ISSN 2348-3156 (Print)
International Journal of Social Science and Humanities Research ISSN 2348-3164 (online)
Vol. 8, Issue 2, pp: (1-10), Month: April - June 2020, Available at: www.researchpublish.com

SPATIO-TEMPORAL ANALYSIS OF RIVER BANK INUNDATION/RECESSION ALONG THE NYPA PALM ANDRHIZOPHORA FRONT IN RIVERS STATE

[1]Mark Ogoro, [2]Omatosan Jochebed Amanoritsewo, [3]Gabriel-Job Chimgozirim Joyce

[1]Department of Geography & Environmental Management, University of Port Harcourt, Nigeria

Corresponding Authors Email: mark.ogoro@uniport.edu.ng

Abstract: **Nigeria as a nation suffers the effect of climate change in one way or the other such as the inundation and erosion of coastal shorelines and river banks. Dredged material has been used in various instances to nourish the beach, dune stabilization with fences and vegetation like the Nypa palm and Rhizophora plants for the protection of shorelines or bank against erosion/inundation. This study analyzed the spatio-temporal analysis of River bank inundation/recession along the Nypa palm and Rhizophora front in selected areas of dominance within Rivers state Nigeria. Landsat images for 1986, 2000 and 2018 were derived from the Global Land Cover Facility data. Spatial analysis and processes of the derived data were thereafter carried out in the ArcGIS 10.4 environment The findings revealed that erosion and accretion rates differ significantly between Nypa palm and Rhizophora dominated River banks. From the analysis a total of 1,075.311sq.m of land retreated within the mangrove/Rhizophora dominated river banks while a total of 75,232.216sq.mof land area advanced within the mangrove/Rhizophora dominated area. Also from the analysis, it is obvious that within the mangrove area, there were more recordings of bank advanced(accretion) than retreat(erosion).In the Nipa palm dominated area, the total areas of the land retreat were recorded at 860,571.1sq.mwhile that of advanced was record at 365,311.2sq.mindicating that there were dominating influence of land retreat (erosion) than land advanced (accretion) over Nipa palm dominated area. It is therefore recommended that improved mangrove species capable of withstanding advance river turbulence should be encouraged within the banks and shorelines.**

Keywords: **Erosion, Inundation, Mangrove, Species, Rhizophora, Nypa-palm, accretion.**

1. INTRODUCTION

Bank erosion has been a major problem with the coastal shoreline and River bank of the community lying in the coastal plain of the country. Varying factors result in bank recession within the study area and impact on residents, making them vulnerable. Their vulnerability encourage their planting of or encourages the growth of special species of plants along the coastal shoreline or river bank. Such species of plants include plants/species like Nypa and Rhizophora plants and many others. These plants are known for its ability to mitigate tidal waves or waves generation as a result of current increase or impact on coastal water. The Nypa palm in the Niger delta region originated from Asia (June, 1995) but was intentionally introduced into the Niger delta to fight coastal and River bank erosion is 1906 (Keay et al 1964) The first point of contact of the palms was Calabar, a town in the Niger Delta region of Nigeria from where they spread further south to other coastal towns along the Atlantic Ocean aided by human activities and tidal currents. The Nypa palm plants and the Rhizophora are found along the River banks and coastal shorelines in Rivers state, such River banks and coastal shorelines where these plants grow in Rivers state can be found in places like Bonny, Khana, Ogu/Bolo and Andoni (Mwonjoria FM 2007). Nypa palm is aggressive and survives in rooted environment, compared to the Rhizophora, Nypa palm has a closer root, stem than the Rhizophora.

The Nypa palm as a plant enjoys great trunk system that grows beneath the ground and flower stalk that grows upwards above the surface, with leaves extending up to 9m (30ft) in height. The flowers of Nypa palm are a globular inflorescence of female flowers at the tip with catkin-like red or yellow male flower on the lower branches. The flower of Nypa palm produces woody nuts arranged in a globular cluster up to 25cm(10m) across on a single stalk, the ripe nuts separate from the balls and are floated away on the tide, occasionally germinating while still water borne making the dispersal rate and spread more rapid across space. It grows in cluster and could multiply in a way in which its stem tie to each other making it very useful in bank protection as the cluster growth prevents storm water from eroding the beach or bank sand.

Rhizophora on the other hand is a tropical mangrove tree. The most common notable specie is the red mangrove (Rhizophora mangle) but some other species and a few natural hybrids are known. The plant has great stamina in breaking wave action, hence, could serve significantly in protecting the River bank and coastal shoreline from erosion and inundation. The Rhizophora and the Nypapalm generally grow in the River banks as well as coastal shorelines and could contain significantly the issue of River bank and shoreline inundation and recession (Sam, 2005). Geomorphologically, River bank erosion is one of the fluvial processes which induce changes in the River channel course and in development of the flood plain (BINH DAI 2014). These are amongst the most dynamic elements of the landscape and thus an understanding of the processes is fundamental to our explanation, understanding and management of the development of fluvial features which could aid in River erosion. Understanding the dynamics and changes in the River banks, coastlines and the role played by these plants in safe guarding residential homes and farmlands, reducing the rate of erosion, rate of change in the morphology of the channel is significant in the proper management of the coastal region. Hence, this work seeks to understand the extent to which Nypapalm and Rhizophora influences and alter the rate of erosion within the River bank of its dominance.

