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Abstract

The study examines land use and land cover change in Kwale Ndokwa-East Local Government area Delta State, Nigeria between 1975 and 2008 using GIS and remote sensing technique. The satellite data that were employed included LandSat (MSS) 1975, LandSat (TM) 1987, LandSat (ETM+) 2001, downloaded from Global Landcover Resources Website (http:www.glcf.com), while images from NigSat1 2008 were obtained from the National Centre for Remote Sensing, Jos, Plateau state, Nigeria. The software used for the processing and analysis for this study includes ARCGIS 9, ERDAS 8.1 and ILWIS 3.2a. Results of the study revealed that on the average, between 1975 and 2008, bare surfaces decreased to by 93.51

Index terms— land use, change, remote sensing, GIS, kwale, nigeria.

1 Introduction

wale falls within the Niger Delta region of Nigeria. The area is located within latitudes 5º40 1 N and 5º50 1 N and longitudes 6º15 1 E and 6º30 1 E (Figure 1a, b) (Anonymous, 2011 and Avbovbo and Ogbe, 1978). The Niger Delta is located within the southern part of Nigeria. It is home to numerous creeks, rivers and possesses the world's largest wetland with significant biological diversity **??**Twumasi and Merm, 2006). Okpai/Aboh region is within Ndokwa East Local Government Area and is situated within the Sombriero Warri deltaic plain deposit invaded by mangroves. The geographical Niger Delta has been said to cover an estimated area of between 19,100 km 2 to 30,000 km 2 based on hydrological, ecological as well as political boundaries (Keddy, 2010;Ibe, 1988;Merki, 1972 andMurat, 1972). Okpai/Aboh region is a low-lying area with elevation of not more than 3.0 metres above sea level and generally covered by fresh water, swamps, mangrove swamp, lagoonal marshes, tidal channels, beach ridges and sand bars along its aquatic fronts (Dublin-Green et al, 1997). The area has a characteristic tropical monsoon climate at the coast with rainfall peaks in June and September/October with prevailing tropical maritime air mass almost all year round with little seasonal changes in wind directions (Olaniran, 1986). Annual mean total rainfall is about 2,500mm. The mean monthly temperature range from 24-25 o C during the rainy season in August to 27-29 o C during the end of dry season in March/April. Leroux (2001) reported that maximum temperatures are recorded between January and March (33 o C) while minimum temperature are recorded in July and December (21 o C), respectively. Temperatures are moderated by cloud cover and damp air. It experiences a humid tropical equatorial climate consisting of rainy season (April to November) and dry season (December to march). The average annual rainfall is about 2,500mm while the wind speed ranges between 2-5m/s in the dry season to up to 10m/s in the rainy season especially during heavy rainfall and thunderstorms. The region is criss-crossed with distributaries and creeks. This area has been classified geomorphologically as tidal flat and large flood plains lying between mean, low and high tides. Three different highs exist within the Kwale, in Ndokwa-East Local Government block, namely a central high where most of the wells have been drilled, an eastern high housing one well and a north western high whose extent has not been clearly defined. The area lies within the freshwater forested region of the Niger Delta. The coastal areas of the Niger Delta are the home to oil exploration and exploitations in Nigeria (Nwilo and Badejo, 1995). This is largely due to the huge deposits of crude oil and natural gas deposits within the region. The World Bank report of 2002 succinctly stated that Rivers and Delta states alone produced about 75% of Nigeria's petroleum, which represents over 50% of national government's revenues. The report also rated, Nigeria as the fifth largest supplier of crude oil to the United

States (EIA, 2003). Nigeria's proven oil reserves drives the economy because it is almost exclusively dependent on earnings from the oil sector, which generates about 20% of GDP, 95% of foreign exchange and about 65% of budgeting revenues (CIA World fact Book, 2008). No doubt, human activities like oil exploration and production have impacted negatively on the delicate balance of nature and the fragile ecosystems of the study area.

