Quantifying Land use/cover change of Oredo, Egor, Ikpoba-Okha LGA, Benin City, Edo State, Nigeria from 1987-2013

Dirisu Dolo Kelvin, Frimpong Emmanuel Osei, Eguaroje Onoshi Ezekiel, Alaga Abayomi Taofik

Abstract - With the phenomenal increasing population globally and in particular Nigeria, it is very important to be aware of the limited resources that are available to the huge number of people. The size of land remains unchanged (devoid of a catastrophe) but to put the land in good use to be sustainable, it is crucial to know the various land cover and land uses of an area to be able to plan how future developments would be executed. This information notwithstanding is not readily available to authorities to help plan the area. It is for this reason that this work was carried out to provide this gab in knowledge on the LULC of the Oredo, Egor, Ikpoba-Okha local government areas (LGA) which are forms the main growing areas of Benin City of Edo State in Nigeria. Changes in the LCLU between the period of 1987 and 2013 in the study area were considered and how the lands uses changed during that period, using geospatial techniques. Satellites images of the area in 1987 and 2013 from the Landsat achieve were used for this work. The figures showed that while forest and water body in the study area decreased at an average of 13.69 Km2 (2.12%) and 0.123 Km2 (1.85%) annually respectively the other land uses increased over the same period – Agricland = 1.409 Km2 at 0.81% annually, Grass = 4.980 Km2 at 2.40% annually, Settlement = 5.421 Km2 at 4.86% annually and wetland = 1.89 Km2 at 2.73% annually. Thus the increasing population of the area has shifted the land use from the natural use as forest and water body to the artificial use as buildings for bot accommodation and commercial as well as farmlands to feed the growing numbers.

Index Terms - Land cover Land use, Geospatial technique, Satellite image, Landsat.

1 INTRODUCTION

IT is a communal practice that the terms land-cover and land-use (LULC) are often used in place of the other. They are however, different. Land-cover refers to the surface cover on the ground, whether vegetation, urban infrastructure, water, or bare soil. Identifying, delineating and mapping land-cover is important for global monitoring studies, resource management and planning activities [1]. When land-cover of an area is well-known it forms the baseline from which monitoring activities (change detection) can be performed and provides the ground cover information for baseline thematic maps.

On the other hand Land-use refers to the purpose the land serves and this includes purposes such as settlement, recreation, or agriculture etc. Knowing what the land-use in an area requires baseline mapping and subsequent monitoring. This will not only enlighten one on the current use of land but also enable one to know how the land-use is changing with time. It is therefore essential to clearly know this difference between land cover and land use, and the information that can be obtained from each [1].

Most major metropolitan areas face the growing problems of urban sprawl, loss of natural vegetation and open space, and a general decline in the extent and connectivity of wetlands and wildlife habitat and urban growth rates show no signs of slowing, especially when viewed at the global scale, since these problems can be generally attributed to increasing population. Cities have changed from small, isolated population centers to large, interconnected economic, physical, and environmental features. Urban growth and the concentration of people in urban areas are creating societal problems world-wide. One hundred years ago, approximately 15 percent of the world's population was living in urban areas. Today, the percentage is nearly 50 percent. In the last 200 years, world population has increased six times, stressing ecological and social systems. Over that same time period, the urban population has increased 100 times, concentrating more people on less land even as the total land devoted to urbanization expands. Yet the temporal and spatial dimensions of the land use changes that shape urbanization are little known, even in the world over.

The story is no different in the study area. Nigeria is the most populous country in Africa accounting for approximately one sixth of the African population (or one fifth of Sub-Saharan African population). United Nation [2] reported that Nigeria had a population of 37,860 thousand in 1950, which has risen steadily over the years to a staggering number of 182,202 thousand in 2015. This represents 381.3% for the 65 year period averaging 5.8% annually. It is also reported by [3] that approximately 50% of Nigerians are urban dwellers. This means that there is going to be a huge stress on the available

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lands in the country to satisfy both the agricultural and accommodation needs of the urban dwellers and so there is the need for proper administration of lands.