The Study Area

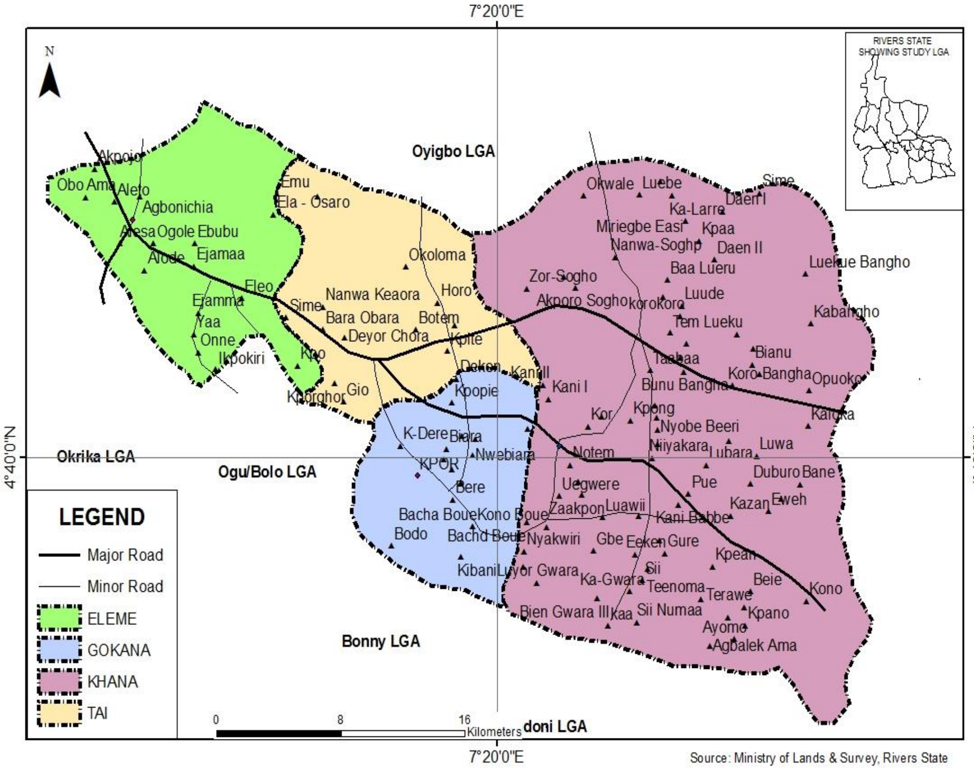


Figure 1: Study area showing coastal communities

Rivers state is one of the 36 states of Nigeria, its capital and largest city is Port Harcourt. It is economically significant as the center of Nigeria's oil industry. Rainfall is generally seasonal, variable, as well as heavy. Rainfall occurs between the months of March and October through November. The wet season peaks in July, lasting at least 290 days, the only dry months are January and February having little to no effect.

Total annual rainfall decreases from about 4,700mm on the coast, to about 1,700 mm in the border. It is 4,698 mm at Bonny along the coast. Some parts of the state still receive up to 150mm of rainfall during the dry period. Relative humidity rarely dips below 60 percent and fluctuates between 90percent and 100percent for most of the year.

The ecological zones of Rivers state can be divided into three thus: - fresh water swamps, mangrove swamps and coastal sand ridges. The fresh water zone extends northwards from the mangrove swamps. This land surface is generally less than 20m above sea level. As a lower Niger floodplain, it contains a greater silt and clay foundation and is more susceptible to perennial inundation by river floods. The flood plain's total thickness rises to about 45m in the north east and over 9m in the beach ridge barrier zones to the south west. On coastal sand ridges, the soils are mostly Sandy or Sandy loamy. Various crops supported are oil palm, cocoyam etc. The drier upland region of Rivers state covers 61percent of landmass while the riverine areas, with a relief range of 2m to 5m, take up 39percent. The riverine part of Rivers state has three hydro-vegetation zones such as beach ridge, salt water and fresh water. Each zone has its own characteristics and composition, with the freshwaters encompassing the upper and lower floodplains of the Niger delta.

Empirical Review

The impact of climate change on the coastal regions of the world is unprecedented; sea level rise stimulates coastal flooding and the submergence of several coastal communities. The coast line is in a constant flux, thus causing apparent confusion. When the sea level rises due to global warming, the available land for cultivation and human habitation generally shrinks having negative implications on food security and human survival. Nigeria has a linear stretch of about 853 kilometers of coastline with numerous littoral settlements or communities on shore line. The littoral communities are constantly being inundated by flooding from the Atlantic Ocean and the distributaries of River Niger. The sediments transported by the network of river channels are deposited at the estuaries, lagoons and delta but when the sediments enter the open sea, different processes take place and the sediments are either washed off the coast causing erosion of the coastline or deposited along the shoreline.

The changes in the coastline largely depend on its geology and geomorphology; structure of the continental shelf and the abutting coastal soil structures. The types and nature of tidal waves impacting the coastline, changes in sea-level, the nature and characteristics of sediment transport by long-shore currents are important considerations in the coastal dynamic studies (Carter and Woodroffe, 1994; Cowell and Thorn, 1994). Coastline changes often result in erosion of coastal areas or accretion of sediments, depending on the dominant processes acting on the coastline (Pidwirny, 2006). Diverse human activities have also impacted coastlines on global and local scales, these include dredging, construction of breakwater infrastructure, mineral exploration, ports construction, removal of backshore vegetation and construction of barrages. Fanos, (2005) observed that traditional methods of studying this phenomenon have relied more on three dimensional stereographic aerial photographs that were used to detect past shoreline position. This approach was supplemented by basic surveying techniques and historical coastline mapping; such as comparison of beach profiles over a period of time (Inman and Jenkins, 1984). Other recent methods have included simulation of coastline changes with numerical models of coastline. The use of Global Positioning System (GPS) receivers has become another recent technique for mapping and monitoring coastal dynamics. The long-shore sediment transport using numerical modeling packages; and the use of airborne Light Detection and Ranging (LIDAR) to map and characterize the coastline is also very common (Robertson et al, 2004). The use of satellite imageries particularly in characterising the coastal ecosystems and resources has been fraught with several limitations especially due to excessive cloud cover around most of the coastal region all the year round (Moore,.2000, El-Raey et al., 1997 and Liu and Jezek, 2004) Other studies that used derived methods to estimate coastline changes include Cori, 1999, which focused on the pressure of human population on the coastline. Mmom and Arokoyu, (2010) used the removal of protective cover from the coastline making them more vulnerable to the tidal activities. However, characterising the dynamics of the coastline and the affected coastal ecosystem have been the focus of research concerns in the last decade. This became necessary due to the global environmental change and the sea level rise. It is important to map resources at risk to coastal flooding and identify human response to progressive take-over of coastal lands by ocean surges.

