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Analysis of Urban Land cover Growth and Projection in Ondo State: A Case Study of Akure South Metropolis

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ABSTRACT

Analysis of urban land cover growth and projection were carried out using medium resolution multi-temporal images (Landsat MSS1986, TM2000 and ETM2015). Spatial data were collected over a period of time to visualize the extent of urban growth and projection. Handheld GPS Map 76CSX was used for the collection of coordinate for ground truthing. The images were processed using Arc GIS 10.2.1 and land cover maps for each study year are presented. The result of the analysis in table 5 shows that urban area steadily increased from 4.8% in 1986 to 9.5% in 2000 and 17.3% in 2015 while vegetation (including forests and scrubs) decreased in an uncontrolled manner from 79.4% in 1986 to 60.5% in 2000 and 51.7% in 2015. The analysis of result used for projected Land Cover map shows that from 1986 to 2030the urban area would have increased to approximately 8,422.11 hectares from 5688.290 hectares with a percentage increase of 8.52%. Furthermore, 18.38% decrease in forest area was predicted to occur while the scrubs and grassland were predicted to increase by 2.15% and 9.73% respectively. The study therefore recommended that analysis of urban land cover growth and projection should be carried out to progressively study the rate and pattern of grow thin an urban area.

Keyword: Land use, Land cover growth, Projection, Landsat, GIS, GPS

INTRODUCTION

The land use/land cover pattern of a region is an outcome of natural and socio – economic factors and their utilization by man in time and space. 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 is essential for the selection, planning and implementation of land use schemes to meet the increasing demands for basic human needs and welfare. This information also assists in monitoring the dynamics of land use resulting out of changing demands of increasing population (Anurag, et al., 2012).

Land cover data documents how much of a region is covered by forests, wetlands, impervious surfaces, agriculture and other land and water types. Land use shows how people use the landscape- whether for development, conservation, or mixed uses.

In Nigeria, land-use and land-cover patterns have undergone a fundamental change due to accelerated population explosion and economic development under different economic policies of past governments (Zemba, A.A., 2006). Urban growth has been speeded up, and extreme stress to the environment has occurred. This is particularly true in regions such as Akure metropolis where massive agricultural land is disappearing each year, converting to urban or related uses. This entails the removal of natural land cover and the introduction of urban materials in form of clearance of natural vegetation; reclamation of swampy areas; construction of buildings, roads, and other concrete surfaces like parks and pools (Xu and Cheng, 2004).

Akure has reportedly been growing rapidly owing to favourable socio-economic, political, and physical factors. This growth became so pronounced when the city was accorded the status of a state and Local Government headquarters. Evaluating the magnitude and pattern of Akure urban growth is an urgent need. This is to generate information that could help in tackling some of the problems that accompanied rapid urban growth. Furthermore, because of the lack of appropriate land-use planning and the measures for sustainable development, rampant urban growth has been creating severe environmental consequences such as urban flood, erosion and pollution problems. Thus, there also is a need to assess the environmental impact of the rapid urban expansion (Zemba, A.A., 2004).

The integration of remote sensing and geographic information systems (GIS) has been widely applied since its recognition as a powerful and effective tool in detecting urban land-use and land-cover change (Treitz, 1992; Harris and Ventura, 1995). Satellite remote sensing collects multispectral, multiresolution and multitemporal data, and turns them into information valuable for understanding and monitoring urban land processes and for building urban land-cover datasets. GIS technology provides a flexible environment for entering, analyzing and displaying digital data from various sources necessary for urban feature identification, change detection and database development. In spite of this however, few of the urban growth studies have been directed towards satellite-based post-change detection environmental impact analysis, especially in the tropical regions due to probably to the previously high cost of remote sensing data (Zemba, A.A., 2006). Hence, the need to conduct such studies as a way of contributing to developing an operational procedure using the existing techniques of remote sensing and GIS for analyzing urban growth has become necessary, especially in tropical regions like Akure.

Almost everyone has seen these changes to their local environment but without a clear understanding of their impacts. It is not until we study these landscapes from a spatial perspective and the time scale of decades that we can begin to measure the changes that have occurred and predict the impact of changes to come (*Oyinloye, A. M. 2013*).

The aim of this study is to analyse and monitor the pattern of urban land cover growth within Akure Metropolis with the objective of detecting and monitoring LULC changes, determining the nature, extent and rate of urban land cover growth and analyse the change patterns and the major driving forces. The study would help to give a thematic representation of the urban land cover in the area and would also serve as a reference work for further research.

