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Analysis of Landcover and Landuse Dynamics in Oshimili South, L.G.A Nigeria, Using Remote Sensing and GIS

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Abstract:
This study examines the use of Remote Sensing and GIS in analysis of landcover/landuse dynamics in Oshimili South L.G.A, Delta State Nigeria, between 1985 and 2015. Thus the study is to carry out a multi-temporal analysis of landcover / landuse changes, thereby detecting the changes that have taken place between 1985 and 2015. Three Landsat images; Landsat 5TM (1985 and 1995), Landsat 7ETM+ (2005) and Landsat 8OLI (2015) were acquired, classified and trend analysis was performed to determine the multi-temporal landcover/landuse changes between the years. The results indicated that built up area had an annual growth rate of 1.07% between 1985 and 1995, it reduced from 1.07% to 0.15% between 1995 and 2005, and then increased at the rate of 0.49% between 2005 and 2015. Vegetation decreased significantly at an annual growth rate of -0.28% between 1985 and 1995, then -0.08% between 1995 and 2005, and then -0.34% between 2005 and 2015. Water bodies also increased at an annual growth rate of -1.05% between 1985 and 1995, then increased to an annual growth rate of 0.09% between 1995 and 2005, and then continued through, at the rate of 0.64% between 2005 and 2015. The results from this study can serve as a base for decision making and planning for urban planning and regional developments in Oshimili South L.G.A.

Keywords: Geographic Information System, Landcover/Landuse, Remote Sensing, Trend Analysis

1. INTRODUCTION

Due to anthropogenic activities, the earth's surface is being significantly altered in some manner and man's presence on the earth and his use of land has had a profound effect upon the natural environment thus resulting into an accelerated growth landuse change and expansion (Zubair, 2008). Data on land use/land cover changes may not be easily obtained except with relevant remote sensing technologies and techniques (Ukor et al, 2016). Remote sensing data are especially important in the areas of rapid land use changes where the updating of information is tedious and time-consuming. The monitoring of urban development is mainly to find out the type, amount, and location of land conversion that has occurred (Yeh and Li, 1999b). Land cover change is determined by the interaction in space and time between biophysical and human influences. Urbanization is a rapid land cover change process that produces different patterns depending on the proximity to large urban centres across the landscape (Wu, 2004). Remote sensing and Geographical Information Systems are powerful tools to derive accurate and timely information on the spatial distribution of landcover/landuse changes over large areas. GIS provides a flexible environment for collecting, storing, displaying and analyzing digital data necessary for change detection (Ukor et al, 2016). With a wide range of techniques used for land use change detection, it's only a matter of choosing the right technique based on the available data. According to Lin et al. (2007), composition, configuration and connectivity are primary descriptions of landscape or land-use pattern, when land use change resulting in land use/ cover pattern changes is being assessed. Nowadays decision makers are becoming more and more dependent on models of land use/cover change (Veldkamp & Verburg, 2004). Description and modeling of land systems is highly dependent on the availability and quality data (Tayyebi et al., 2010). The spatial dependency of land cover changes can be analyzed by the integration of remote sensing and GIS techniques. These techniques have an efficient spatial capability to monitor urban expansion in urban areas. Understanding the phenomenon of landuse change and analyses of development trends would help in addressing the needs of the present and future needs of a region. This plays a key role in planning for infrastructure and becomes crucial in regional planning especially when resources are scare (Sudhira et. al., 2000). Therefore the main aim of this study is to analyze the landcover/landuse dynamics in Oshimili South Local Government using Remote Sensing and GIS with a view to providing recommendations for sustainable development and decision making.

2. STUDY AREA

Oshimili South is a Local Government Area of Delta State, Nigeria. Its headquarters are in the town of Asaba. It has an area of 603 km² and a population of 149,603 at the 2006 census. It is located between latitudes $6^0$4'30" N and $6^0$15'0"N and longitudes 6^0 30'0"E and $6^0$15'0"E

3. METHODOLOGY

For a proper and effective optimization, planning is very important. In this phase of the project, a user requirement analysis was done to focus on what information is presently

being used, who is using it and how the source is being collected, stored and maintained. The necessary information was obtained through interviews, documentations, reviews and workshops. This also involves the hardware and software selections and method to be used.