2. MATERIALS AND METHODS

The image of the study area was obtained from Landsat TM image available at the Global Land Cover Facility data. This was used to classify the area land cover and obtain a land cover map for the study area. Spatial analysis and processes of the derived data were thereafter analysed in the ArcGIS 10.4 environment. The entire image was converted and classified using the signature file and maximum likelihood algorithm. The land cover of the study area was delineated via the processed image. The total land area of classified area in the study area was calculated using the geometry extension of calculating the area in the ArcGIS environment while the spatial distribution of the eroded areas were analysed using the spatial analysis tools in the ArcGIS 10.4 environment, this aided the generation of erosion/inundation areas.

ISSN 2348-3156 (Print)
International Journal of Social Science and Humanities Research ISSN 2348-3164 (online)
Vol. 8, Issue 2, pp: (1-10), Month: April - June 2020, Available at: www.researchpublish.com

3. RESULTS AND DISCUSSION

The land cover map shown in figure2 demonstrates the growth of Nypa palm with some level of competition among other species in the region for dominance along the river bank in the year 2000.

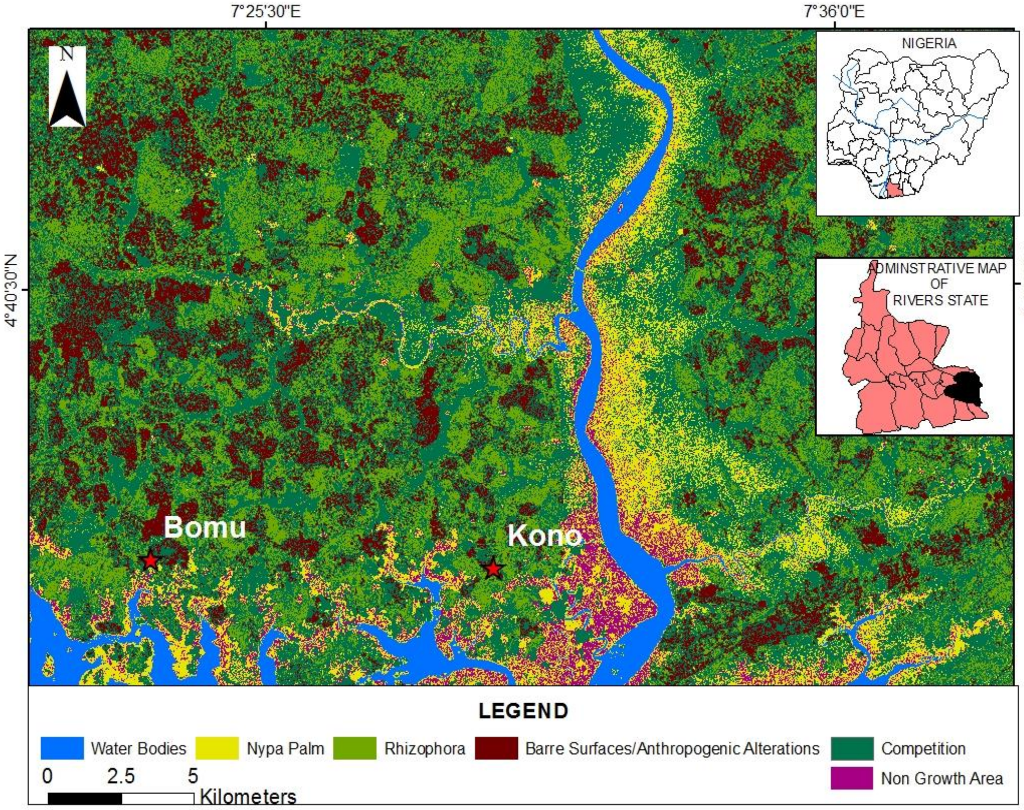


Figure 2: Image of the Study Area in the Year 2000 Showing the Spread of Nypa Palm