STUDY AREA

Akure is the capital of Ondo state which is located along latitude 7°15′00″N to 7°18′22″.32N and longitude 5°09′12″E to 5°14′10″E. The town is situated in the tropical rainforest zone in Nigeria. The city comprises of two local Government areas- Akure South and Akure North. Akure is the trade centre for a farming region where cocoa, yams, cassava, corn and tobacco and cotton are grown.At the time of the colonial rule in Nigeria, Owo, Ondo and Ekiti regions were merged to form a new province with its headquarters in Akure. Akure became the capital of Ondo State in 1976 when the state was created. As the state capital, Akurecity is the centre of commercial and administrative activities and has witnessed a steady increase in population since creation.

The study area, Akure South Local Government area is located within Akure covering an area of $331km^2$ with a population of 353,211 as at the 2006 census.

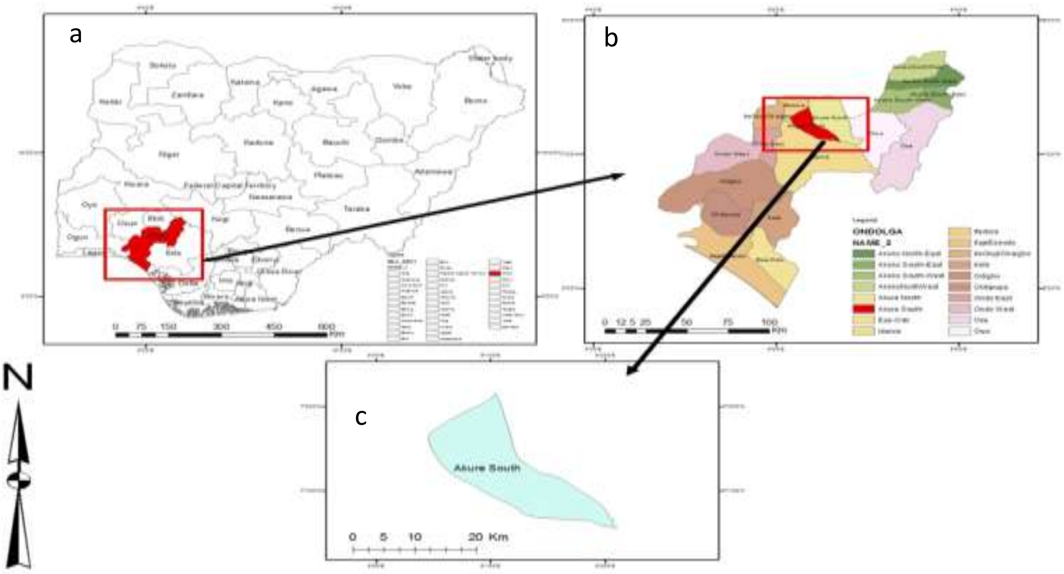


Figure 1: Study Area Map (a) Nigeria Showing Ondo State (b) Administrative Map of Ondo showing Akure South (c) Map of Akure South Local Government

METHODOLOGY

This study addresses the issue of urban land cover growth and projection in Akure South Metropolis over a period of 29 years (1986-2015) and a projection over a period of 15 years (2015-2030). Urban Akure in this study refers to the built-up area that defines AkureMetropolis and its immediate surroundings. This section focus on the fundamentals principle, methods and procedures that was adopted in the study. This include; data acquisition, instrumentation and data processing. Figure 2 Shows the process adopted in the methodology of this study.