Land use and land cover have become very important parameters in highlighting such environmental changes that have taken place over time within the earth's surface (Matiko et al, 2012). It has become one of the major parameters for environmental change monitoring and natural resource management (Zhang et al, 2008). Thus, Fuchs (1996) aptly stated that land use and land cover and impacts on terrestrial ecosystems including forestry, agriculture, and biodiversity have been identified as high priority issues at global, national, and regional levels. The indirect impact of landuse and land cover is altering climate on the waters (Weng, 2001) while the direct effect could be compromising water quality (Rogers, 1994). Kwale region is not alone with respect to deterioration of its landscape. Woodgate and Black (1988) reported that an estimated 66% of Victoria's native vegetation has been cleared as a result of the growth and economic development of the State. Geographic Information Systems (GIS) Global Positioning System (GPS) and Remote Sensing (RS) have become indispensable tools in almost all environmental endeavors (UN, 1986). These concepts have been employed in various studies including atmospheric studies (Fagbeja, 2008), lithospheric (Maruo et al, 2002), hydrologic (Nwilo and Badejo, 1995) biodiversity (Salami and Balogun, 2006), assessment of developmental change over time **??**Twumasi and Merem, 2006), land use and land cover categories (Ehlers et al., 1990; Treitz et al., 1992) as well as ground water (Maruo et al, 2002). Kwale region's landscape had undergone environmental changes over a long period of time as a result of oil exploitation in the area. This environmental change, therefore, has necessitated the need to carry out a holistic approach to land use and land cover inventory of the area with a focus of establishing the geospatial infrastructure for policy makers as well as for proper planning and management of the environmental conditions of the region.

2 II.

3 Methodology

The types of data acquired for this study are shown in Table 1. They were sourced from global Land cover resources website (http:www.glcf.com), while the image from the Nigsat1 2008 was obtained from the

4 Data Extraction Process

Following the acquisition of the required satellite images from their respective sources for the aforementioned years, the extraction of the study area portion from the entire image covering the entire South Western /South Southern corner of the country was done using ArcGIS. The georeferencing of the satellite data as well as the subset operation using ILWIS 3.3 Academy software was performed.

IV.

5 Digital Image Processing and Analysis

The stage of analysis include a reconnaissance field survey (ground truthing) with GPS to obtain coordinates of each location; the 1975 topographic sheet (1: 25,000) covering the entire region was used to aid in identifying notable spatial features of the area. This process proved very useful in unraveling, demystifying and harmonizing the disparity between what was observed on ground and their respective spectral signatures displayed in the images. In this regard however, it was observed that both bare surfaces and settlements exhibited somewhat similar spectral characteristics as both randomly did have a mix of cyan and white color, which are the standard color representations for both settlements and bare surfaces.

The procedure developed for the sample dataset of the submap was carried out based on the supervised classification techniques using the eight (8) land use/cover classes (features) of the area as indicated in Table 2. Furthermore, the maximum likelihood method of classification (MLC) in the ILWIS 3.3 Academic software was adopted for the classification. The maximum likelihood method is a statistical decision rule that examines the probability function of a pixel for each of the classes, and assigns the pixel to the class with the highest probability. The classifier assumes that the training statistics (sample sets) for each class have a normal or 'Gaussian' distribution. The classifier then uses the training statistics to compute a probability of whether of a pixel belonging a particular land cover. This allows for within-class spectral variance. MLC usually provides the highest classification accuracies. Accordingly, it has a high computational requirement because of the large number of calculations needed to classify each pixel (Natural Resources Canada, 2005).

Three softwares were used to analyse the spatial data. ARCGIS was used for curve fitting processing while ERDAS Imagine was used for land use land cover classification, evaluating the quality of input data and ensuring that thematic maps were accurately classified. Finally, ILWIS (Integrated Land and Water Information System) was very useful in combining raster (image analysis), vectors and thematic data operations in one comprehensive phase.

V.

6 Results and Discussion

Table 3 shows that bare surfaces rose astronomically from 35,395 km^2 in 1975 to 154,630 km^2 in 1987 representing an area change of 119,235 km^2 (336.87%). This could be due to the establishment of the Agip Gas Plant. which started operation within the area in 1975 (NAOC, 2007). Oil exploration and production activities abound in the region (Oboli, 1978). From 1975 to 1987 oil exploration and exploitation activities were at their peak.

