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Research Paper

Spatio – Temporal Changes in the Geomorphic Shoreline of Bonny Island

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ABSTRACT:- Increased inundation of coastlines which causes loss of habitable island, properties, mangrove vegetation is attendants' effects of climate change. The present study examines the vulnerability and spatio – temporal changes in the shoreline of Bonny Island, Nigeria sequel to rises in sea level over time. Satellites imageries of Land-Sat Tm of 30m x 30m of 1986 and 2001 and Niger Sat Image of 30m x 30m of 2006 and 2011 were employed to determine changes in bonny shoreline. From the analysis, 1,819.4sq km and 4,588.38 sq km of land was lost to sea between 1986 through 2001, and between 2001 through 2006 respectively, while 1,781.96 sq km of land was lost between 2006 and 2011. Hence the study recommended among others that there should be integrated coastal zone management and developmental planning to enhance shoreline protection and mitigation of the impact of sea level rise on the region.

Keywords:- Bonny Island, Sea Level Rise, shoreline, Vulnerability, Inundation

I. INTRODUCTION

Bonny Island is one of the most densely populated Local Government Areas in Rivers State, Nigeria. Majority of its inhabitants' live in the riverside and coastline area prone to natural hazard such as shoreline retreat/inundation, coastal inundation, flood etc the physical Geography of the area features its long coastline and the Equatorial climate. In the wake of today's' environmental challenges faced by humanity, almost all the worlds' oceanic coastline shows evidence of submergence during the last 15,000 years or so, due to the melting of Pleistocene ice. The most prominent result of submergence is the drowning of river valley, which produces estuaries or long dendritic fingers of sea water projecting inland (McKnight, 1992). Awosika, Ojo, & Ajayi, 1993 affirms that if sea level rises, inundation could occur along more than 70 percent of the Nigeria coastline, placing land at risk many kilometers inland, thus a 1meter rise in sea level will result to 600km^2 of land at risk. Hence, understating the spatio – temporal changes in the geomorphic shoreline of bonny island sequel to a rise in sea level is fundamental to solving the problem of coastline inundation. Therefore mapping the spatio – temporal changes in the geomorphic shoreline can be seen as a starting point in shoreline protection, integrated coastal zone management and developmental planning.

II. THE STUDY AREA

Nigeria has a shoreline of 800km^2 in length out of which the Niger Delta constitute about 60% of the Nigerian coastline (Oyegun, 2007). Bonny Island is located in the south southern part of Nigeria. It comprises of Bonny Town, New Finima and other smaller settlements. Its coastline located along the Atlantic Ocean is classified as a passive margin coast because 'major tectonic activities within the Atlantic Ocean occurs in the centre of the ocean along the Mid – Atlantic Ridge, whereas the coastal area are tectonically passive, with little mountain building or volcanic activities. The Island is about 40 kilometer from the state capital Port Harcourt.

The 2006 population figure of Nigeria put the study area population at 33,666 persons, out of which 18,282 are male and 15,385 female. The Island is categorized as a passive margin cost subject to its low relief structure with broad coastal plains and wide submerged edge of the continent called continental shelves (Robert, James, Michael, & Dorathy, 2009).