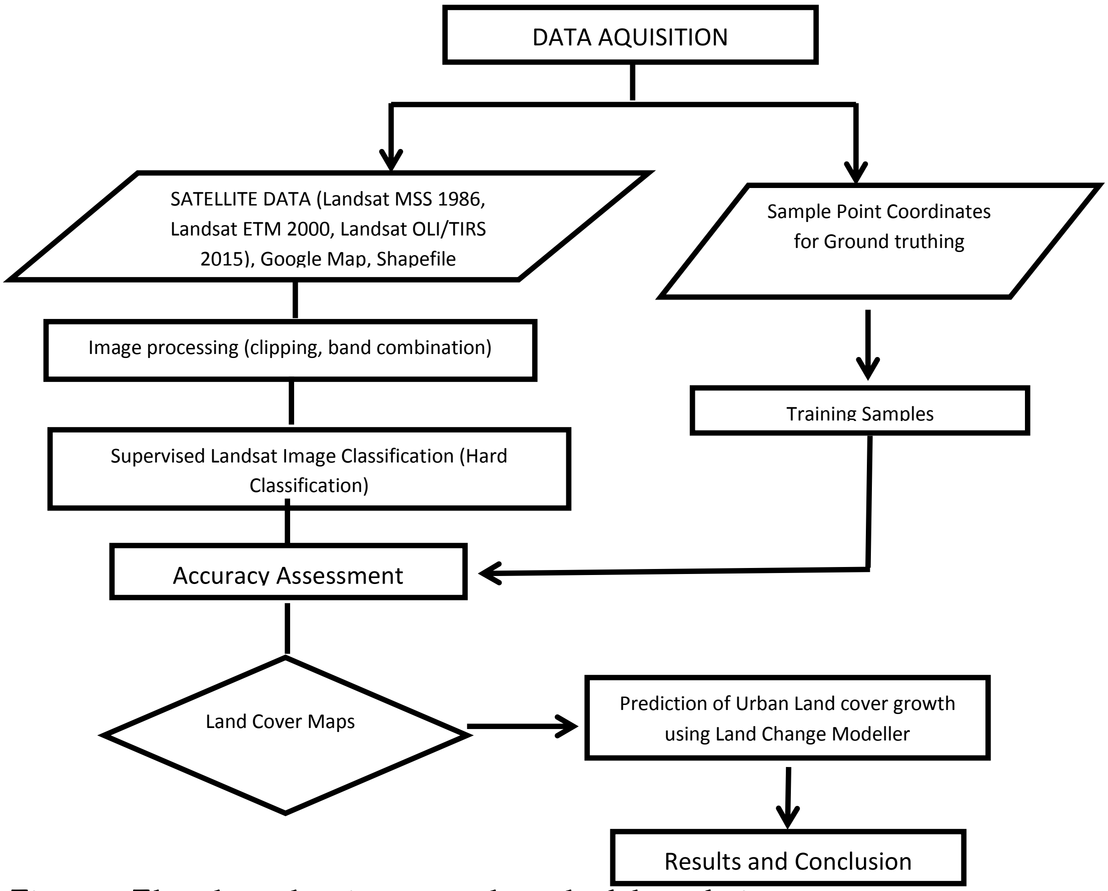


Figure 2: Flowchart showing research methodology design

Data used in the study

The study made use of primary and secondary data. The primary data were obtained using Handheld GPS Map76CSX in coordinate format (X and Y) picked randomly within the study area. While the secondary data were raster images (Landsat for years 1986, 2000 and 2015) with a resolution of 79m and a radiometric resolution of 64 levels downloaded from the USGS website and vector file (shapefile) of Nigeria downloaded from DIVA-GIS website.

Table 1: Landsat Data Attributes (source: http://www.glovis.usgs.gov)

Reference Year	Spacecraft	Sensor	Ground Resolution	WRS: Path/Row	Date of Acquisition
2015	Landsat_8	OLI/TIRS	30m	190/55	15/01/2015
2000	Landsat_7	ETM	30m x 30m	190/55	15/02/2015
1986	Landsat_5	TM	30m x 30m	190/55	(last accessed June 2015 on the USGS website)

Data Processing and Analysis

Clipping

The shape file of Akure South Local Government was clipped out from a shape file of all local government areas in Nigeria. The shape file of the Akure South Local Government boundary was used in clipping the sub-scene from the full image and so the output assumed the exact shape of the shape file when individual bands in each year were clipped out independently.

Composite Creation

In creating a composite image, a number of bands (usually 3 and above) in a multispectral satellite image are combined together to form multiband images. A composite image enhances visualization of features in the image. The table below shows the bands used for creating a composite in each image as shown in figure 3.

