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Analysis Of Land Use Dynamics Of Awka South L.G.A Using Remote Sensing And Geographic Information System

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Abstract:*This study is aimed at analysing the land use dynamics of Awka South L.G.A using Remote Sensing and GIS approach. The objectives were successfully completed byperforming multi-temporal analysis, deriving pattern and extent of development in Awka South using satellitedata of 1995, 2005 and 2016, and performing trend analysis of the derived development pattern. Using three multi-temporal sets of images (Landsat 5 TM, Landsat 7 ETM and Landsat 8 OLI) of 1995 to 2016, land usemaps of 1995, 2005 and 2016 were producedbyusingthe supervised maximum likelihoodclassification algorithmin ERDASImagine 9.1 and trend analysis was done to determine the trend of change and annual growth rate of landuse in the study area. Results showed that for the past 21 years, 1995-2016, Awka has been undergoing extensive land use change. The built up area in the city has grown from 13,693.85 hectares in 1995 to 16,993.58 hectares in 2005 and to 22,653.83hectares in 2016. The highest rate of urban growth is observed during the second period of urbanization (2005 to 2016) in which the built up area increased more than twice (46.10%) and in the first period of urbanization there was a change of 27.87%. This indicates that a more rapid urbanization has been taking place in the study area during the period of 2005 to 2016 compared to the period of 1995 to 2005. In total, 8959.97 hectares of non-built up land has been converted to urban area. The land use classes in 1995 indicated that Bare Surfaces was 19.78%, Urban Area 27.87%, Water Bodies 12.21% and Vegetation 40.14%. In contrast, from 1995 to 2005 bare surfaces decreased from 19.78% to 15.28%, with built up area increasing from 27.8% to 34.58%, water bodies increased unremarkably from 12.21% to 12.44%, while vegetation decreased slightly from 40.14% to 37.70%.Then from 2005-2016, bare surfaces stood at 10.42%, urban area increased by 11.52% to stand at 46.10%, while water bodies increased to 14.04% vegetation decreased further from 37.7 % to 29.44%.The results from this study can serve as a decision support system on planning and development within the study area.*

Keywords: *Change Detection, Landuse Dynamics, Remote Sensing, GIS, Urbanization*

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I. Introduction

Understanding the phenomenon of landuse dynamics would help in addressing 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 scarce (Sudhira et.al, 2000).

In this context, prior knowledge of patterns of landuse change and its trend would help the development machinery in planning the basic necessities of a region. This requires spatial and statistical data for a different time period. Temporal data acquired remotely (i.e. remote sensing data) for a region along with the historical data of a region (such as population growth patterns, etc.) would help in finding out the patterns and trends of change. Geographic Information System would help in integrating both spatial and statistical data and generate themes based on various growth trends (Sudhira et.al, 2000). According to Barnes et. al., (2001), the process of landuse change is caused by population growth, migration and infrastructureinitiativesresulting inthegrowth and modifications of landuse status.

Theneed forunderstanding landuse change has been stressed(TheRegionalist, 1997; SierraClub,1998) and attempted in the developed countries(Batty*etal.*,1999, TorrensandAlberti,2000;Barnes*etal.*,2001,YehandLi, 2001;Hurd*etal.*,2001;Epstein*etal.*,2002).

The physical expressions and patterns of changes on landscapes can be detected, mapped, and analysed using remote sensing dataand geographical information system(GIS) (Barnes et al., 2001) with image processing and classification.

Awka South has witnessed a remarkable, expansion, growth and development activities such as building constructions, many other anthropogenic activities since inception, just like many other local government areas in Nigeria. Faced with past decades of neglect and bad governance, the shift in human migration has posed problems to available infrastructure, environmental sanitation, erosion control and other

social services. As a result, major cities have become characterized by inadequate and deteriorated road networks, walkways, unregulated building patterns, poor sanitation, uncontrolled street trading, mountains of garbage, and chaotic transport system, creating congestion, noise pollution and overcrowding.

This has therefore resulted in increased land consumption and a modification and alterations in the status of her land use over time, without a detailed and a comprehensive attempt to evaluate the status as it changes over time. It is therefore necessary for a study such as this to be carried out, with a view to detecting the trend of change and annual growth rate of landuse change in the study area, and also make attempt to map the changes that have occurred, so that planners can have a basic tool for planning.

