete slabs. Most sea dikes built along coastlines has characteristics feature of top-mounted wall preventing or reducing the wave overtopping volume. This method of coastal management could also be used in Niger Delta coastal region of Nigeria

Figure 14: Typical Structure of a Sea Dikes

4.2.2 Seawalls

A seawall is a form of coastal defence built where the sea, and related coastal processes, impact directly upon the landforms of the coast. The reasons for building seawall is to protect areas of human habitation, conservation and leisure activities from the action of tides, waves, or tsunamis (Kamphuis, 2010). Seawalls are also built to prevent or lessen overtopping and flooding of the coastal land by storm surges and waves. It is usually built parallel to the coastline as a reinforcement of a part of the coastal profile. A small section of the Niger Delta coastline already has seawalls protecting important coastal infrastructures from storm surge and waves. The sea wall coastal engineering structures protecting the coastline, the lower flat portion of the seawall is intended to induce wave breaking, while the sloped part allows for waves to run up the top, which is capped with the flat portion where people are walking for erosion from wave run-up

Figure 15: Typical Structure of a Sea Wall

4.2.3 Revetment

One of the most applied coastal engineering mitigation actions against erosion are longitudinal revetments that allow to fix the shoreline position as well as shelter people and properties in urban waterfronts (Coelho *et al.*, 2016). In coastal engineering, revetments are sloping structures positioned on banks or cliffs so as to absorb the energy of arriving water. Coastal revetments are built with the aim of protecting the slope and guiding against erosion. Revetments are cheap techniques of coastal erosion defence in areas where crashing waves are eroding the coastline. Wooden revetments has gradually been replaced by modern concrete-based defence structures known as tetrapods. Construction of revetment could be very effective in some sections of the Niger Delta coastline.

Block revetments are very useful in protecting the coastal area against wave action (Capel, 2015). Most of these block revetments are built up by a matrix of individual concrete blocks placed next to each other. In the past these block revetments were often constructed by natural stones. Currently pre-fabricated concrete units are extensively used and the fixing of these artificial blocks is carried mechanically

Figure 16: Typical Structure of a Revetment

4.2.4 Groyne

A coastal structure constructed perpendicular to the coastline from the shore into the sea to trap long shore sediment transport or control long shore currents. This type of structure is easy to construct from a variety of materials such as wood, rock or bamboo and is normally used on sandy coasts. It has the following disadvantages: Induces local scour at the toes of the structures, causes erosion down drift; requires regular maintenance and typically more than one structure is required. Single groynes are structures typically normal to the shoreline, which block the littoral drift partially or completely. In modern beach management strategies, single groynes are used to create smaller sediment cells in which the beach can turn against the locally predominant wave direction (Kristensen *et al.,* 2016)

Figure 17: Typical Structure of a Groyne

5.0 SUMMARY AND CONCLUSION

The Niger Delta being among the most dynamic deltas in the world is also supporting one of the world's most extensive wetlands. Located in the Gulf of Guinea, the delta experiences a combination of wave, tide and current action from the waters of the Atlantic Ocean. This results in relatively significant environmental changes following land subsidence, storm surges, coastal flooding and erosion. Some areas of the Niger Delta coastline faces the high-energy dynamic environment of the Atlantic Ocean.

Currently, the shoreline of the Niger Delta is eroding. Coastal erosion on the coastline of the Niger Delta could create modification of the composition of the biophysical and socio-economic systems thereby leading to monumental effects. There is a need to protect this fragile coastal system by adopting effective integrated coastal zone management strategies. Promoting socioeconomic and ecological resilience will play an essential part in lessening the vulnerability of coastal communities in the Niger Delta region of Nigeria.

If the occurrence of coastal erosion in Nigeria is to be tackled headlong, there is need to adopt some of the sophisticated adaptation responses such as sea defenses in high energy areas. Though some of the soft-engineering approach like mangrove regeneration is taking place currently in some parts of the Niger Delta coastline, re-assessment of adaptation approaches applicable to the region need to be made. Such re-assessment will give an idea of appropriate coastal engineering approach to coastal erosion management along the Niger Delta coastline.

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