Table 2: Landsat Band Combinations

Image	1986(Landsat TM)	2000(Landsat ETM)	2015(Landsat OLI/TIRS)
Spectral band combination	4,3,2	4,3,2	5,4,3
Spectral band names	NIR, Red, Green	NIR, Red, Green	NIR, Red, Green

Figure 3: RGB Composite images of the study area

The bands chosen are well suited for studying land cover and vegetation characteristics. Vegetation appears in different shades of red. Deep red colour indicates thick forests/ healthy vegetation, while lighter tones indicates scrubs, bushes, grasses, etc. Rocks can also be easily detected from these composite. Bare soil and patches appear as brown or light brown. Urban areas appear as cyan blue (densely populated areas appear as light blue)

Panchromatic Sharpening

Panchromatic sharpening is a form of radiometric transformation which uses a higher-resolution panchromatic image (or raster band) to fuse with a lower-resolution multiband raster dataset.Images were acquired from Landsat 7 and 8 sensors contain the panchromatic band (band 8) with a higher spatial resolution of 15m. Therefore the respective panchromatic bands for the images of year 2000 and 2015 were fused with the composite image in order to increase the spatial resolution from 30 metres to 15 metres.

Image Classification

Image classification and interpretation was performed using Supervised Classification on ArcGIS 10.2. Using reference image (Google Maps) and the ground truthing data, training samples were gathered from more than 20 points as signatures for each Landsat satellite images. The training points were proportionally distributed to each cover types with at least 10 points per cover type.The images were classified under the following classes as shown in the table 3.

Table 3: Land Cover class description

Land Cover Class	Description
Urban Area	This classes includes urban fabric, industrial, commercial, and other related built up areas of non-agricultural, vegetated areas
Forest	It comprises forest land, shrub and other mixed forest land, herbaceous vegetation associations
Scrubs	Heterogeneous agricultural areas, thick bushes. Non-forest
Grassland/Bare surfaces/soil	Grasslands, sparsely vegetated areas, open spaces with little or no vegetation. Transport units (roads) also fall under the category of bare surfaces
Rocks	Bare (exposed) rocks
Water	Rivers, Lakes, ponds

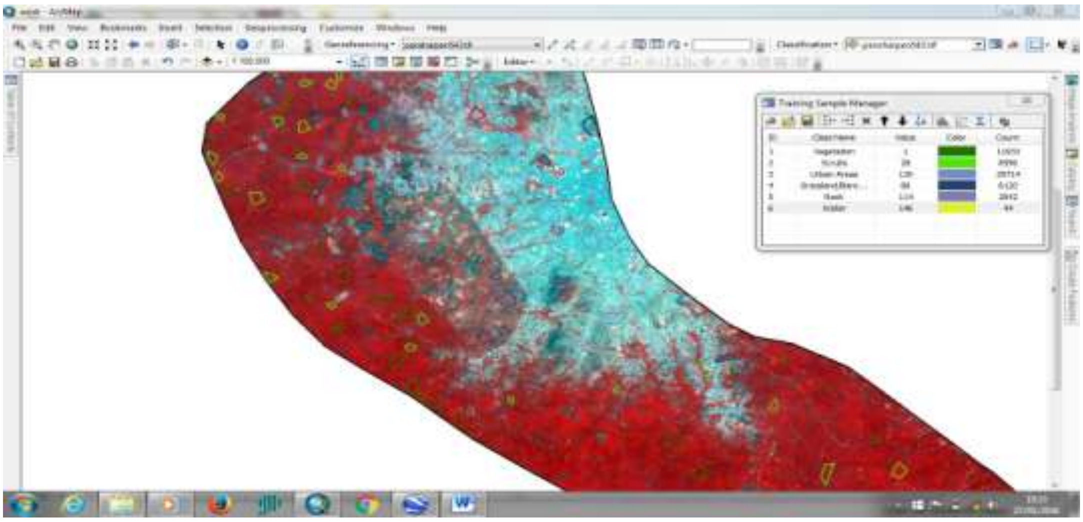


Figure 4: training sites and training sample manager during supervised classification

Accuracy Assessment

Accuracy assessment is considered an important step in evaluation of different image processing routines in image classification (Foody, 2002 in Lu and Weng, 2005). The accuracy of classified images in this study were checked with a stratified random sampling method of shapefiles of reference point for each year. Random data set of locations were picked on the ground for verification of the true land cover type. An overall accuracy, producer's accuracy, user's accuracy, and Kappa Coefficient were the outcome of accuracy assessment (table 4).