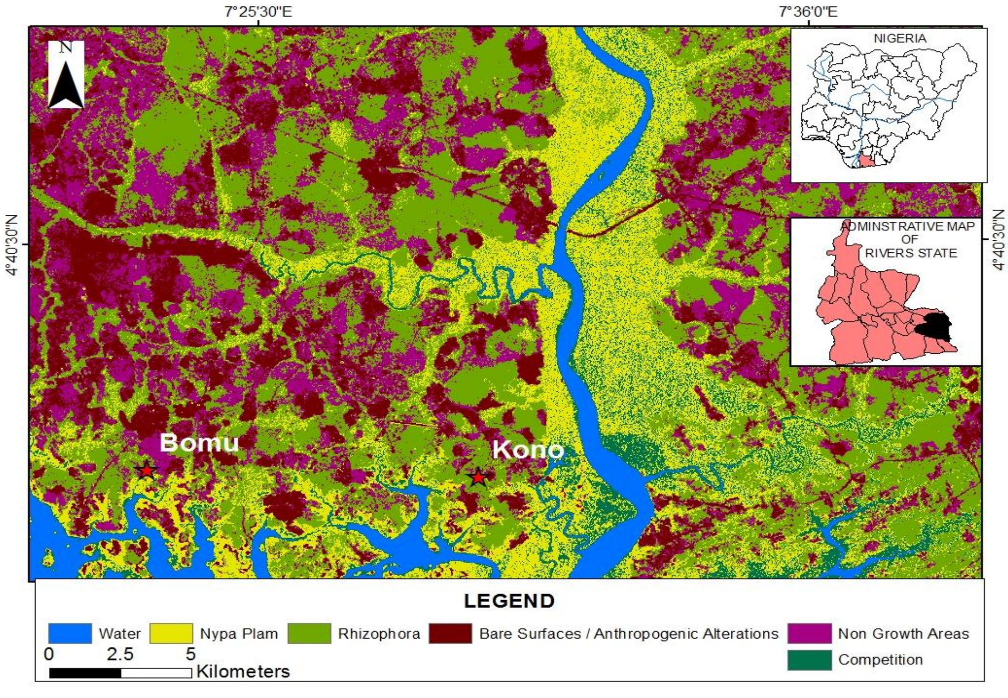


Figure 3: Image of the Study Area in the Year 2018 Showing the Spread of Nypa Palm

ISSN 2348-3156 (Print)
International Journal of Social Science and Humanities Research ISSN 2348-3164 (online)
Vol. 8, Issue 2, pp: (1-10), Month: April - June 2020, Available at: www.researchpublish.com

In the year 2018 as illustrated in the figure 3, it reveals that Nypa palm gained dominance across the study area and this is attributed to the fact that Nypa palm pollinates from the seed, when the seed gets into the water, it is dispersed through the flow of the water which aids the Nypa palm spread and gain of dominance. There was also less competition between the Nypa palm and other species of plants, with noticeable increase in non-growth areas which can be attributed to oil spillage within the study area.

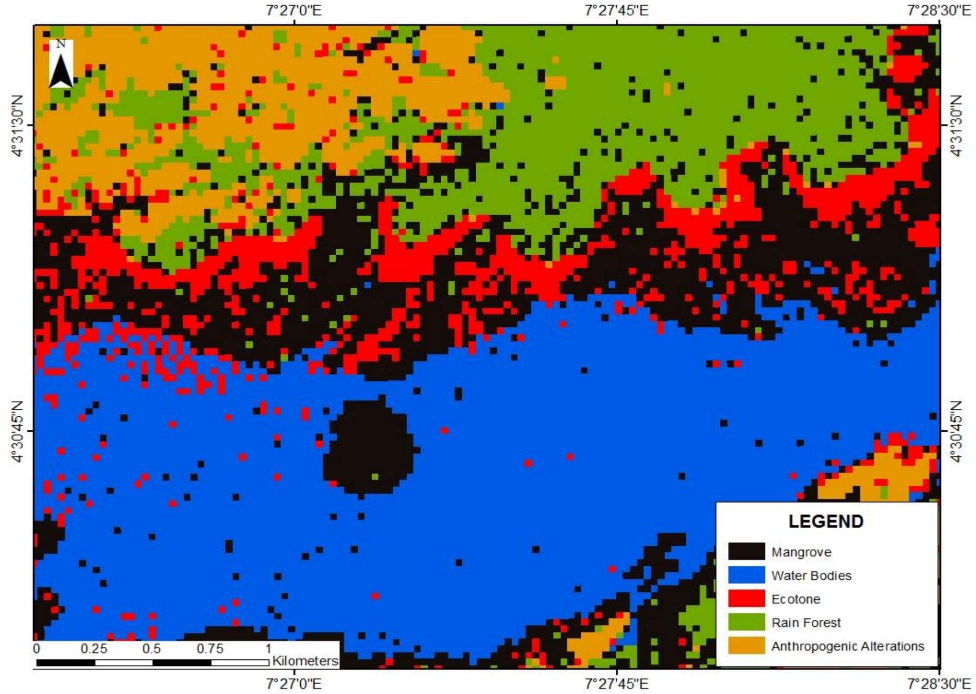


Figure 4: Image of the Study Area in the year 2000 Showing the Spread of Mangrove

Figure 4 shows mangrove growing areas in the study area. The growth of mangrove as at the year 2000 also met some level of competition with other species resulting in pockets of ecotone environment along the river bank of the study area.