3.1 Data Requirement

Data used in this research includes;

a. Landsat 5TM, 7 ETM+ and Landsat 8 OLI Imagery covering the study area

b. GPS Co-ordinates of ground control points picked during site visit

c. Administrative map of Delta State showing Local Government boundaries

d. Materials on Oshimili South L.G.A available in Academic journals, conference papers, relevant texts, brochures, internet and statistical files of government offices

3.2 Methods and Techniques

The method used in this study involved image subset, image classification techniques as well as multi-temporal image analysis. Image subset was done on the three multi-temporal sets of images obtained (Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI) in order to cut out the study area from the image set, after which land cover maps of the study area were produced using the supervised maximum likelihood classification algorithm in ERDAS Imagine used by (Onojeghuo and Onojeghuo, 2013). Trend analysis was also performed to determine the trend of change and annual rate of change between the landcover / landuse features in the time period between 1985 and 2015.

4. RESULTS

4.1 Land cover / Land use Distribution of 1985

In mapping landcover/land use, three different classes were identified to include built up area, vegetation and water body. The classified image of Oshimili South L.G.A is shown in figure 4.1

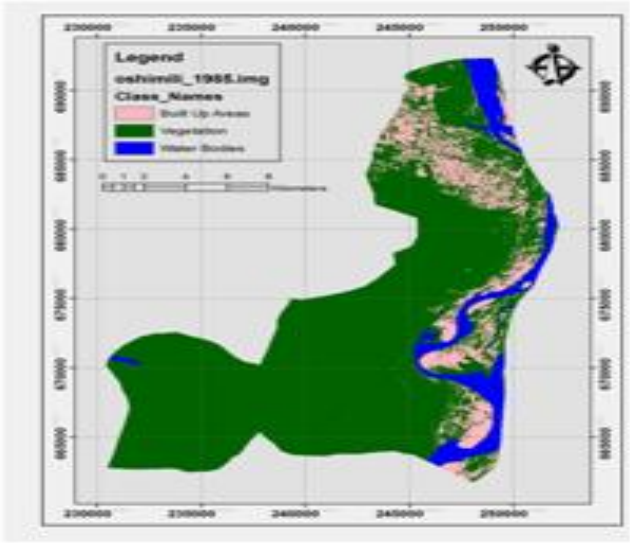

Figure.1. Landcover/Landuse map of Oshimili South L.G.A 1985

The land cover/land use distribution of Oshimili South L.G.A as shown in table 4.1, indicate that built up area, vegetation and water body accounted for about 23.11%, 67.67% and 9.22% respectively, with areas of about 7121.82, 20852.61 and 2841.9 hectares respectively.

Table.1. Landcover / Landuse distribution of Oshimili South L.G.A 1985

Class Type	1985	
	Area (Hectares)	Percentage %
Built Up Areas	7121.82	23.11
Vegetation	20852.61	67.67
Water Bodies	2841.9	9.22
Total	30816.33	100

4.2 Land cover / Land use Distribution of 1995

The landcover/landuse distribution of Oshimili South L.G.A in 1995 as shown in fig 4.2 and table 4.2, indicate that built up area, vegetation and water body accounted for about 28.65%, 63.88% and 7.46% respectively, with areas of about 8829.67, 19685.42 and 2300.24 hectares respectively.