Table 4: Classification of Accuracy Assessment Result

YEAR	OVERALL ACCURACY	KAPPA COEFFICIENT
1986	0.74829932	0.689492764
2000	0.810035842	0.763396643
2015	0.876325088	0.845509561

Land Change Modelling (LCM)

This is mainly to predict the land cover change that is likely to occur over a period of time. The Land Change Modeller (an integrated software environment within IDRIS) was used. The Land Cover maps of year 2000 and 2015 were the parameters used for Land Change Model (LCM) and prediction. These were imputed under the LCM project parameters tab. Transition potential files were created for change from forest, scrubs and grassland or bare surface/soil to urban areas under the Transition Potential tab. This files were used as input for the change prediction. The prediction was done using Markov's chain Model and the projection date was set to the year 2030.

Figure 5: the Land Change Modeller module and the change prediction tool

RESULTS

The results obtained from the classification of the images and change prediction processes which has occur over the years (1986, 2000 and 2015) are presented in Figure 6Showing the land cover map of 1986 obtained from Landsat composite image, Figure 7 Showing the land cover map of 2000 obtained from Landsat composite image, Figure 8 Showing the land cover map of 2015 obtained from Landsat composite image and Figure 9 Showing the projected land cover map for year 2030

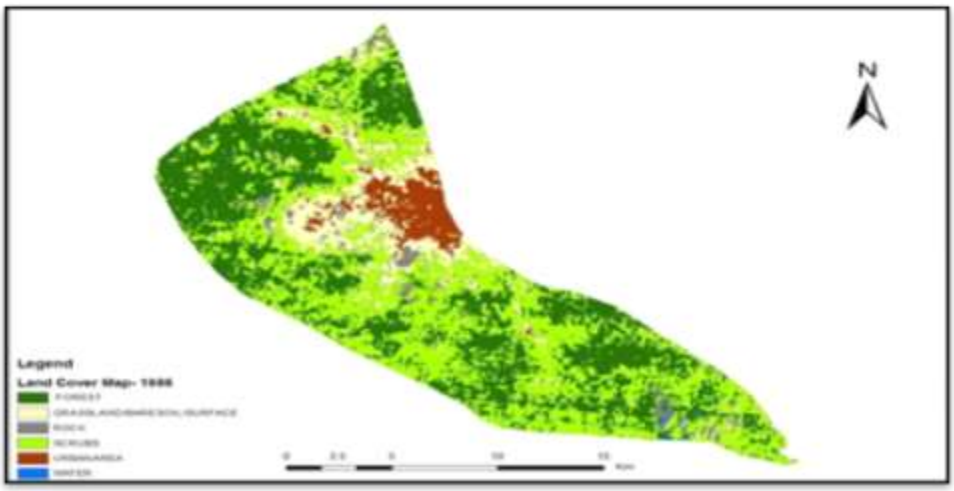


Figure 6Landsat Land Cover Classification Map for 1986

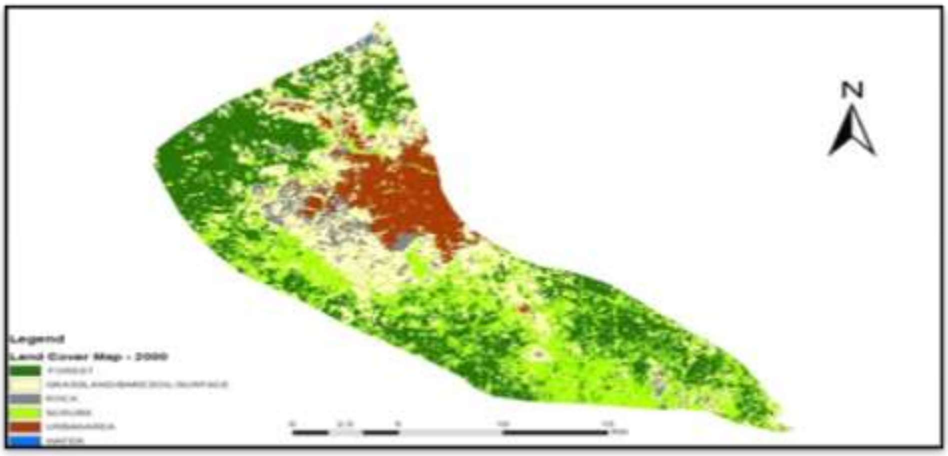


Figure 7 Landsat Land Cover Classification Map for 2000

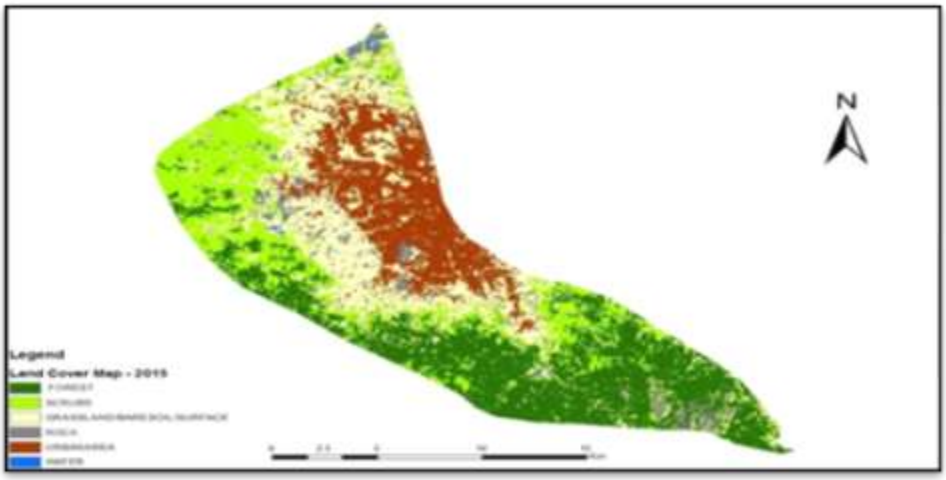


Figure 8 Landsat Land Cover Classification Map for 2015