Nigeria has 36 States and Edo is one of the states located in the South South part of the country [4]. Nigerian National Population Commission [4] reports that, the population of Edo state stood at 3,233,366 with Benin City accounting 35.5 (%) per the 2006 population and housing census. Benin City has employing methods as ground surveys, aerial photogrammetry and satellite remote sensing in the past five decades to extensively map LULC. The cost and time-consuming nature of ground surveys and aerial photogrammetry confines them to small areas and low temporal domains [5]. Satellite remote sensing has the advantages of long-term data, wide spatial and synoptic coverage as well as high temporal resolution, making this technique an important technology for mapping LULC and its

2 MATERIALS AND METHODS

2.1 Study Area

Oredo, Egor, and Ikpoba-Okha are local government areas in Benin City Edo state in Nigeria. This area is densely populated than every other area in Benin with a population of about 544,479 and 359.802 km^2 [4]. The geographical co-ordinates of the city limits lie within the Latitudes 6°261 and 6°341 North of Equator and Longitude 5°351 and 5°41 East of Greenwich Meridian. Most of the social amenities, including the University of Benin, are located in these areas. This constitutes the driving force for the tremendous increasing population of the area. Apart from other commercial activities, craft work and agriculture are the main occupations of the people of Benin-City. Being a tropical climate area cultivation of crops like maize, yam, cassava, plantain, palm produce, rubber, and cocoa is very suitable. It is no surprise there are numbers of government farms scattered in and around the city [11].

2.2 Materials

Cloud Free Landsat images for the years 1987 and 2013 with path 189 and row 056 containing the study area were downloaded free from the USGS website. According to [10] and [12] Landsat images have high spatial resolution suitable for the USGS Land cover classification system level 1. The analytical tools used were ERDAS Imagine 2014 and ENVI 5.0 for the image processing including pre-processing, image classification and accuracy assessment. The output of these computer programs was then put in ArcGIS 10.2.2 to generate output (thematic) maps and also used to carry out all the GIS analysis that was done. The statistics from the thematic maps were extracted and taken to Microsoft excel for further analyses.

2.3 Method

Fig. 2 below is a flow chart summarizing the methodologies that were used during the execution of this research work.

seven (7) Local Government Areas (LGAs) with three being the most populated. These are Oredo (374,515), Egor (340,287) and Ikpoba-Okha (372,080). For this reason of the high population in these LGAs in Benin City, this work will quantify the various land use and land cover in the area for effective planning.

There has been attempts by scientist to improve on their knowledge of the world in this direction over the years changes for the past three decades after the launch of the Landsat group of satellites [1].

Remote sensing methods of mapping LULC change include multi- data composites, change vector, image algebra image differencing, image ratio), on-screen digitization, GIS overlay and post-classification comparison [6]; [7]; [8]; [9]; [10].

Therefore, this study will adopt remote sensing as a tool for quantifying the LULC change in the study area.

Figure 1. Study Area for the work

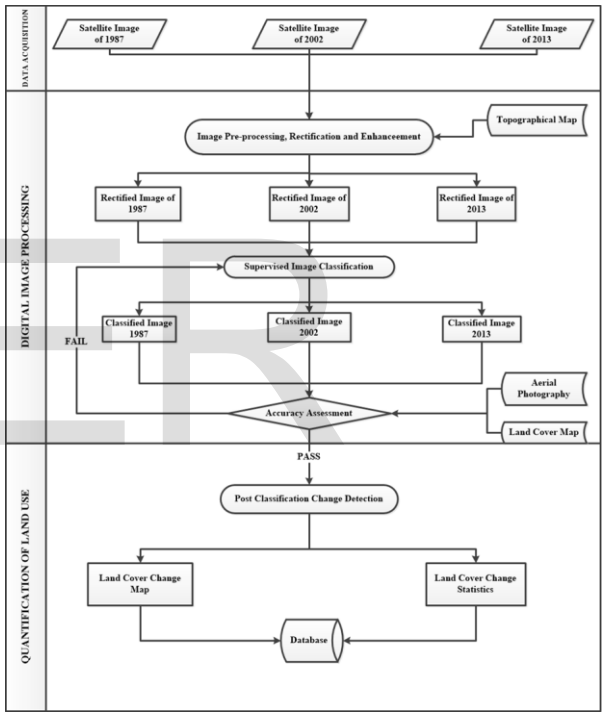

Figure 2. Flowchart summarizing the various methodologies and processes that were used to execute this work.

3 RESULTS & DISCUSSION

The three main land cover classes, which is sub divided into six, used in this study is based on the Anderson Classification System [13] are shown in

TABLE 1.

TABLE 1
Description of the land cover classification system used in the study

Main Cover Class	Sub Cover Class	Description
URBAN	Urban/Built- up	This comprises of areas of intensive use with much of the land covered by structures. Included in this category are cities, towns, villages, highways and transportation, power, and communications facilities.
WATER	Water and Wetland	This consists of areas persistently covered with water; provided that if linear they are at least 200m wide. This category includes; streams and canals, lakes, reservoirs, bays and Estuaries
NON-URBAN	Barren land	Barren Land is land of limited ability to support life and in which less than one-third of the area has vegetation or other cover.
	Agricultural land	Agricultural Land may be defined broadly as land used primarily for production of food and fiber. This category includes; Cropland and Pasture, Ornamental Horticultural Areas.
	Forestland	Forest Lands have a tree-crown areal density (crown closure percentage) of 10% or more, are stocked with trees capable of producing timber or other wood products, and exert an influence on the climate or water regime. Forestlands include Deciduous, Evergreen and Mixed Forestlands.