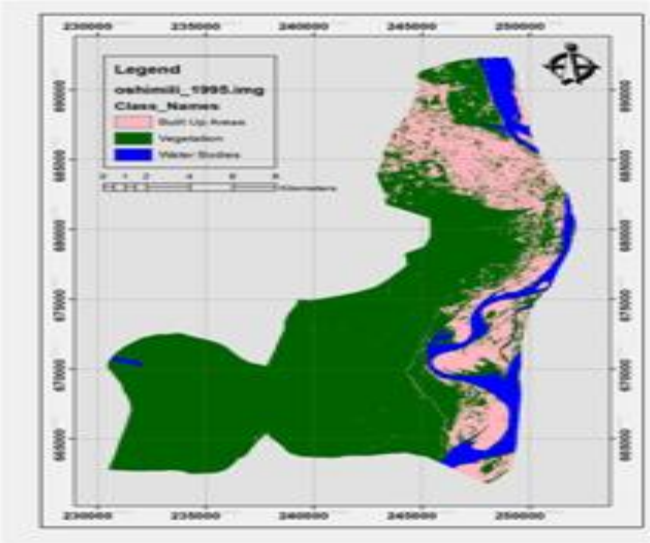

Figure.2. Landcover/Landuse map of Oshimili South L.G.A 1995

Table.2. Landcover / Landuse distribution of Oshimili South L.G.A 1995

Class Type	1995	
	Area (Hectares)	Percentage %
Built Up Areas	8829.67	28.65
Vegetation	19685.42	63.88
Water Bodies	2300.24	7.46
Total	30815.33	100

4.3 Land cover / Land use Distribution of 2005

The landcover/landuse distribution of Oshimili South L.G.A in 2005 as shown in fig 4.3 and table 4.3 indicate that built up area, vegetation and water body accounted for about 29.53%, 62.85% and 7.60% respectively, with areas of about 9101.43, 19370.21 and 2343.69 hectares respectively.

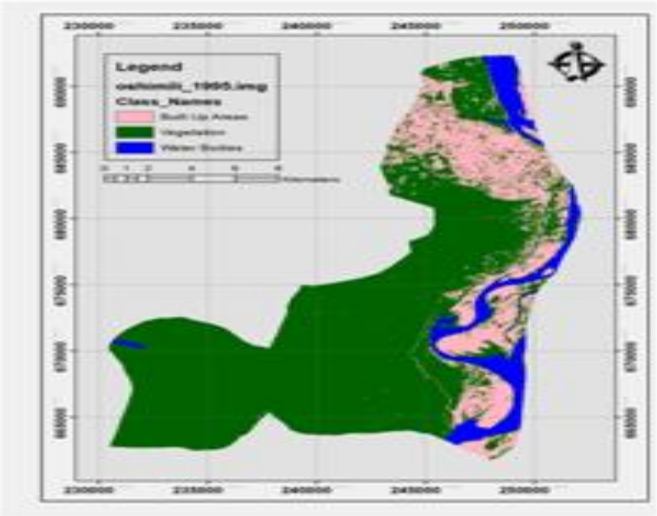

Figure.4.3 Landcover/Landuse map of Oshimili South L.G.A 2005

Table.3. Landcover / Landuse distribution of Oshimili South L.G.A 2005

Class Type	2005	
	Area (Hectares)	Percentage %
Built Up Areas	9101.43	29.53
Vegetation	19370.21	62.85
Water Bodies	2343.69	7.60
Total	30815.33	100

4.4 Land cover / Land use Distribution of 2015

The landcover/landuse distribution of Oshimili South L.G.A in 2015 as shown in fig 4.4 and table 4.4 indicate that built up area, vegetation and water body accounted for about 32.62%, 58.71% and 8.66% respectively, with areas of about 10054, 18092.2 and 2669.13 hectares respectively.

