Land use and Land cover Pattern of Stubbs Creek, Akwa Ibom State between 1986 and 2019 using Geospatial Techniques

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***Abstract*: This study assessed the land use/land cover patterns in Stubbs Creek, Akwa Ibom, Nigeria from 1986 to 2019. The study used Landsat imageries of 1986, 2000 and 2019 to determine the spatial extent, trend and percentage of changes of different land use/land cover in the study area. Supervised classification using maximum likelihood algorithm was used to classify the imageries into different major land use/land cover in Arc GIS 10.6. Descriptive statistics were used to analyze the data. The results indicated that between 1986 and 2019, water bodies, flood plain/riparian/mangrove and thick vegetation land use types reduced by 43.87%, 70.60%, and 93.19% respectively. On the other hand, built-up area and Nypafructicans/Sparse Vegetation increased by 1425.03%, and 1855.25% respectively. The study concluded that majority of Stubbs Creek is presently dominated by Nypafructicans and human activities. It is therefore recommended that the increase in built up area representing urban growth has enormous implication on the ecosystem balance of the study area; thus there is therefore the need to enact laws against forest encroachment and expansion so as to protect the ecosystem; and there is need for periodical monitoring of the vegetation status in the Stubbs Creek, Akwa Ibom State for sustainable forest resource management and biodiversity in the entire study area to mitigate the associated risk of global climate change.**

***Keywords:* Land use/Land cover; Biodiversity, Stubbs Creek; Geospatial Techniques; Akwa Ibom**

I. INTRODUCTION

Land is one of the most important natural resources, as life and developmental activities are based on it (Ezeomedo and Igbokwe, 2013; Jacob et al., 2015); and land use and land cover change have emerged as a global phenomenon and perhaps the most significant regional anthropogenic disturbance to the environment, especially in the 20th century. Land cover change has been described as the most significant regional anthropogenic disturbance to the environment (Roberts et al, 1998). In essence both land use and cover changes are products of prevailing interacting natural and anthropogenic processes by human activities. Land use and cover change and land degradation are therefore driven by the same set of proximate and underlying factor elements central to environmental processes, change and management through their influence on biodiversity, heat and moisture budgets, trace gas emissions, carbon cycling, livelihoods and a wide range of socio-economic and ecological processes (Desanker et al., 1997; Verburg et al., 2002; Verbug et al., 2000; Fasona and Omojola, 2005). Land is becoming a scarce resource due to immense agricultural and demographic pressure. Hence, information on land use/land cover and possibilities for their optimal use becomes pertinent for the selection, planning and implementation of land use schemes to meet the increasing demands for basic human needs and welfare (Ezeomedo and Igbokwe, 2013).

Land-use change and land-cover change (LULCC) are terms often used interchangeably but the two have different meanings. Land cover describes the natural and anthropogenic features that can be observed on the Earth's surface (deciduous forests, wetland, developed/built areas, grasslands, water, etc.) and Land use, by contrast, describes activities that take place on the land and represent the current use of property such as residential homes, shopping centers, tree nurseries, state parks, reservoirs, etc. (Jensen, 2005). LULCC, especially those caused by human activities, is one of the most important components of global environmental change (Jensen, 2005). Land use/land cover and human/natural modifications have largely resulted in deforestation, biodiversity loss, global warming and increase of natural disaster-flooding (Reis, 2008). Therefore, available data on LULC changes can provide critical input to decision-making of environmental management and planning the future (Jacob and Olajide, 2011). The growing population and increasing socio-economic necessities creates a pressure on land use/land cover. This pressure results in unplanned and uncontrolled LULC changes. The LULC changes are generally caused by mismanagement of agricultural, urban, range and forest lands which lead to severe environmental problems such as landslides, floods etc. (Reis, 2008).