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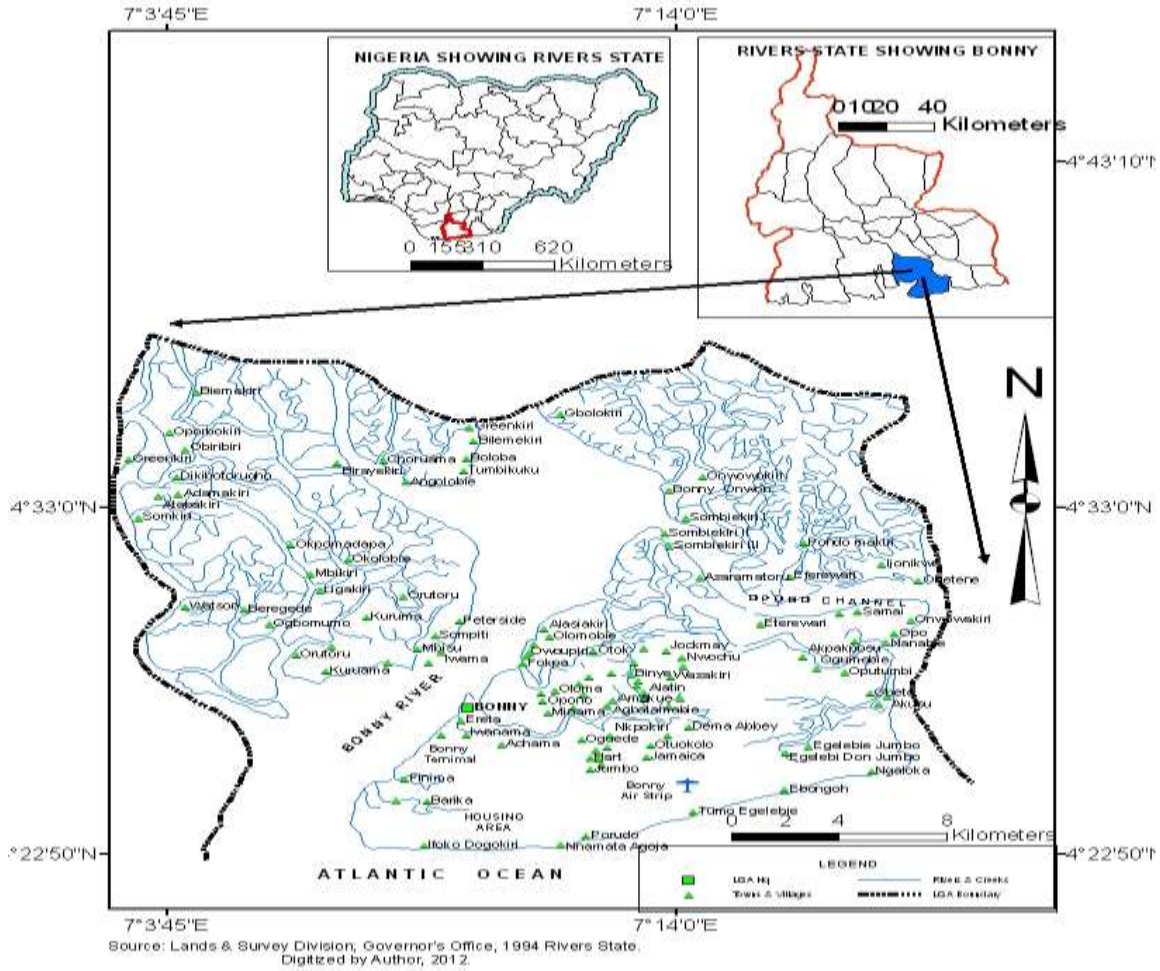

Figure 1: Study Area Showing Natural Drainage

2.1 LANDFORM AND DRAINAGE

The Island comprises two landform namely; the beach ridge barrier and tidal flats (BMP, 2002). The Beach Ridge Barrier is a series of elongated sandy ridge with intervening trough. They run roughly parallel to the coastline and have been formed by the opposing action of the Niger River extending its seaward and the Atlantic Ocean currents impinging on the coast as shown in plate 1 & 2 below

Photo: Author's Fieldwork, 2012

Plate 1: Coast of Bonny Island Showing Seaward Extension of Delta

Photo: Author's Fieldwork, 2012

Plate 2: Coast of Bonny Island Showing the Impact of Atlantic Ocean on the Coast

These barriers form the break between the ocean and hinterland and rise some 3 meter or so above sea level (BMP, 2002).

Inland are a series of abandoned beach ridge and depression that also run parallel to the coast and which are isolated from the effects of tidal inundation. The tidal flats are extensive flats depression that lies behind the beach ridge barrier shown in plate 3 below

Photo: Author's Fieldwork, 2012

Plate 3: The reclaimed tidal flat behind a fortified beach ridge barrier

The course of the Bonny River which is the largest in the study area flow south easterly in to a large water basin at the centre of the study area from where it flows southerly and then slightly south westerly as it empties in to the Bright of Brafia. Its flow is between the two neighbouring estuaries of the Atlantic coastline formed by the New Calabar River to the west and the Andoni River to the east. A further major connection formed by the Cawthurne channel link the New Calabar and Bonny River estuaries. Two other rivers; the Oboama Toru and the Huge Channel run approximately parallel to the Cawthurne channel. East of the Bonny River, is the Opobo channel which links up with the Andoni River and flows in a generally parallel course to it.

The Opobo Channel flows generally east to west draining severity of creeks. The largest of which is located at the eastern boundary.

2.2 CLIMATE

The climate of the area is generally hot, very humid tropical. The mean annual rainfall is very high at over 4,000 mm with no month having less than 50 mm therefore putting the growing season at 330 days or more with an average monthly temperature in the range of 26^{o}c, mean annual potential evapo-transpiration estimated to be 1100 mm.

The course of the Bonny River which is the largest in the study area flow south easterly in to a large water basin at the centre of the study area from where it flows southerly and then slightly south westerly as it empties in to the Atlantic Ocean. Geographically, it flows between the two neighboring estuaries of the Atlantic coastline formed by the New Calabar River to the west and the Andoni River to the east. A further major connection formed by the Cawthorne channel linking the New Calabar and Bonny River estuaries. East of the Bonny River, is the Opobo channel which links up with the Andoni River and flows in a generally parallel course to it. The Opobo Channel flows generally east to west draining severity of creeks. The largest of which is located at the eastern boundary.