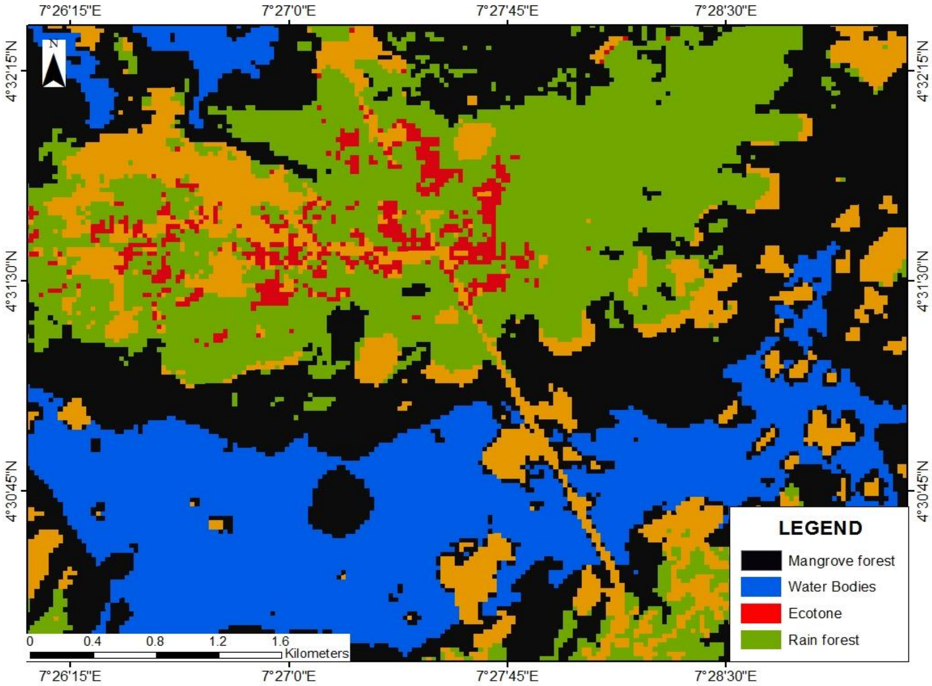


Figure 5: Image of the Study Area in the year 2018 Showing the Spread of Mangrove

This figure shows that in the year 2018 mangrove vegetation gained a lot of dominance across the study area. Mangrove forest encompasses the rainforest and even goes as far as growing in the water bodies creating a level of bank dominance across the study area making it more effective in erosion control within the study area.

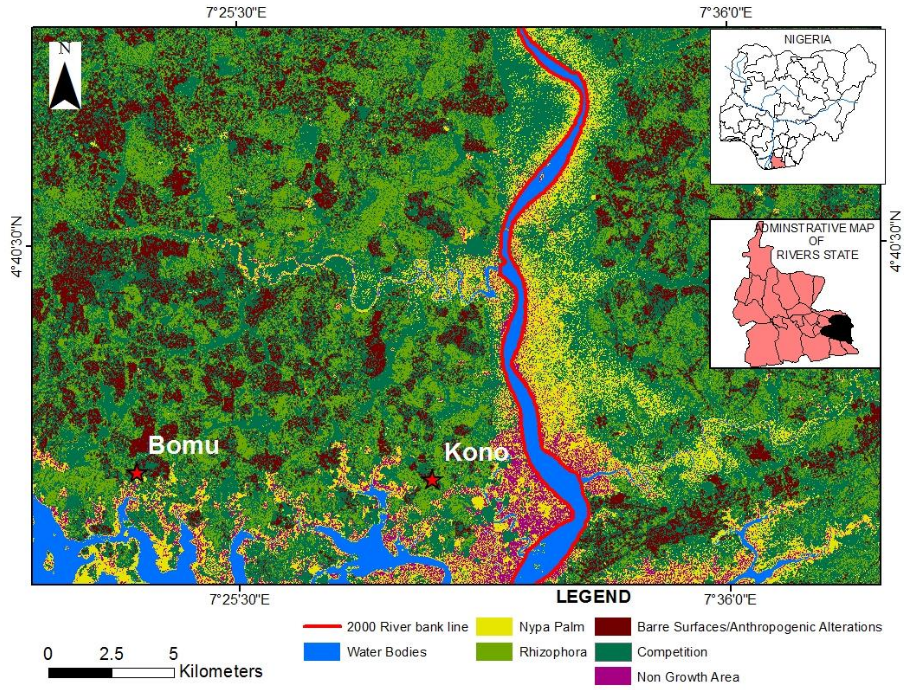


Figure 6: Image of the Study Area Showing Specie Competition Along the River bank in the year 2000

In the year 2000 both Nypa palm and Rhizophora competed for dominance as illustrated in this figure, the competition mostly occurred in the north of the River bank line this competition continued up but stopped in the south of the River bank line where there was no growth.