Sesil and Aydinoglu, (2005) and Jacob et al., (2015) noted that coastal regions are the most important biodiversity spot and intensely used areas settled by humans in the world. In Nigeria, the Niger delta region is an ecological fragile region with high levels of biodiversity and is known to be a repository of biologically diverse plants that offers opportunities for food and pharmaceuticals (NDES, 1997). In addition to providing plants for medicinal purpose, the forest ecosystem also offers products such as fuel wood for cooking, heating, drying/smoking of fish, timber for construction, building industry or boat construction and edible wildlife plants in forms of leafy vegetables, fruits and seeds, spices, food wrappers and starchy tubers (Onojeghuo and Onojeghuo, 2015). Stubbs Creek Forest Reserve located in the Niger delta is believed to contain the largest intact block of forest remaining in Akwa Ibom State (Udo*et al.*, 1997). The reserve is unique because of its composite nature - it includes mangrove forest, swamp forest, and lowland rainforest. As a result of population increase, unemployment, oil exploration, etc. and its resulting negative consequences in the area, the unstable and unbalanced development is bringing about destruction to the flora and fauna biodiversity loss. Several studies have been conducted on land use/land cover in Akwa Ibom State using multiple satellite imageries. These included the works of Ekpeyoung (2015); and Onojeghuo and Onojeghuo (2015) which used satellite imageries to determine the extent of forest cover loss over a period of more two decades in the tropical forests landscape of Akwa Ibom and Cross River States. The studies did not consider analyzing the land cover change in the Stubbs Creek of Akwa Ibom State. The present study examined the land use and land cover change in the Stubbs Creek in Akwa Ibom State, Nigeria, with a view to extending the study to 2020.

II. MATERIALS AND METHODS

The study was carried out in the Stubbs Creek Forest Reserve (SCFR), in Akwa Ibom State, Nigeria. It covers about 320 square kilometers (Ndoho*et. al.,* 2009, Jacob *etal*., 2015). The SCFR lies approximately between latitudes 4° 32' N and 4° 38'N and longitudes 7° 54'E and 8° 18'E. It is bounded by Mobil Producing Nigeria Unlimited (MPNU) installations and Ntak to the West and Unyenge and Okposso communities in the East (Ndoho*et. al.,* 2009*)*. The SCFR is bordered by water on three sides: the Atlantic Ocean on the South, the Qua Iboe River on the West, and the Cross River Estuary on the East (Baker, 2003). The Stubbs runs west-east in the northern half of the reserve (Gadsby, 1989). Mean annual rainfall for this coastal region is high – from 2,000mm to 2,500mm. The mean minimum and maximum temperature are 26 °C and 30.5 °C respectively while the mean relative humidity of the area is about 83% (Werre, 2001).

Stubbs Creek is predominantly a freshwater swamp forest that seasonally floods in some zones. It also comprises brackish-water swamp forest, mangrove forest in the eastern end of the reserve, secondary forest, farmland, palm bush, and abandoned farms (Gadsby 1989). In Akwa Ibom State, Stubbs Creek represents the only remaining natural coastal swamp forest of any significant size (Tooze*et al*. 1998a; Tooze*et al*. 1998b). Stubbs Creek experiences two distinct seasons namely the rainy and dry seasons. The rainy season begins from April to October and at times extends to November every year with a short break of dry season in August otherwise called August break; whereas the dry season starts from November and ends in March the following year. The total annual rainfall of the state ranges from 1700mm to 4700mm and mean monthly temperature of 25°C to 28°C. The topography is moderately flat with seemingly undulating and hilly terrain of about 200ft above sea level particularly around Itu and IbionoIbom axis of the state. Even though the Southern part of the state is bounded by the Atlantic Ocean, Akwa Ibom State unlike other states within the Niger Delta has the longest and moderately smooth shoreline of about 129km with beautiful beaches and creeks in the country extending from IkotAbasi to Oron axis of the State. The soil is well drained acidic soil which is dominated by sandy soil with fairly percentage of clay (Nwakoala and Warmate, 2014; Ukut, *etal*., 2014). The vegetation contains mangrove and freshwater swamp and the place is known to harbour various plant and animal species and this makes it possible to be referred to as one of the major biodiversity hotspots within the Gulf of Guinea (Unwana, 2015).