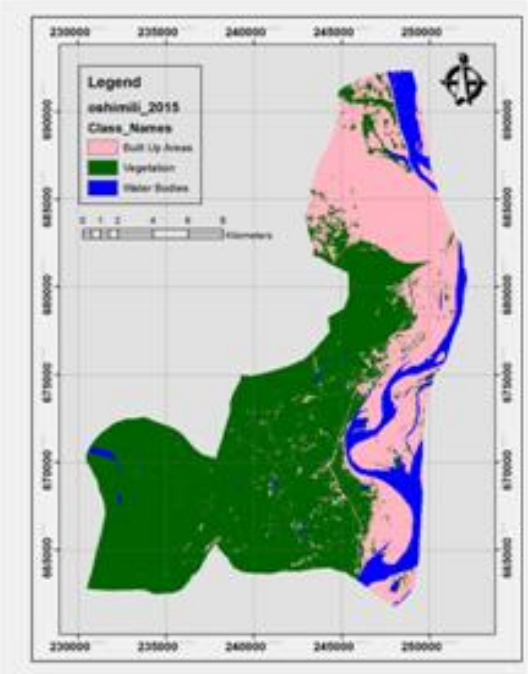

Figure.4.4 Landcover/Landuse map of Oshimili South L.G.A 2015

Table.4. Landcover / Landuse distribution of Oshimili South L.G.A 2015

Class Type	2015	
	Area (Hectares)	Percentage %
Built Up Areas	10054	32.62
Vegetation	18092.2	58.71
Water Bodies	2669.13	8.66
Total	30815.33	100

4.5 Trend Analysis

A method of calculating and comparing the area (meters) of the resulting land cover/land use types of each year used by Long et al. (2007), was adopted for data analysis. The comparison of the land cover/land use statistics will assist in identifying the percentage change, trend and rate of change between 1985 and 2015. In achieving this table was prepared showing the areas and percentage change for each year measured against each other. To determine the rate of change of land cover/land use, the year period 1985-2015 was divided into three sub-periods 1985-1995 and 1995-2005, 2005-2015 and compared against each other. The comparative analysis in land cover/land use change focuses on the three sub-periods and the spatial distribution of the average (annual) rate of land cover/land use change between three periods. Percentage change to determine the trend of change can be calculated by dividing the observed change by the sum of the area of the particular land cover/land use type in that period multiplied by 100

(Trend) % change = Observed change x 100

Total Area

Where Observed change = (Area of before year – Area off after year)

Total Area = Sum of total area of both years

The annual percentage rate = Trend divided by N (number of years).

A trend percentage with a value greater than zero means that the land cover/land use type has increased over the period of years while a value less than zero shows a decrease in the land cover/land use type over a period of time. The results of the trend analysis are presented in table 4.5.

Table .5. Trend Distribution between 1985 and 2015

Class type	Trend of Change (%) 1985-1995	Trend of Change (%) 1995-2005	Trend of Change (%) 2005-2015	Annual Rate (%) 1985-1995	Annual Rate (%) 1995-2005	Annual Rate (%) 2005-2015
Built up Area	10.70	1.51	4.97	1.07	0.15	0.49
Vegetation	-2.87	-0.80	-3.41	-0.28	-0.08	-0.34
Water Body	-10.53	0.93	6.49	-1.05	0.09	0.64

The results indicate that built up area had a trend of change of 10.70% between 1985and 1995, it reduced from 10.70% to 1.51% between 1995 and 2005, then increased at the rate of

4.97% between 2005 and 2015. This is significant as this indicates a trend of urban expansion in the study area from 1985 to 2015. Vegetation decreased significantly at the trend rate of -2.87% between 1985 and 1995, then -0.80% between 1995 and 2005, then -3.41% between 2005 and 2015. This is by far the most significant decrease in the study area, and this loss is attributed to urban expansion and other anthropogenic activities in the study area, this activity gives rise to vegetation encroachment thereby resulting in the decrease of vegetation from 1985 to 2015. Water bodies also increased at a trend rate of -10.53% between 1985 and 1995, then increased to a trend rate of 0.93% between 1995 and 2005, then continued through a trend rate of 6.49% between 2005 and 2015 as shown in figure 4.5.