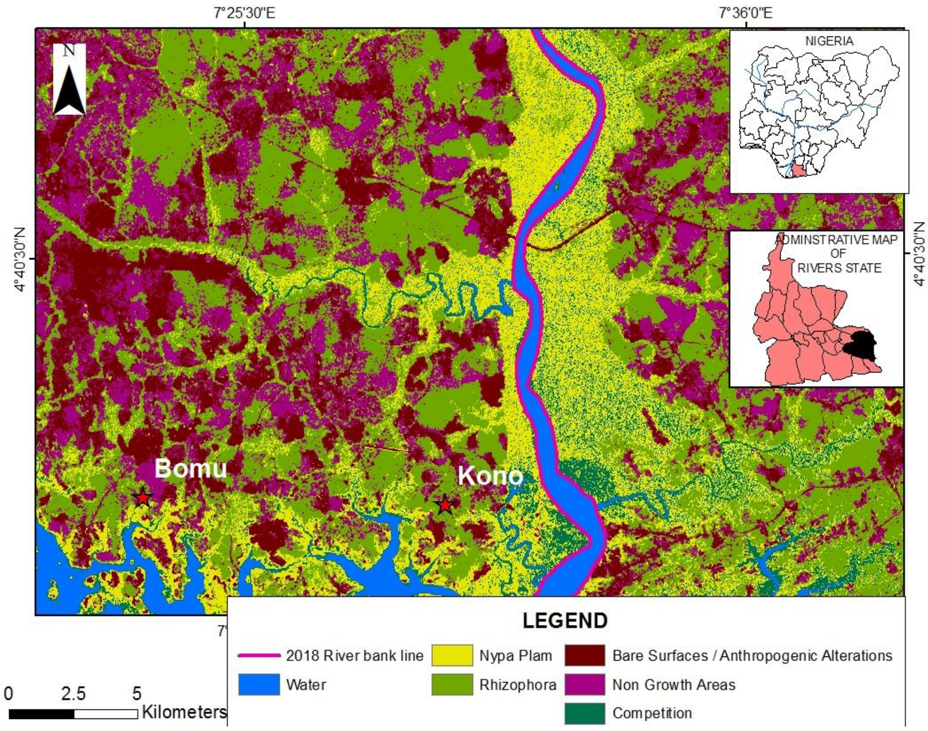
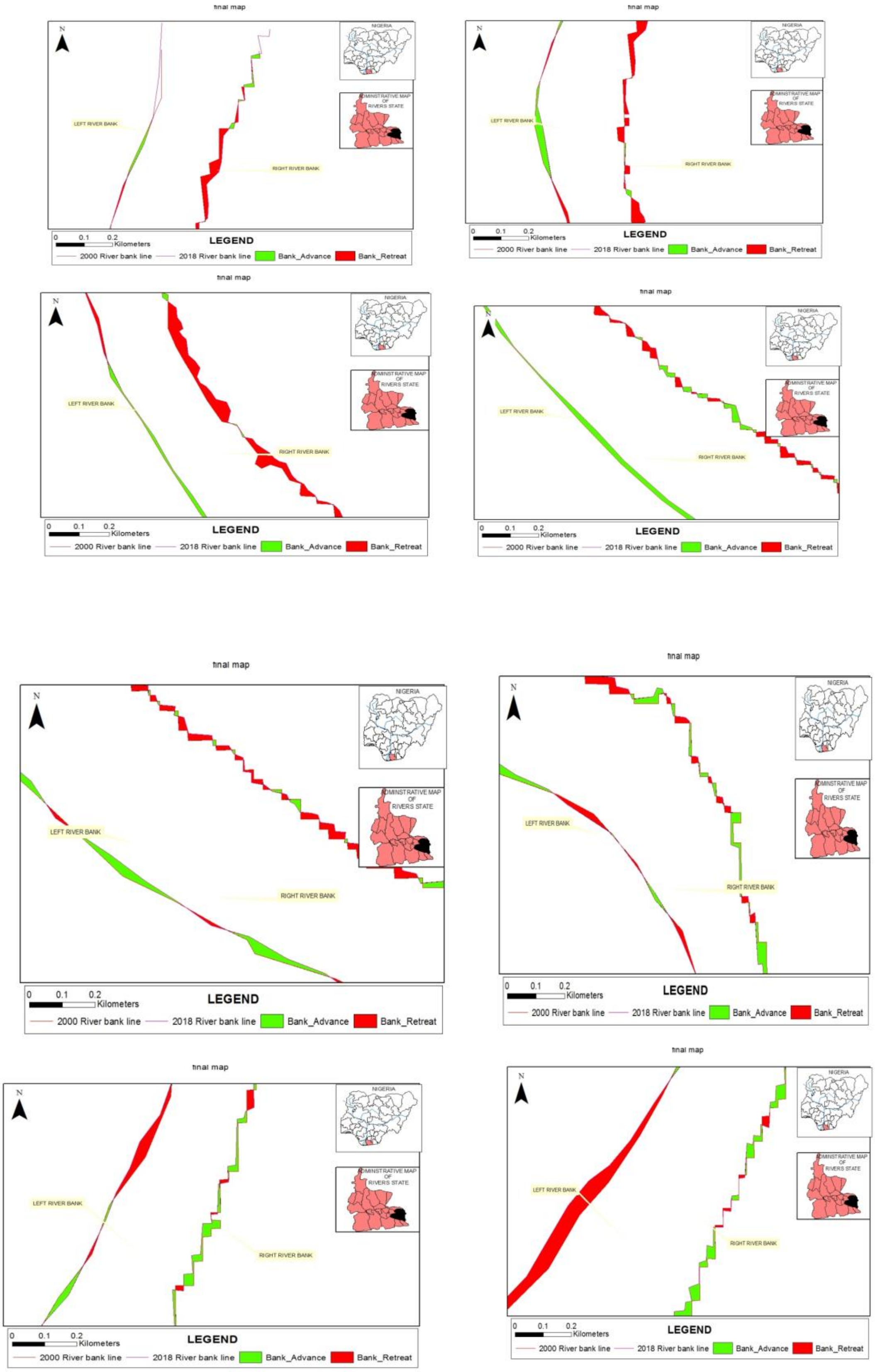


Figure 7: Image Showing Specie Competitions Along the River Bank in the year 2018

ISSN 2348-3156 (Print)
International Journal of Social Science and Humanities Research ISSN 2348-3164 (online)
Vol. 8, Issue 2, pp: (1-10), Month: April - June 2020, Available at: www.researchpublish.com

In figure 7, the spread of non-growth areas increased in the year 2018 across the study area. This can be attributed oil spillage in the water bodies which gave Nypa palm perceived advantage to dominate and spread across the study area.



ISSN 2348-3156 (Print)
International Journal of Social Science and Humanities Research ISSN 2348-3164 (online)
Vol. 8, Issue 2, pp: (1-10), Month: April - June 2020, Available at: www.researchpublish.com