Image geo-processing for Land use change and Percentage Change

The study made use of multi-spectral satellite images of Landsat 4 TM, Landsat 7 ETM and 8 OLI/TIRS of 1986, 2000 and 2019 respectively. Landsat images were used because of their ability to have valuable and continuous records of the earth's surface for identifying and monitoring changes in man-made and physical environments (El Bastawesy, 2014). The images were enhanced by combining image bands. A false colour composite band sequence 5, 4, 2, RGB was used for classifying the land cover. Enaruvbe and Atafo (2014) confirmed that a combination of channel 5 (red), channel 4 (green) and channel 2 (blue) is effective in discriminating different vegetal cover types. Information from each land cover classes was collected from extensive field survey before the classification of satellite imageries (Balogun*et al*., 2011). The field survey was performed throughout the study area with the use of global positioning system (GPS) to track the coordinates of the sample points in each landuse/land cover. The scenes of the images of each year were mosaicked to represent one image for each year. Thereafter supervised classification using maximum likelihood algorithm classifiers in (Lillesand and Kiefer, 1994) was used to classify similar spectral signatures into various classes which included thick vegetation, water bodies, flood plain/riparian/mangrove, built-up area and Nypafructicans/sparse vegetation. Maximum likelihood classifier was chosen because it is the most widely adopted parametric classification algorithm (Manandhar*et al*., 2009). The area of each landuse class was computed in ArcGIS 10.5 which was used to compute the landuse change and percentage change in squared kilometers. The percentage change was computed using equation (1) as given in Enaruvbe and Atedhor (2015).

$$\frac{\left(\frac{d}{t1}\right)*100}{y2-y1} \quad \text{………………………………………Equ.1}$$

Where,

d is the difference in the value of area covered by a land cover category at the initial time point and final time point

t_1 is the value of the area covered by a land cover category in the initial time point

y1 and y2 are base year and final year respectively.

III. RESULTS AND DISCUSSIONS

Land use and Land Cover Change and Percentage Change in the Study Area (1986-2019)

Land use patterns of Study Area between 1986 and 2019

The landuse pattern in 1986, 2000, and 2019 presented in Table 1 and Figures,1, 2, 3 and 4 showed that in 1986, thick vegetation had spatial extent of 348.97km^2 (55.76%) of the total land area, built-up area had 10.07km^2 (1.61%), Nypafructicans/Sparse Vegetation occupied 17.26 km^2 (2.76%), flood plain/riparian/mangrove occupied 134.33 km^2 (21.46%) while water bodies occupied 115.26 km^2 (18.42%) respectively. In 2000, thick vegetation had spatial extent of 240.29 km^2 (38.39%) of the total land area, built-up area had 69.01 km^2 (11.03%), *Nypafructicans*/Sparse Vegetation occupied 95.05 km^2 (15.19%), flood plain/riparian/mangrove occupied 116.4 km^2 (18.60%) while water bodies occupied 105.14 km^2 (16.80%) respectively. While in 2019, thick vegetation had spatial extent of 166.09 km^2 (26.54%) of the total land area, built-up area had 145.54 km^2 (23.25%), *Nypafructicans*/Sparse Vegetation 204.13 km^2 (32.61%), flood plain/riparian/mangrove occupied 59.62 km^2 (6.31%) while water bodies occupied 50.51 km^2 (8.07%) respectively.