II. Study Area

Awka South is located between latitudes 6°10′ N and 6°15′ N and longitudes 7°2′ 30′ E and 7°7′ 30′ E on the South eastern part of Nigeria. The study area covers 144.5 ha with a 2006 contested population of 116, 208 persons (NPC, 2006). This includes such outlying communities as Amawbia, Okpuno and Amansea which are fastly being annexed to the town by urbanization. Its topography presents a rugged relief as it lies completely on Awka Orlu upland. Generally, the average height ranges from 91 m in the western parts to 160.2m in the eastern zone, although there are local variations within the L.G.A which are drained by a number of streams.

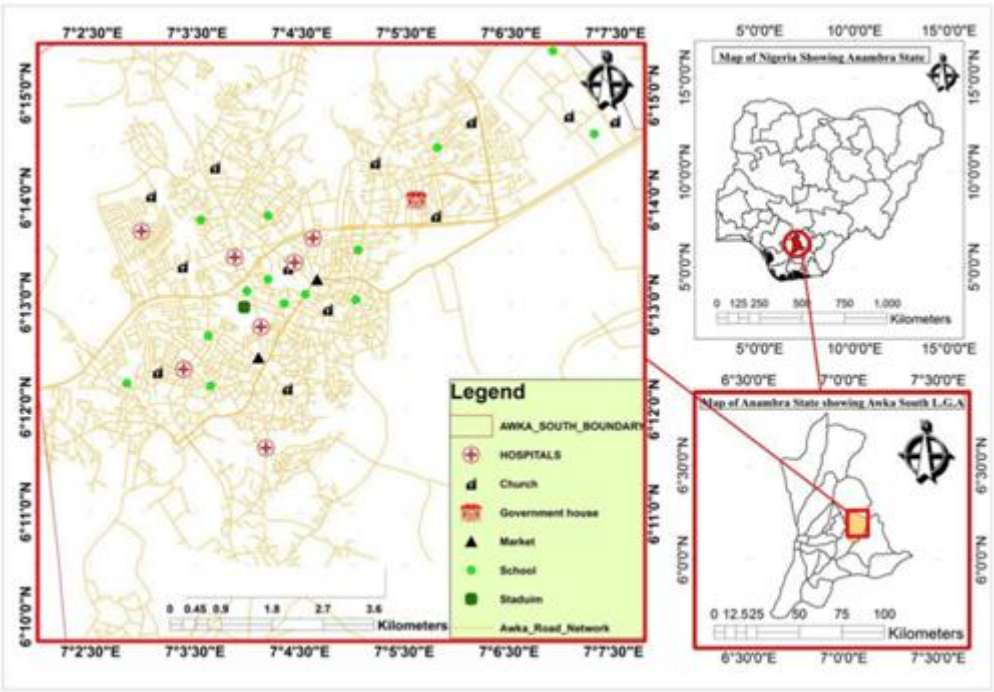

Fig 1: Map of the study Area

III. Methodology

This section details thestepsadopted in the analysing landuse dynamics of Awka South. These include: thedatasourcesandtypes,methodsoffielddata collection,imageclassification technique that was employed and trend analysis used,used to achieve the study objective.

Data Requirement and Sources

The data used to achieve the aim and objectives of this study was classified into primary and secondary data.

The Primary Data

Medium resolution (LandSat5 TM, LandSat7 ETM+, LandSat8 OLI) satellite imagery of the study area for 1995, 2005 and 2016 periods, these were downloaded from www.earthexplorer.usgu.gov

The Secondary Data

I. Thedigital administrativemapsofNigeria and Awka were sourced from the Ministry of Land, Survey and Urban Development, Awka, Anambra state.

Method

Themethodology incorporated inthisstudyinvolvesremotesensingimageclassification, spatio-temporal analysisofthe results gotten from the classified imagery and then trend analysis.First, thethree (3)multi-

temporalsetsofimages obtained(LandSat4 TM , LandSat7 ETM+, LandSat8 OLI)coveringtheentirestudy area were usedtoproducethelandcovermapbyusingthe supervised maximum likelihoodclassification algorithmin ERDASImagine 9.1 (Onojeghuo and Onojeghuo,2006). Spatio-temporal analysis of the development trend was carried out using the results gotten from image classification and Trends analysis by (Long et al, 2007), was used in calculating and comparing the area (hectares) of the resultingland use types of each year. The comparison of the land cover/land use statistics assists in identifying the percentage change, trend and rate of change between 1995 and 2016. In achieving this, a table was prepared showing the areas and percentage change for each year measured against each other. To determine the rate of change of land use change, the year period 1995-2016 was divided into two sub-periods 1995-2005 and 2005-2016 and compared against each other.