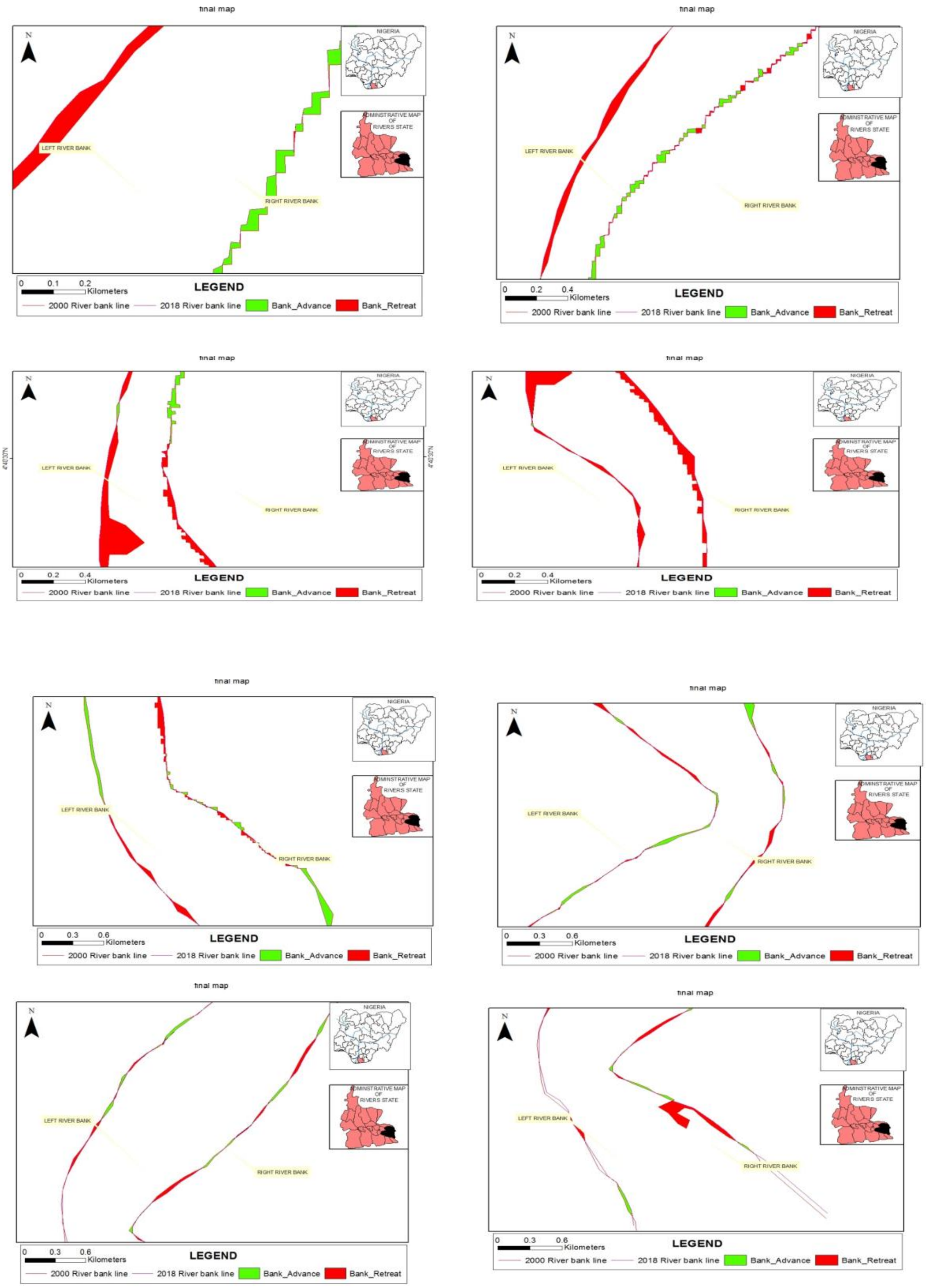


Figure 8: Analysis of River Bank Accretion and Erosion in Segment Along Rizophora and Nypa palm Dominated River Banks

The figure 8 shows the trend of erosion and accretion along the Nypa palm dominated river bank in comparism to the Rhizosphora dominated river bank across various segments of the river bank. The color red along the line indicated areas of bank retreat while the apple color indicated areas of bank advanced for the different segment of the river channel.

From the analysis a total of 1,075.311sq.m of land retreated within the Mangrove/Rhizosphora dominated river bank while a total of 75,232.216 sq.m of land area advanced within the mangrove dominated area. From the analysis, it is obvious that within the mangrove area, there were more recording of bank advance(accretion) than retreat(erosion).

In the Nypa palm dominated area, the total areas of the land retreat were recorded at 860,571.1sq.m while total land advanced was record at 365,311.2 sq.m indicating that there were dominating influence of land retreat (erosion) than land advanced (accretion) over Nypa palm study area as shown in the figure 8.

Table 1: River Bank Dynamics Between 1986 Through 2018 Along the Nypa Palm and Rhizophora River Banks

	Erosion (Retreat) in sq.m	Accretion (Advance) in sq.m	Difference in sq.m	Percentage of change
Nypa Palm	860,571.1	365,311.2	495,259.9	40.4% land eroded
Rhizophora	1075.311	75,232.216	74,156.905	97.2% land gained

4. CONCLUSION

The study has shown that erosion rate differs significantly between Nypa palm and Rhizophora dominated River banks, the rate of bank erosion in Nypa palm dominating banks is much higher than the rate of bank erosion in Rhizophora dominating banks. Though, both Nypa palm and Rhizophora play a role in mitigating River banks and coastal erosion/inundation.

The Rate of Retreat in Nypa palm protected River bank/coastal shoreline is higher than the rate of advance unlike in Rhizophora protected River bank/coastal shorelines, which means that Rizophoraplays more protective role in river bank and coastal shorelines protection than the Nypa palm. It is therefore recommended that a more advanced method and species for bank protection should be brought to page at the same time advanced engineering approach should be incorporated to mitigate the pace of bank and shoreline erosion and inundation.

REFERENCES

[1] Abam, T. S. K (1993) On the control of erosion using permeable groynes. J. Environ. Geol. Wat. Sci. (accepted for publications).

[2] Akpokodje, E. G (1987) The engineering geological characteristics and classification of the major superficial soils of the Niger delta. Eng. Geol 23, 193-204.

[3] Bandaranayake, W.M. 1995. Survey of mangrove plants from Northern Australia for phytochemical constituents and UV-absorbing compounds. Current Topics in Phyto chemistry 14:69-78.

[4] Bouchahma, M., Yan, W. and Ouessar, M. (2012) Island Coastline Change Detection Based on Imaage Processing and Remote Sensing. Canadian Center of Science and Education, 5, 27-36.