Close observation reveals that areas covered by thick oil sleeks after oil spillage, do become bare with time (Fabiyi, 2008). This could be responsible for huge leap of bare surfaces from the 1975 and 1987. In 2001, there was a significant decrease in land area to 61,374 km^2, accounting for 25,979 km^2 (73.40%) area change. By 2008, there was a further significant decrease to 2,296 km representing -33,099 km^2 (-93.51%) area change. This gross reduction from the 1987 estimates to those of the 2001 and 2008 could be as a result of the frantic efforts of prospecting oil and gas companies at carrying out environmental remediation and mitigation mainly through phytoremediation within the study area. This showed that bare surfaces are losing their space to marshlands, cultivated lands shrub lands and water bodies (Figure 2).

The area had a forest reserve that was recognized by the Federal Government of Nigeria as far back as 1975 (Mensah and Amukali, 2000; Ekine and Iyabe, 2009). Also, the Green Revolution of Field observations revealed that the study area is exposed to massive deposition of organic agents like silt, clay, debris and a host of other decomposable materials as supported by (GGFRI, 2009 andAllen, 1972). Thus, the increase in marshlands area prior to 1987, but when oil related activities increased within this area, after the 1980's, easy formation, transportation and deposition of marshlands became affected and this could be

7 Conclusion

The delicate balance of nature and fragile ecosystem of the Kwale in Ndokwa-East Local Government area has been altered by natural and human factors over time. This study was able to model the long term land use and land cover changes between 1975 when the area was still free of exploration and exploitation activities to 2008 when oil-related activities reached their peak and provide analysis of LUCC information in the area which helped in showing significant trends. The results of this study showed that between 1975 and 2008, bare surfaces decreased by 33,099 km^2 representing 93.51%, forest vegetation to 14,054 km^2 amounting to 30.98%, settlement to 5,654 km^2 which is equivalent to 25.61% and woodlands 133,377 km^2 representing 37.19%. Furthermore, scattered cultivation, scrublands and water bodies correspondingly increased by 68,294 km^2 (54.45%), 77,603 km^2 (124.42%), 6,322 km^2 (3.21) and 31,274 km^2 (319.91%), respectively. This indicate that bare surfaces, forest vegetation, settlements and woodlands were gradually being replaced by marshlands, scattered cultivation, shrublands as well as water bodies. This study therefore, recommends the reclaiming of the areas occupied by bare surfaces and marshlands to agricultural activities to reduce poverty and improved food security in the region.

VII. [1]

[1] Assessment of Land use and Land Cover Change in Kwale, Ndokwa-East Local Government Area, Delta State, Nigeria

1a

Figure 1: Figure 1a :


MAP OFNIGERIA SHOWING DELTA STATE
Legend
DELTA STATE BOUNDARY
Nigerian State Boundary

Figure 2:

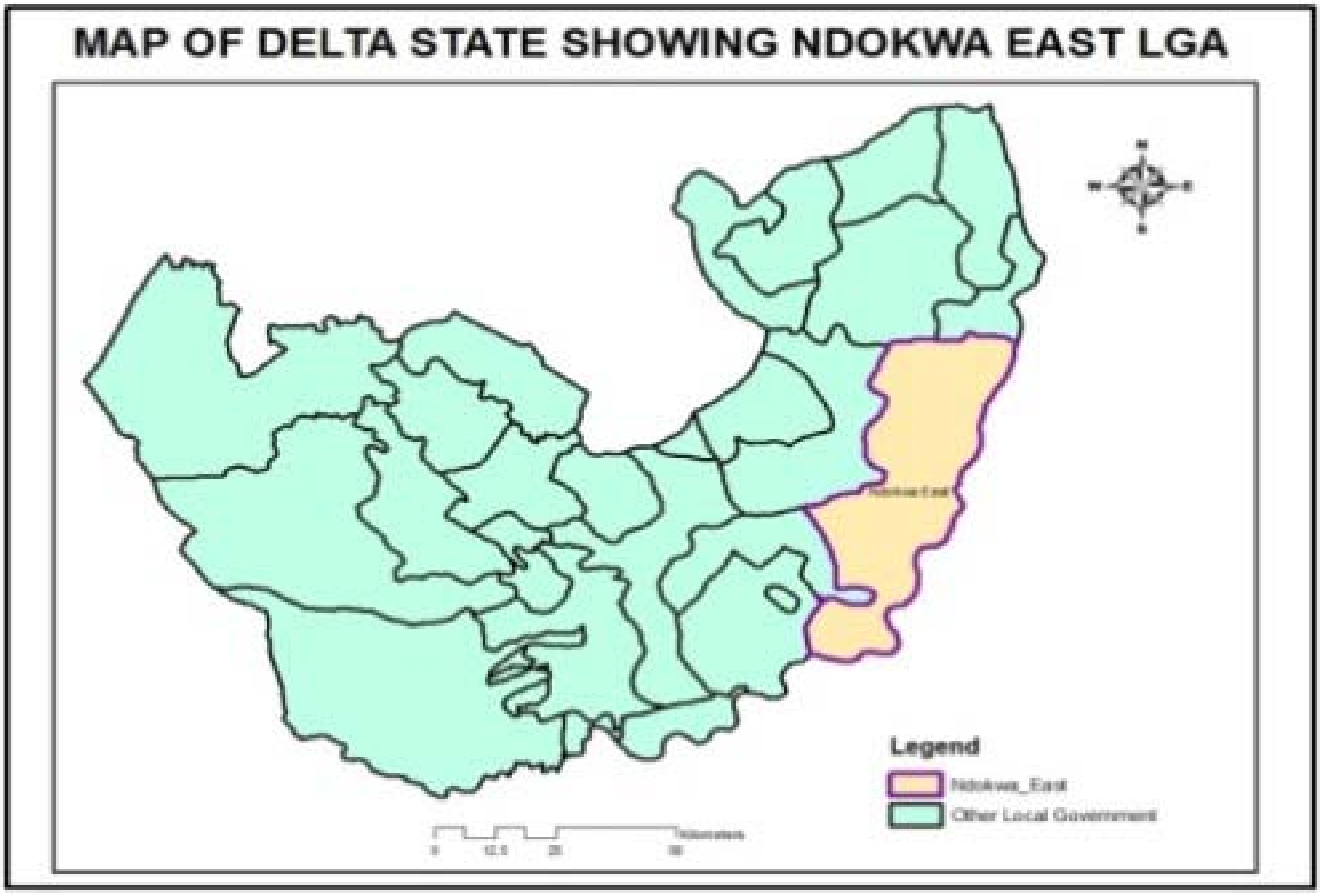
MAP OF DELTA STATE SHOWING NDOKWA EAST LGA
Legend
Ndokwa_East
Other Local Government

Figure 3:

2

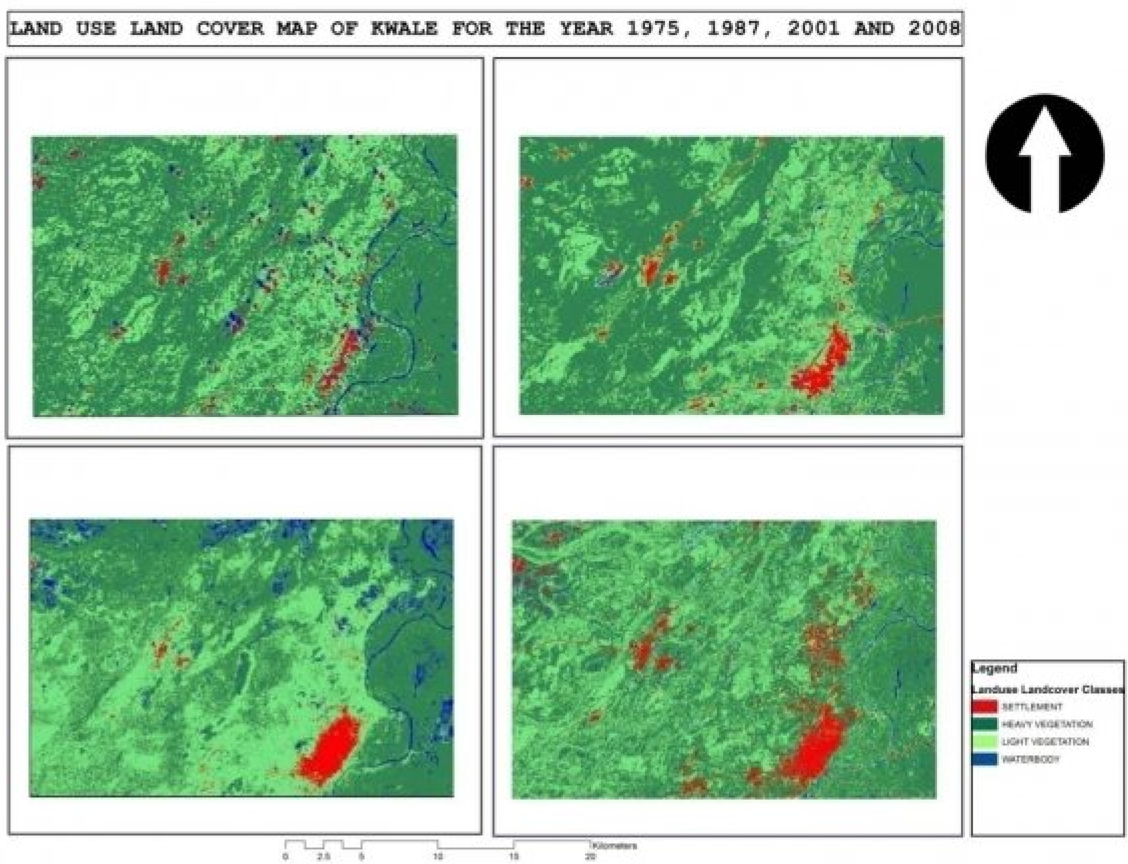

Figure 4: Figure 2 :

1

S/No	Satellite imagery	Year	Resolution
1	Landsat MSS	1975	60m
2	Landsat TM	1987	28.5m
3	Landsat_ETM	2001	28.5m
4	Nigsat 1	2008	28.5m
III.			

Figure 5: Table 1 :

2

	the Study Area
Code	Class
1.	Bare Surface
2.	Forest Vegetation
3.	Marshland
4.	Cultivated land
5.	Settlement
6.	Shrubland
7.	Water Body
8.	Woodland

Sources : Adapted from Dami (2003)

Figure 6: Table 2 :

3

Main Landuse/ Cover Class	1975
Bare Surface (km²)	35,395
Forest Vegetation (km²)	45,363
Marshland (km²)	125,431
Scattered Cultivation(km²)	62,374
Settlement (km²)	22,074
Shrubland (km²)	196,724
Water Body (km²)	9,776
Woodland (km²)	355,979

responsible for the decrease in marshlands noticed in 2001 while the further increase in the 2008 value could be attributed to factors like lumbering and farming as well as those factors that earlier favored increases. Mensah and Amukali (2000) described the rural communities in the area as rural subsistence farmers. In 1975, scattered cultivated areas were estimated at 62,374 km^2 which slightly decreased to 61,916 km^2 representing area change of -458 km^2 (-0.73%) in 1987. In 2001, there was a massive increase to 88,156 km^2 representing area change of 25,782 km^2 (41.34%) and this continued till 2008 where an increase of 139,977 km^2 representing area change of 77,603 km^2 (124.42%) occurred.. The slight decline of scattered cultivated areas from 1975 to 1987 must have been influenced by farmers giving up farming to taken in juicy jobs in the oil industry. Settlement areas decreased from 22,074 km^2 in 1975 to 17,437 km^2 representing area change of -4,637 km^2 (-21.01%) in 1987 and later to 13,375 km^2 representing area change of -8,699 km^2 (-39.41%) in 2001. However, by 2008 the areas covered by settlements were shown to be 16,420 km^2 representing area change of -5,654 km^2 (25.61%), respectively. As shown from the interpreted satellite images (Figure 2), settlements were initially seen to be scattered but in 2008, the settlements became more concentrated within specific geographical regions. This trend could be explained by the recent resettlement of some communities within the study area to pave way for more oil exploration and exploitation. Shrub lands decreased from 196,724 km^2 in 1975 to 79,998 km^2 representin
for the increase noticed from 1987 to 2001. It could also be due to decreased activities of oil prospecting and production companies within the area owing to the activities of militants, increased agricultural cultivation

Figure 7: Table 3 :

.1 Acknowledgement

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