IV. Results

This section details the results from the image classification, spatio-temporal analysis of development trend and alsotrendanalysis wasconducted using multi-temporal datasets. Mostofthediscussionsaresupportedbymaps,tablesandillustrativegraphs

Summary of Land use Area for 1995, 2005 and 2016

The classification results indicate the land use classes in 1995 as: Bare Surfaces 19.78%, Urban Area 27.87%, Water Bodies 12.21% and Vegetation 40.14% respectively. In contrast, from 1995 to 2005 bare surfaces decreases from 19.78% to 15.28%, with built up area increasing from 27.8% to 34.58%, water bodies increased unremarkably from 12.21% to 12.44%, while vegetation decreased slightly from 40.14% to 37.70%. Then from 2005-2016,bare surfaces stood at 10.42%, urban area increased by 11.52% to stand at 46.10%, while water bodies increased to 14.04% vegetation decreased further from 37.7 to 29.44%.

Table 4.1 Summary of Land use Area for 1995, 2005, 2016

Class Type	1995		2005		2016	
	Area (Hectares)	Percentage %	Area (Hectares)	Percentage %	Area (Hectares)	Percentage %
Bare Surface	9,719.32	19.78	7,509.20	15.28	5,119.32	10.42
Urban Area	13,693.85	27.87	16,993.58	34.58	22,653.82	46.10
Water Body	6,000.43	12.21	6,111.52	12.44	6,900.46	14.04
Vegetation	19,724.74	40.14	18,524.04	37.70	14,464.74	29.44
Total	49,138.34	100.00	49,138.34	100.00	49,138.34	100.00