III. OBJECTIVES

- To map the shoreline of the province in order to support coastal management programme in the area
- To assess the shoreline spatio – temporal changes.

IV. METHODOLOGY

Information on the elevation, shoreline changes was derived from satellite imageries. The height above mean sea level was determined through the use of Google Earth 2011 version. These values were called z – coordinate and were used in conjunction with x and y coordinates to derive a topographic map of the entire Bonny Island. The topographic map was imported in to the Arc GIS 9.3 environment to enhanced further analysis. Satellites imageries which include Landsat Tm of 30m by 30m of 1986 and 2001; Nigeriasat of 30m by 30m of 2006 and 2011 were employed for the study. The satellite images underwent series of geo – processing in order to make them suitable for further analysis. This image was then overlaid. The image was then smoothened in order to obtain sharp boundary between the land and the ocean which serves as the shoreline. Thereafter, the shoreline for each year was digitized as polylines. Shoreline changes were analyzed using different images of 1986, 2001, 2006 and 2011. The digitized shoreline were overlaid and converted to polygon which now gives room for categorizing the polygon as advance (seaward) and retreat (land ward). The spatial extent in space per square kilometer was calculated for both advance and retreat and thereafter total advance was subtracted from total retreat.

V. SPATIO – TEMPORAL CHANGES

Shoreline analysis was carried out in the Bonny Island. The shoreline of Bonny Island was subjected to geographic analysis using satellite imageries of 1986, 2001, 2006 and 2011. The analysis shown in the table 1, shows the result of overlaying the image of 1986 on 2001, 2001 on 2006 and 2006 on 2011. Land gain, represents land advancing seaward creating a continental environment. While land loss indicates land retreating and water advancing resulting to a submarine environment. The difference between land loss and land gain in km^2 determines the direction of change, while the percentage loss or gain was calculated over the digitized shoreline in km^2

Table 1: Analysis of Shoreline changes over the years

Years	Land gain (sq km)	Land Loss (sq km)	Shoreline difference	Percentage Loss	Percentage gain
1986 – 2001	402.4	1819.4	-1417	82	
2001 – 2006	2078.89	4588.38	-2509.49	69	
2006 - 2011	2551.12	1781.96	769.16		41

Source Authors' Analysis, 2012

The analysis as showed in figure 3, 4 and 5 reveals the shoreline path from the imageries given an understanding of land advancement (gain in sq km) or land retreat (loss in sq km). The two lines were converted to polygon using feature to polygon module whose interception and area in the advances (land in to the ocean) and the retreat (water in to the land) calculated in square kilometers in each periods under consideration.

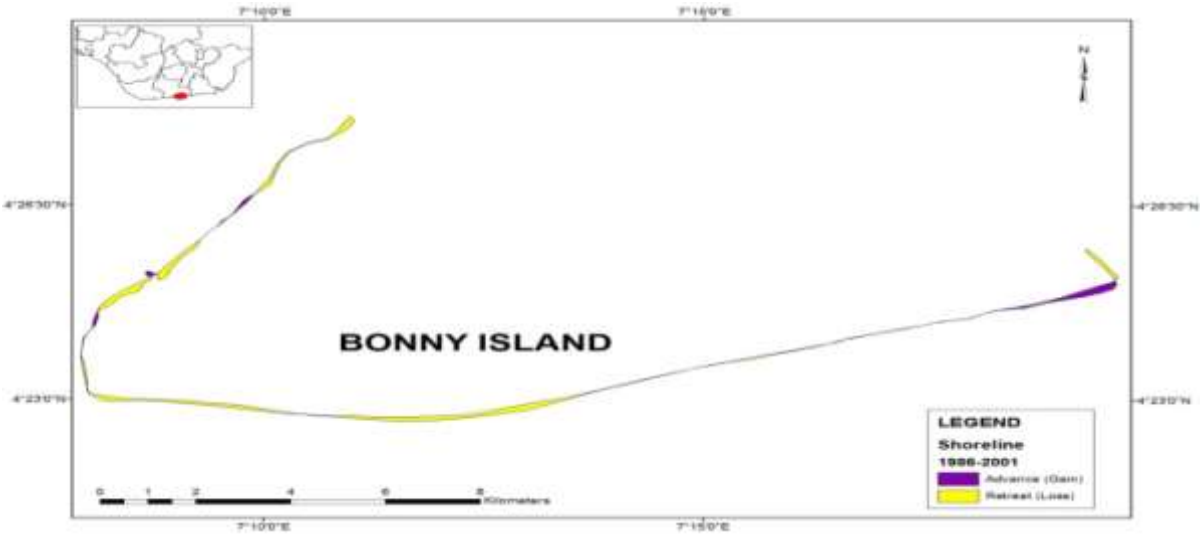

Figure 3: Shoreline changes 1986 to 2001
Source: Researchers' Fieldwork/Analysis, 2012