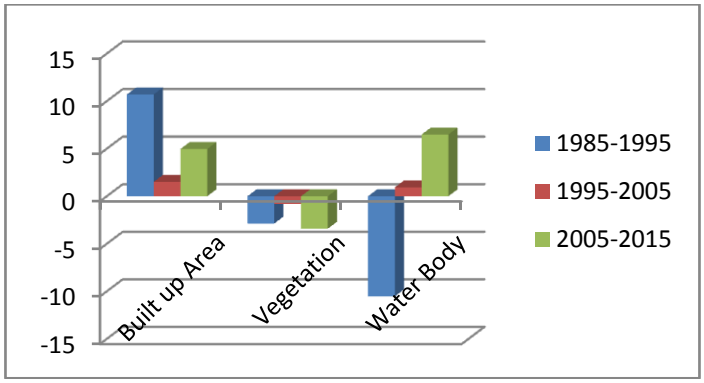

Figure.5. Trend of change between landcover /landuse features from 1985 to 2015

The results indicate that built up area had an annual growth rate of 1.07% between 1985and 1995, it reduced from 1.07% to 0.15% between 1995 and 2005, and then increased at the rate of 0.49% between 2005 and 2015. Vegetation decreased significantly at an annual growth rate of -0.28% between 1985 and 1995, then -0.08% between 1995 and 2005, and then -0.34% between 2005 and 2015. Water bodies also increased at an annual growth rate of -1.05% between 1985 and 1995, then increased to an annual growth rate of 0.09% between 1995 and 2005, and then continued through at the rate of 0.64% between 2005 and 2015 as shown in figure 4.6.

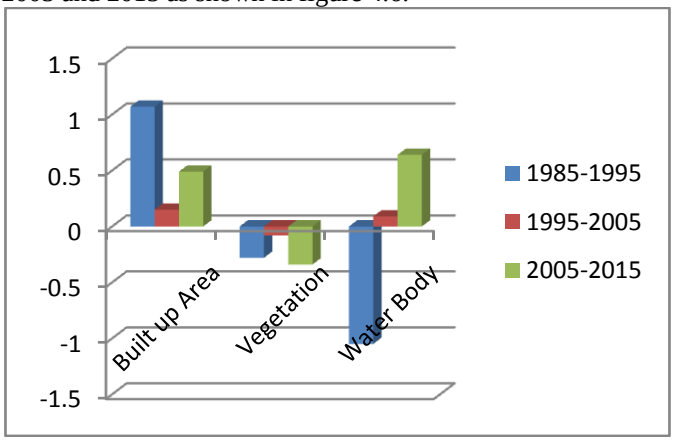

Figure.6. Annual rate of change between landcover / landuse features from 1985 to 2015

5. CONCLUSION

This study demonstrates the ability of Remote Sensing and GIS in capturing spatial-temporal data. Attempt was made to capture as accurate as possible the three land use land cover classes as they change through time. The results indicate that built up area had a trend of change of 10.70% between 1985and 1995, it reduced from 10.70% to 1.51% between 1995 and 2005, and then increased at the rate of 4.97% between 2005 and 2015. This is significant as this indicates a trend of urban expansion in the study area from 1985 to 2015. Vegetation decreased significantly at the trend rate of -2.87% between 1985 and 1995, then -0.80% between 1995 and 2005, then -3.41% between 2005 and 2015. This is by far the most significant decrease in the study area, and this loss is attributed to urban expansion and other anthropogenic activities in the study area, this activity gives rise to vegetation encroachment thereby resulting in the decrease of vegetation from 1985 to 2015. Water bodies also increased at a trend rate of -10.53% between 1985 and 1995, then increased to a trend rate of 0.93% between 1995 and 2005, then continued through a trend rate of 6.49% between 2005 and 2015. The results also indicated that built up area had an annual growth rate of 1.07% between 1985and 1995, it reduced from 1.07% to 0.15% between 1995 and 2005, and then increased at the rate of 0.49% between 2005 and 2015. Vegetation decreased significantly at an annual growth rate of -0.28% between 1985 and 1995, then -0.08% between 1995 and 2005, and then -0.34% between 2005 and 2015. Water bodies also increased at an annual growth rate of -1.05% between 1985 and 1995, then increased to an annual growth rate of 0.09% between 1995 and 2005, and then continued through at the rate of 0.64% between 2005 and 2015. The study therefore recommends that landcover / landuse mapping should be carried out at regular intervals for effective and efficient planning.

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