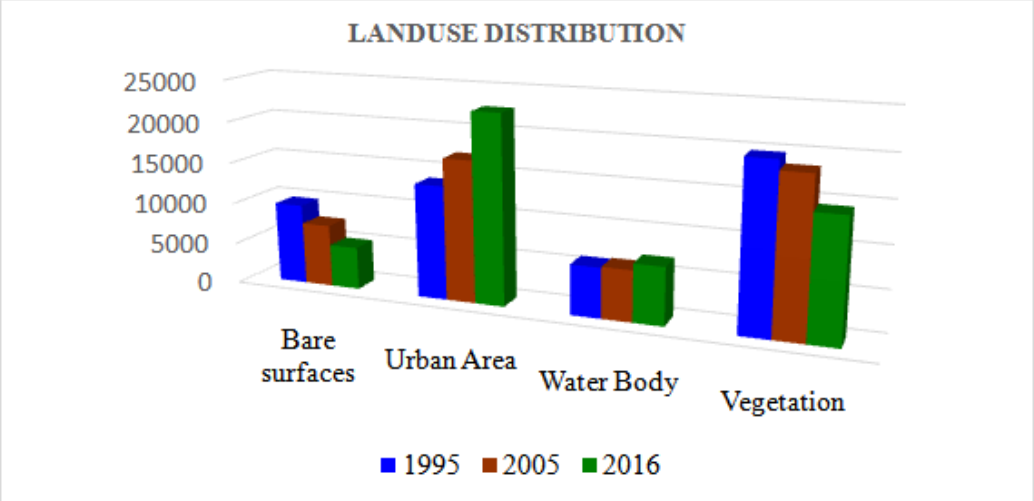

Figure 4.1: Histogram of Landuse summary 1995, 2005 and 2016

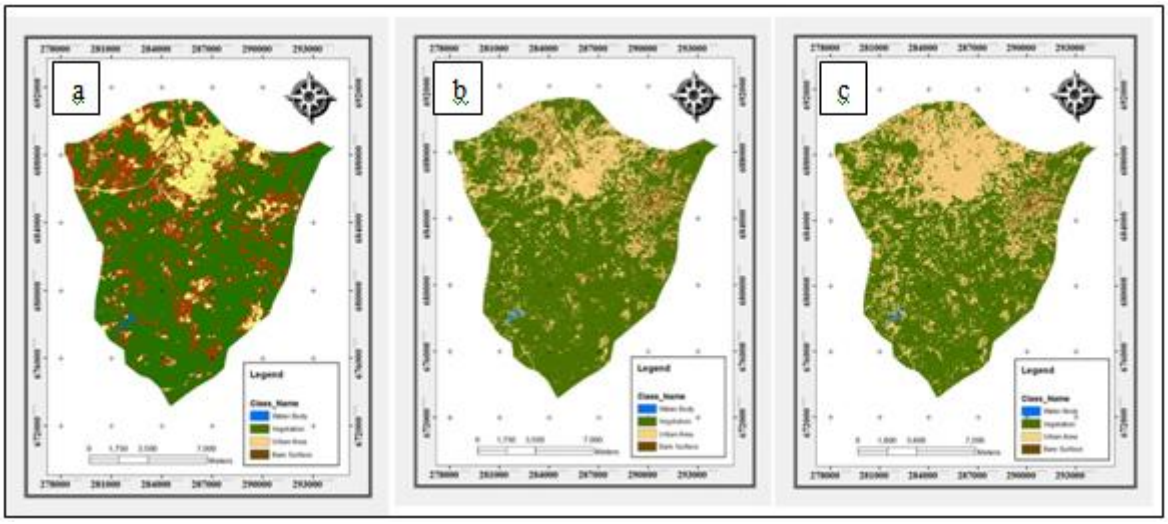

Fig 4.1: (a) Landuse map of Awka South 1995, (b) landuse map of Awka South 2005, (c) Landuse map of Awka South 2016

Trend and Analysis for Land use/land cover

The analysis of trend of change and annual growth rate of the land use classes in the study area as computed is shown in 4.2a and b.

Table 4.2a Trend of change and Annual rate of Land use change 1995-2005

1995-2005				
Class Type	Difference (Hectares)	Total Area (Hectares)	Trend of Change (%)	Annual Rate (%)
Bare Surface	-2,210.12	17,228.52	-12.83	-1.28
Urban Area	3,299.73	30,687.43	10.75	1.08
Water Body	111.09	12,111.95	0.91	0.09
Vegetation	-1,200.7	38,248.78	-3.14	-0.31

Table 4.2b Trend of change and Annual rate of Land use change 2005-2016

2005-2016				
Class Type	Difference (Hectares)	Total Area (Hectares)	Trend of Change (%)	Annual Rate (%)
Bare Surface	-2,389.88	12,628.52	-18.92	-1.89
Urban Area	5,660.24	39,647.4	14.28	1.43
Water Body	788.94	13,011.98	6.06	0.60
Vegetation	-4,059.3	32,988.78	-12.31	-1.23

The results obtained from the four (4) class landuse/land cover, shows that between 1995 and 2005, there was an annual decrease in bare surfaces at the rate -1.28%, and Vegetation at the rate of -0.31 respectively whereas there was an annual increase in Urban areas and Water bodies at the rate of 1.08% and 0.09%.

Between 2005 and 2016 urban areas and Water bodies increased annually by 1.43% and 0.60%, while bare surfaces and Vegetation decreased by -1.89% and –1.23% annually, see figure 4.2 for graphical representation.