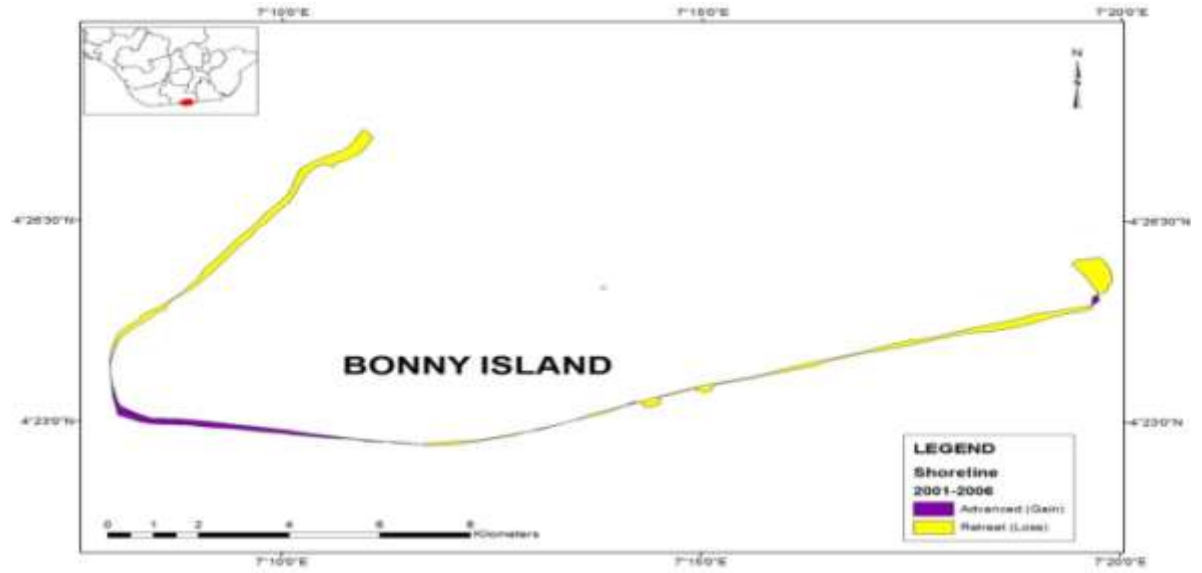

Figure 4: Shoreline changes 2001 to 2006
Source: Researchers' Fieldwork/Analysis, 2012

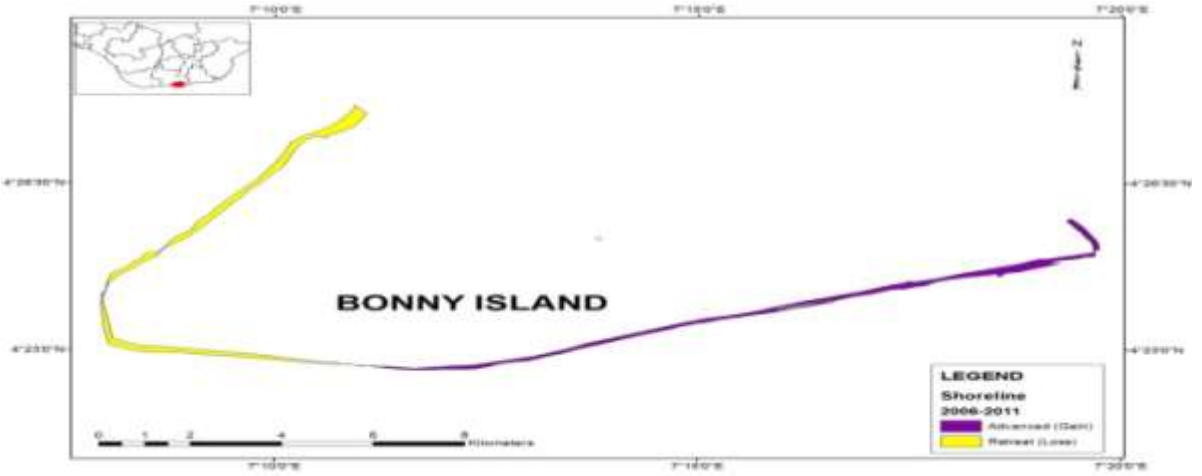

Figure 5: Shoreline changes 2006 to 2011
Source: Researchers' Fieldwork/Analysis, 2012

VI. CONCLUSION

Assessing the shoreline status for the periods under consideration, it was observed that much landmass was inundated within 1986 to 2001 and 2001 to 2006 with a gain in 2006 to 2011. It could therefore be said that the shoreline of Bonny Island is a shoreline of erosion and accretion affirming Awosika (1993) that there is wide spread erosion and flooding of the barrier island of the Niger Delta of Nigeria

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