Table 1: Spatial Extent (sq km) of Land use/ Land cover in the study area between 1986 and 2019

Landuse	1986		2000		2019	
	Spatial Extent (sq km)	Percentage (%)	Spatial Extent (sq km)	Percentage (%)	Spatial Extent (sq km)	Percentage (%)
Water bodies	115.26	18.42	105.14	16.80	50.51	8.07
Flood Plain/Riparian/Mangrove	134.33	21.46	116.4	18.60	59.62	9.53
Thick Vegetation	348.97	55.76	240.29	38.39	166.09	26.54
Built Up Area	10.07	1.61	69.01	11.03	145.54	23.25
Nypafructicans/Sparse Vegetation	17.26	2.76	95.05	15.19	204.13	32.61
Total	625.89	100.00	625.84	99.99	625.89	100.00

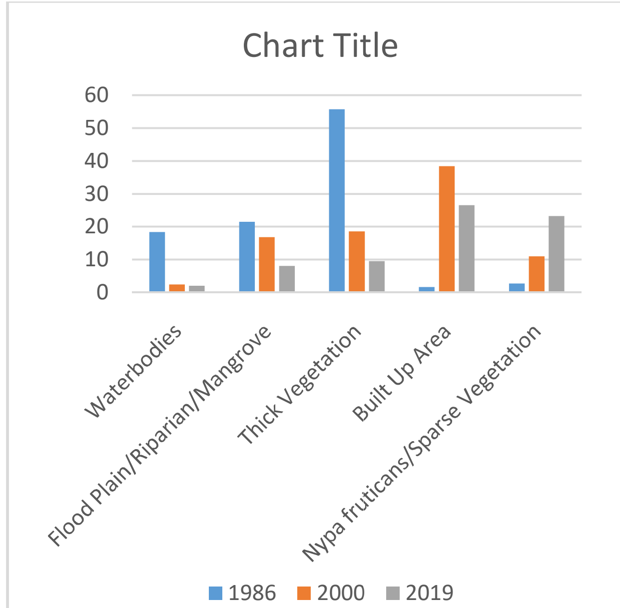

Figure 1: Spatial Extent (sq km) of Landuse/ Land cover in the study area between 1986 and 2019