[5] Callaghan, D.P. and Wainwright, D. (2013) The Impact of Various Methods of Wave Transfers from Deep Water to Nearshore When Determining Extreme Beach Erosion. Coastal Engineering Journal, 74, 50-58. http://dx.doi.org/10.1016/j.coastaleng.2012.12.001 Kumaravel, S.,

[6] Chapman V. J(976) coastal vegetation second edition. Pergamon press-oxford, New York, Toronto, Sydney, Paris, Frankfurt 292.

[7] Charlton F. G (1989) River stabilization and training in gravel-bed rivers. In: Gravel-bed Rivers ed. R.D Hey , J. C. Bathrust & C. R. Thorne, John wiley & sons, chichester, UK, 635-657.

[8] Coastal Engineering Manual, Chapter 3, Shore Protection Projects (US Army Corps of Engineers, Washington DC, EM 1110-2-1100, Part V) 2003, pp. V-3-80 - V-3-86.

[9] Dalrymple, R.A. and Rogers, B.D. (2006) Numerical Modelling of Water Waves with the SPH Method. Coastal Engineering Journal, 53, 141-147.

[10] Davidson, M.A., Splinter, K.D. and Turner, I.L. (2013) A Simple Equilibrium Model for Predicting Shoreline Change. Coastal Engineering Journal, 73, 191-202.

[11] Gupta K R, (Ed.), Global warming: problems and policies,(Atlantic Publishers and Distributors, New Delhi) 2005, pp. 304.

[12] Hegde A V, Lecture presentation made at NITK, Surathkal,2004.

[13] http://www.surfrider.org/a-z/managed_retreat.php.

[14] http://www.fao.org/forestry/11286-1-0.pdf.

[15] http://www.soest.hawaii.edu/SEAGRANT/CEaBLiH.html.

[16] http://www.surfrider.org/a-z/managed_retreat.php.

[17] Ibe A C, Coastline Erosion in Nigeria, Ibadan, (University Press, Ibadan, Nigeria) 1988, ISBN: 978 2345041, pp. 217.

[18] Integrated Regional Information Networks (IRIN), Liberia: Coastal erosion displaces hundreds, 28 May 2008, (http://www.unhcr.org/refworld/docid/48440538e.htmlaccessed on 3 April 2010).

[19] IUCN, An Assessment of Post Tsunami Restoration and Conservation Initiatives in Coastal Stretch of Matara, IUCN-Sri Lanka Country Office, Ecosystems & Livelihoods Group, Asia, 2009.

[20] Le Cozannet, G., Garein, M., Bulteau, T., Mirgon, C., Yates, M.L., Mendez, M., Baills, A., Idier, D. and Oliveros, C. (2013) An AHP Derived Method for Mapping the Physical Vulnerability of Coastal Areas at Regional Scales. Natural Hazards Earth Systems, 13, 1209-1227. http://dx.doi.org/10.5194/nhess-13-1209-2013

[21] Muthukumarasamy, R., Mukesh, M.V., Tamilselvi, M., Singarasubramanian, S.R., Chandrasekaran, A. and Sabeen, H.M. (2013) Shoreline Changes Using Remote Sensing and GIS Environment: A Case Study of Valinokkam to Thoo-thukudi Area, Tamil Nadu, India. International Journal of Innovative Technology and Exploring Engineering (IJITEE), 2, 72-75.

[22] Ngo Ngoc Cat, Pham Huy Tien, Do Dinh Sam, and Nguyen Ngoc Binh. Status of coastal erosion of Vietnam and proposed measures for protection, 2005,

[23] P.C.M.mom, and S.B.Arokoyu,(2010) Mangrove forest depletion, biodiversity loss and traditional resources management practices in the niger delta, Nigeria, Re- search Journal ofApplied Sciences, Engineering and Technology, ISSN: 2040-7467, 2(1), 28-34 (2010).

[24] Ramkumar, T., Gurunanam, B., Suresh, M. and Dharanirajan, K. (2013) An Application of Remote Sensing and GIS Based Shoreline Change Studies—A Case Study in the Cuddalore District, East Coast of Tamilnadu, South India. International Journal of Innovative Technology and Exploring Engineering (IJITEE), 2, 211-215.

[25] Restall, S.J., Jackson, L.A., Georg, H. & Hornsey, W.P., Case studies showing the growth and development of geotextile sand containers: An Australian perspective, Geotextiles and Geomembranes, 20(5)(2002) 321-342.

[26] Singh, B., Climate-related global changes in the southern Caribbean: Trinidad and Tobago, Global and Planetary Change, 15(3-4)(1997) 93-111.

[27] Souza Filho, P.W.M. and Paradella, W.R. (2003) Use of Synthetic Aperture Radar for Recognition of Coastal Geomorphological Features, Land Use Assessment and Shoreline Changes in Braganca Coast, Param, North Brazil. Brazilian Academy Sciences, 75

[28] Van der A, D.A., Ribberink, J.S., van der Werf, J.J., Donoghue, T.O., Buijsrogge, R.H. and Kranenburg, W.M. (2013) Practical Sand Transport Formula for Non-Breaking Waves & Currents. Coastal Engineering, 76, 26-42. http://dx.doi.org/10.1016/j.coastaleng.2013.01.007

[29] Vinayaraj, P., Johnson, G., Udhaba Dora, G., Sajiv Philip, C., Sanil Kumar, V. and Gowthaman, R. (2011) Quantitative Estimation of Coastal Changes along Selected Locations of Karnataka, India: A GIS and Remote Sensing Approach. International Journal of Geosciences, 2, 385-393. http://dx.doi.org/10.4236/ijg.2011.24041