The results of the supervised classification produced the thematic maps in Figures 3 and 4 with the accompanying statistics in Table

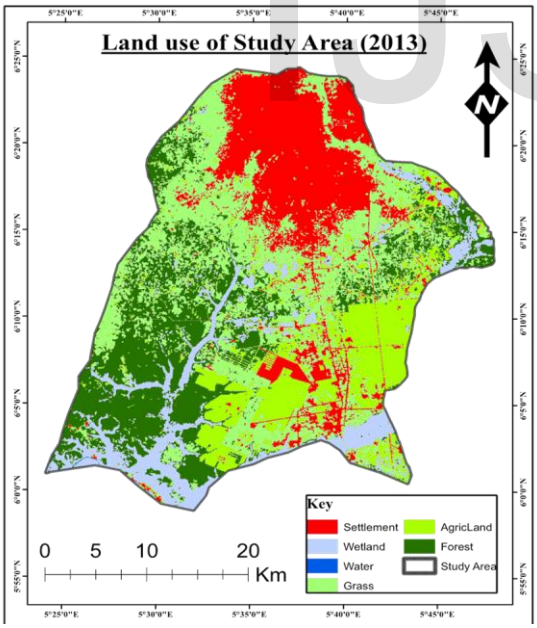

Figure 3. . Land Cover Land Use map of the study area in 2013 generated from ENVI 5.0 supervised classification and ArcGIS 10.2.2

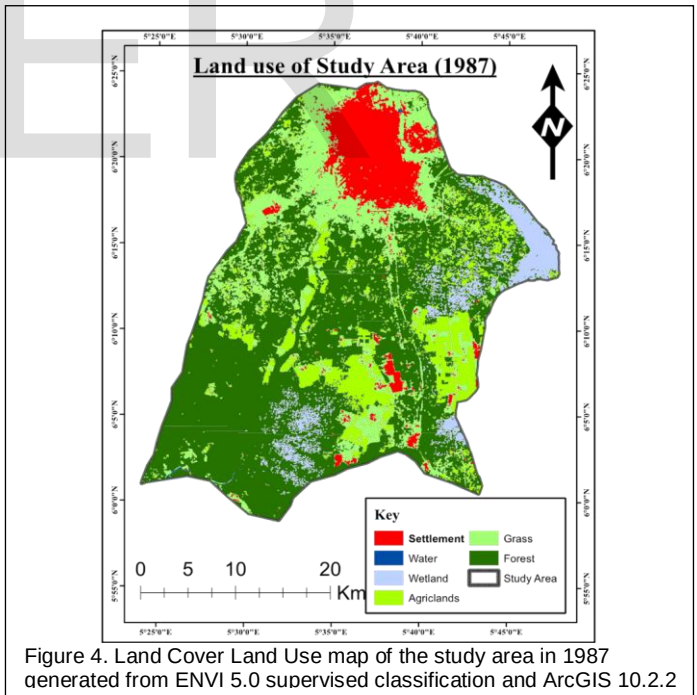

Figure 4. Land Cover Land Use map of the study area in 1987 generated from ENVI 5.0 supervised classification and ArcGIS 10.2.2

Very significant among the figures in the table 2 is the forest cover. While in 1987 there was a total of 646.4363 Km^2 of forest cover representing more than half (53.45%) of the total land cover of the study area, it has dwindled to as low as 290.5646 Km^2 (24.03%). That is a decrease of 355.8717 Km2 representing 55.05% of the forest cover. From both the table and figure below it is observed that all the other land uses (except for water which decreased as indicated in the figure) increased. This makes sense in that the population kept increasing from 1987 to 2013 and so to sustained life, forest had to give way to other uses as agriculture and for other

buildings for both accommodation and commerce. It is hence not much of a surprise to the cover area of forest halved when the settlements and Agriclands moved from 111.5278 Km^2 (9.22%) and 173.1536 Km2 (14.32%) respectively in 1987 to 252.4694 Km^2 (20.88%) and 209.7762 Km^2 (17.35%) respectively in 2013.

TABLE 2
Land cover statistics for the study period (1987-2013).