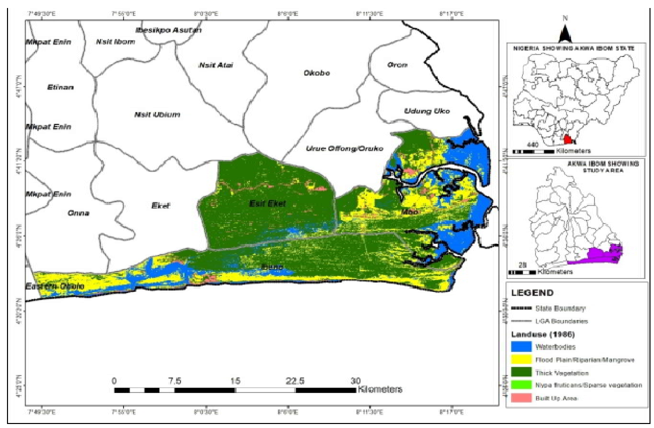

Figure 2: Spatial Extent of Landuse/ Land cover in 1986

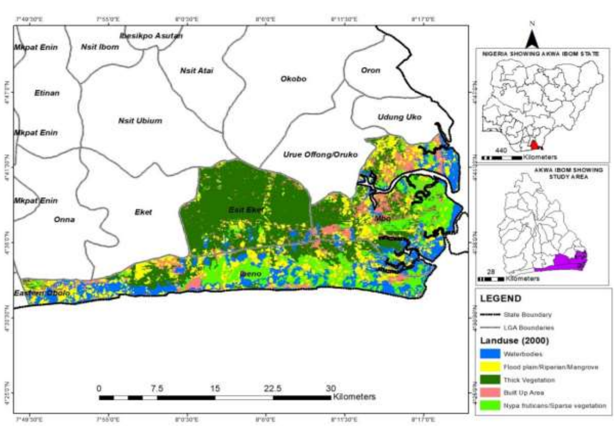

Figure 3: Spatial Extent of Landuse/ Land cover in 2000

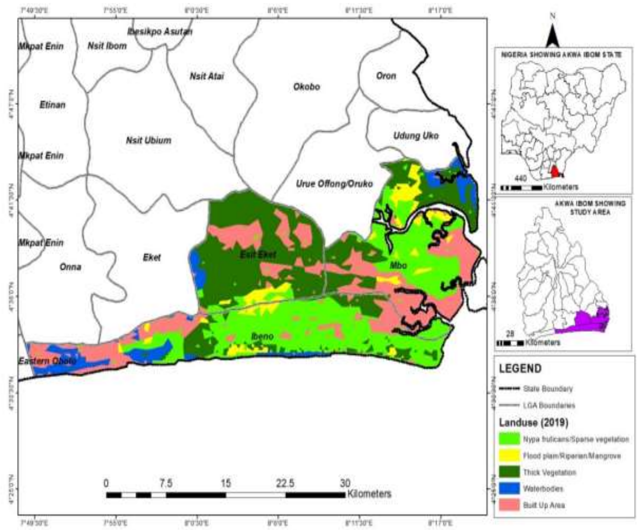

Figure 4: Spatial Extent of Landuse/ Land cover in 2019

Trend and magnitude of land use change and percentage change ofland use in the between 1986 and 2019

Considering the result of the analysis in Table 2 and Figure 5, it is clearly observed that water bodies, flood plain/riparian/mangrove and thick vegetation land use types reduced by 8.78%, 13.35% and 31.14% respectively; while built up area and *Nypafruticans*/Sparse vegetation land use types increased by 585.30% and 450.70% respectively between 1986 and 2000. The result also shows that water bodies, flood plain/riparian/mangrove and thick vegetation reduced by 51.96%, 48.78%, and 30.88%, respectively while built up area and *Nypafruticans*/Sparse Vegetation increased by 110.90% and 114.76% between 2000 and 2019. Furthermore, between 1986 and 2019, water bodies, flood plain/riparian/mangrove and thick vegetation land usetypes reduced by 56.18%, 55.62%, and 52.41% respectively. On the other hand, built-up area and *Nypafruticans*/Sparse Vegetation increased by 1345.28%, and 1082.68% respectively.

Table 2: Trend and magnitude of land use change and percentage change in the study area between 1986 and 2019

Landuse	(1986-2000)		(2000-2019)		(1986-2019)	
	Trend/Magnitude ofland usechange (km^2)	Percentage change (%)	Trend/Magnitude ofland usechange (km^2)	Percentage change (%)	Trend/Magnitude ofland usechange (km^2)	Percentage change (%)
Water bodies	-10.12	-8.78	-54.63	-51.96	-64.75	-56.18
Flood Plain/Riparian/Mangrove	-17.93	-13.35	-56.78	-48.78	-74.71	-55.62
Thick Vegetation	-108.68	-31.14	-74.2	-30.88	-182.88	-52.41
Built Up Area	58.94	585.30	76.53	110.90	+135.47	+1345.28
Nypafruticans/Sparse Vegetation	77.79	450.70	109.08	114.76	+186.87	+1082.68

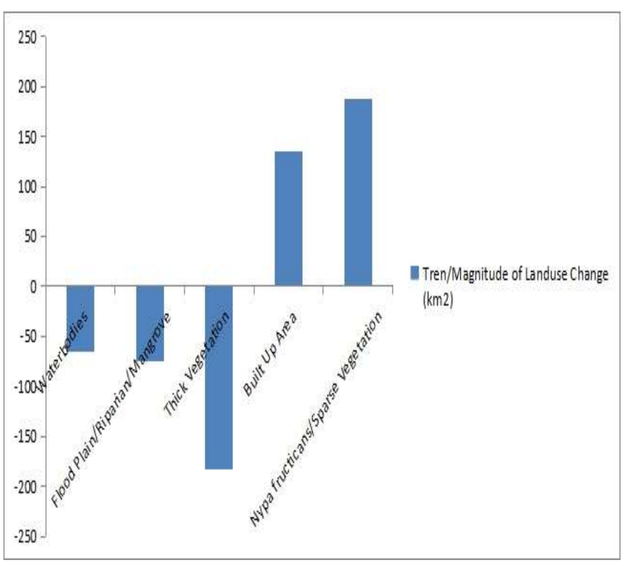

Figure 5: Trend and magnitude of land use Change between 1986 and 2019 in the study area