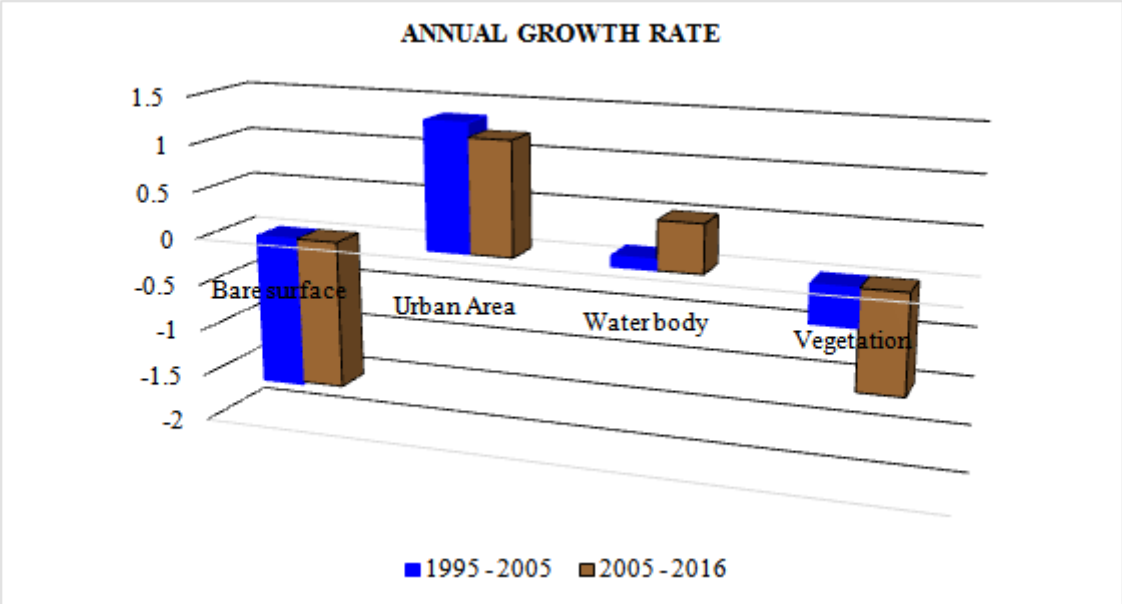

Figure 4.2: Trend Analysis and Annual Growth rate

Multi-TemporalComparismofDevelopment Trend

Theclassification ofthemulti-temporalsatelliteimages into bare surfaces,built-up areas,waterbody and vegetation forthe threedifferenttimeperiodsof1995,2005, and 2016hasresultedinahighly simplified andabstracted representation ofthestudyarea.Thesemapsshowaclearpatternofincreaseddevelopment expansionprolonging from Awka City centre toadjoiningnon-builtupareasalongmajortransportation corridors especially the Enugu - Onitsha express.Themapsshowthemulti-temporal urbangrowthpatterninthestudyarea.Multi-temporal comparismoftheclassifiedimagesrevealedthegrowthpatternofthecityindifferentdirections, the infillingoftheopenspacesbetweenalreadybuilt-upareasandthedynamics ofurbanexpansion inthe studyarea.However, itisimportanttoassistthefindingswithstatisticalevidencesasitisusefulto describe thespatialextentandthis will help tounderstand howthecityischangingovertimeandtocompare thevarious growthpatternstakingplaceindifferenttimeperiodsquantitatively.

Theresultspresentedintable 4.1showsthat thetotalbuilt-upareahasgrownfrom13,693.85 hectaresin1995to16,993.58 hectaresin2005 andto 22,653.82 hectares in2016.Thehighestrateofurbangrowthis observedduringthe secondperiodofurbanization (2003)inwhichthebuiltupareaincreased by14.28%within12 years, and in the first period, there was a change of 10.75%. Thisindicates thatmore urbanization tookplaceinthestudyareaduring theperiod from2005 to2016 compared tothe period from 1995 to 2005.

Generally,the multi-temporalComparismoverthe entirestudyareadescribed here, indicatesthatthe urbanizationhassubstantiallychangedthestatus of landusein thestudyarea,witha significant landconversion rate.

V. Conclusion

For the past 21 years, 1995-2016, Awka has been undergoing extensive land use change. The classification of multi-temporal satellite images of three different time periods, i.e. 1995, 2005, and 2016, into bare surfaces, urban areas, water bodies and vegetation on the other hand has resulted in a highly simplified and abstract representation of the study area.The synoptic analysis of multi-temporal land use change revealed that development has significantly transformed the urban landscape of Awka. The built up area has grown from 13,693.85 hectares in 1995 to 16,993.58 hectares in 2005 and to 22,653.83hectares in 2016. The highest rate of urban growth is observed during the second period of urbanization (2005 to 2016) in which the built up area increased more than twice (46.10%) and in the first period of urbanization there was a change of 27.87%. This indicates that a more rapid urbanization has been taking place in the study area during the period of 2005 to 2016 compared to the period of 1995 to 2005. In total, 8959.97 hectares of non-built up land has been converted to urban area.

Annual growth rate of urban area for the period between 1995 and 2005 is given as 1.08 while that of 2005 to 2016 is given as 1.43. Also the annual growth rate of bare surface and vegetation is given as -1.28 and -1.89, then -0.31 and -1.23 for the periods 1995-2005 and 2005-2016 respectively.

Inthisstudy,ithasbeenpossibletosuccessfullycapturethelanduse dynamicsin Awka South, giventheresultspresentedinthisstudy,remotesensingapproach coupledGIS are invaluable toolfortheanalysisandextractionof information on landuse dynamicsand theycanoffer a

comprehensiveopportunityforthedescriptionofprocess,andfacilitateintraurbancomparison.

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