	1987		2013	
Feature	Area (Km^2)	Cover	Area (Km^2)	Cover
Agric land	173.1536	14.32%	209.7762	17.35%
Forest	646.4363	53.45%	290.5646	24.03%
Grass	208.2027	17.22%	337.6845	27.92%
Settlement	111.5278	9.22%	252.4694	20.88%
Water	0.6638	0.05%	0.3450	0.03%
Wetland	69.3335	5.73%	118.4779	9.80%
Total	1209.3177	100.00%	1209.3177	100.00%

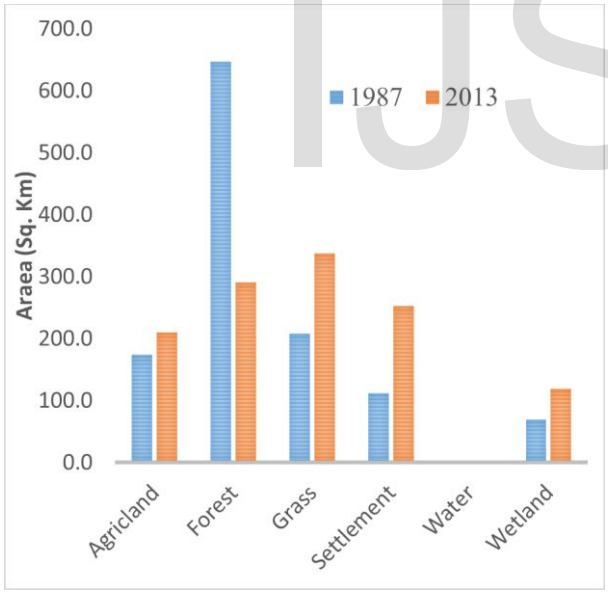

Figure 5. Distribution of the various land features in the study area for the years 1987 and 2013

4 CONCLUSION

The various LULC of Oredo, Egor, Ikpoba-Okha LGA of Benin City in the Edo State of Nigeria was investigated using two period in a time series analysis – 1987 and 2013. The results and analyses revealed the following during the period under study:

1. There was an annual decrease of 13.69 Km^2 of the forest cover representing 2.12%.
2. Water body in the study area also decreased at an average of 0.123 Km^2 constituting 1.85% annually.
3. At an annual average rate of 0.81% which is equivalent to 1.409 Km^2, Agricland increased.
4. Grass grew at 4.980 Km^2 (2.40%) annual
5. Settlement figures which are indicative of the need for the exponential rising number of population showed the highest increase. With an increasing rate of 5.421 Km^2 per annum, it represented a whopping 4.86%.
6. Wetland on the other hand grew at 1.89 Km^2 at 2.73% annually.

From the above observations, two main driving forces were identified as the causes for these trends. The first is the population boom. The exponential increase in the population has caused for the use of the lands to support and sustain life. Hence the increase in the use of the land for buildings and for agricultural purposes. Thus building of structures and growing of food has replaced the natural forest of the area. Secondly, Urbanization is the other main factor responsible for the changing land use of the area. Huge structures that come with metropolitan cities have sprung up in the area forcing the forest line backward. These two factors have significantly caused the area to change drastically in 2013 as compared to the situation in 1987.

REFERENCES

[1] Canada Centre for Remote Sensing, Fundamentals of Remote Sensing, Natura Resources Canada, 2004, pp. 215-218.

[2] United Nations, "World Population Prospects," 2015.

[3] Wikipedia, "Demorgarphics of Nigeria," July 2009. [Online]. Available: https://en.wikipedia.org/wiki/Demographics_of_Nigeria#cite_note-9. [Accessed 10 September 2015].

[4] Nigerian National Population Commission, "2006 Population and Housing Census," Abuja, 2010.

[5] E. Stemn, "Assessment of urban expansion and its effect on surface temperature in the Sekondi-Takoradi Metropolis of Ghana - A remote sensing and GIS approach," 2013.

[6] A. O. Zubair, "Change Detection in Land Use and Land Cover Using Remote Sensing Data and GIS: A case study of Ilorin and its environs in Kwara," Ibadan, Nigeria, 2006.

[7] E. Coppin, I. Jonckheere, K. Nackaerts and B. Muys, "Digital Change Detection Methods in Ecosystem Monitoring: A review," *International Journal of Remote Sensing,* vol. 25, no. 9, pp. 1565-1596, 2004.

[8] D. Lu, P. Mausel, E. Brundizio and E. Moran, "Change Detection Technique," *International Journal of Remote Sensing,* vol. 25, no. 12, pp. 2365-2407, 2004.

[9] R. S. Lunetta and C. D. Elvidge, "Remote Sensing Change Detection," *Environmental Monitoring Methods and Application,* 1999.

[10] J. B. Campell, "Introduction to Remote Sensing," 2002.

[11] Nurhi, 2013.

[12] J. R. Jensen, "Remote Sensing of the Environment: an Earth Resource Perspective," 2000.

[13] J. R. Anderson, E. H. Ernest, J. T. Roach and R. E. Wutmar, "Land Use and Land Cover Classification System for Use with Remote Sensing Data," 1976.