IV. DISCUSSION OF FINDINGS

Findings showed that water bodies, mangrove and thick vegetation continued to reduce from 1986 to 2019. Meanwhile, the *Nypafruticans*/sparse vegetation and built up area increased in spatial extent. The *Nypafruticans* has increased because of the nature of the survival in the mangrove environment. The decrease in the mangrove may be as a result of environmental competition which is inevitable due to the growth of *Nypafruticans*. The increase in the built up area is in consonance with the findings of Jat*et al*. (2008) and Mundia and Aniya (2006) whose studies revealed that the rapid changes of landuse/landcover particularly in developing nations, are often characterized by rampant urban sprawling, land degradation by agricultural development and tourism industry. Furthermore, Obiefuna*et al.* (2013) revealed that the obvious consequence of the population expansion on natural resources in a coastal terrain included water bodies and mangrove. However, rapid urbanization is known to generate negative impacts on the environment as it leads to changes in landscape patterns, ecosystem functions and the capacity to perform functions in support of human populations (UN-Habitat, 2010).

The increase in the built up area is also similar to Zubair (2006) and Bankole and Bakare (2011) whereby it was stated that expansion of human settlements and its accompanying activities, especially the rapid urbanization occurring in the developing countries, play an important role in global land use and cover change, causing changes in the ecological processes at both local and global scales. Suleiman et al, (2014) reported that the continuous increase in built up areas is due to increase in the inflow of population that places heavy demand on the environment and thus leading to great increase in the size of the settlement in both the city center and the suburbs. Globally, land cover today is altered principally by direct human use such as agriculture and livestock raising, forest harvesting and management, urban and suburban construction and development. Incidental impacts on land cover from other human activities on the forest could also be by acid rain from fossil fuel combustion, and oil exploration (Zubair, 2006). According to Arowolo and Deng (2016), in recent decades, human activities have significantly influenced land use/land cover. Also, Ademiluyi*et al*. (2008) reported that land use and landcover change have emerged as a global phenomenon and perhaps the most significant regional anthropogenic disturbance to the environment, especially in the 20th century. It is known that rapid urbanization/industrialization and large scale agriculture and major changes in human activities have been identified as the major causes of the dramatic changes in land cover and land use patterns globally.

V. CONCLUSION AND RECOMMENDATIONS

The study affirmed that the land use and land cover of the study area has changed over the years. While some experienced increase in terms of spatial coverage such as built up areas and *Nypafruticans,* others like thick vegetation, water bodies and mangrove experienced reduction in the extent of coverage. The Land Use Act (CAP 202, LFN 2004) places the ownership, management and control of land in each state of the federation in the Governor. Land is therefore allocated with his authority for commercial, agricultural and other purposes.There is equally the Urban and Regional Planning Act (CAP N138, LFN 2004), which is aimed at overseeing a realistic, purposeful planning of the country to avoid overcrowding and poor environmental conditions. It provides in Section 39 (7) that an application for land development would be rejected if such development would harm the environment or constitute a nuisance to the community. While Section 72 also provides for the preservation and planting of trees for environmental conservation. It is thus suggested that there should adequate compliance to these regulatory laws to ensure environmental sustainability in the study area.

Furthermore and based on the findings, the study recommended that the increase in built up area representing urban growth has enormous implication on the ecosystem balance of the study area; thus there is therefore the need to ensure compliance to appropriate enacted laws against forest encroachment and expansion so as to protect the ecosystem; while also carrying out periodic monitoring of the vegetation status in the Stubbs Creek, Akwa Ibom State for sustainable forest resource management in the area. Finally, the changes in land cover highlighted in this study calls for sustainable and proactive management of the biodiversity to mitigate the associated risk of global climate change.

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