The results as shown in Figure 6, 7 and 8 help to visualize the extent and nature of urban growth in the study area. In 1986, the urban area mainly covered the north eastern part of the Akure. The urban area spread out mainly upwards from the north eastern part of the metropolis in the northern direction in 2000. These areas were earmarked for the construction of Government Residential Areas (GRAs) and government ministries. Besides, the area was the location of Ijapo Estate, a notable residential estate in the city which attracted much influx into the area. The construction of Ilesha-Akure-Owo highway which passes through the north-eastern part of the city was another notable factor that plays a prominent role in attracting people to the area. (Julius & Oyewole, 2015).

Meanwhile Figure 9 shows the projected land cover class for year 2030 which was produced using the Land Change Modeller on IDRIS Selva.

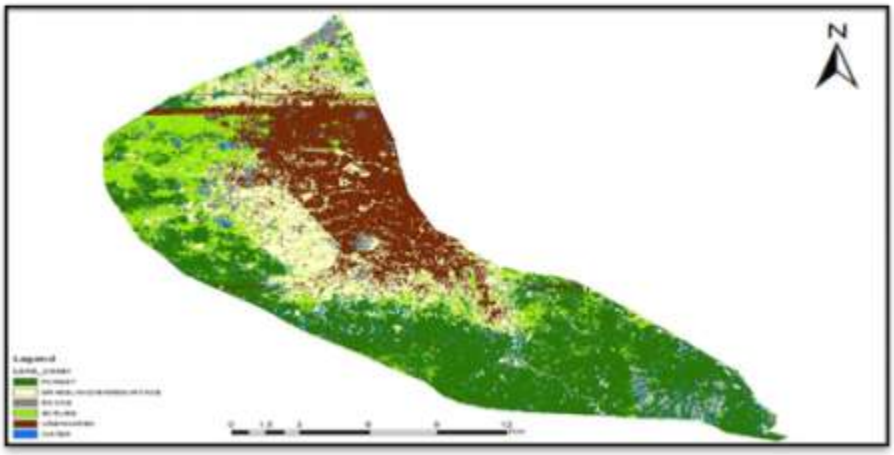


Figure 9 Projected land cover map for year 2030

DISCUSSION

In 2015 the spread was diffused in all directions (figure 8). This was probably due to congestion in this area and availability of cheap lands and good topography which favours construction in other parts of the city.

As shown in table 5, larger part of the study area was covered in thick vegetation in 1986. The forest and scrubs which made up the thick vegetation covered 12145.818 hectares and 13897 hectares respectively which totalled 79.384% of the whole study area. The urban area only covered 1572.435 hectares (4.793%), grassland or bare surface/soil covered 3713.932 hectares (11.32%), 1370.672 hectares (4.178%) was covered by rocks and water only covered about 106.080 hectares (0.323%) as represented in figure11a.

In 2000, the extent of land covered by forest and scrubs reduced noticeably to 10640.228 and 9215.100 hectares respectively which made up 60.518% of the study area. Urban areas, grassland or bare surface/soil and rocks all increases to 3130.515 hectares (9.542%), 8114.467 hectares (24.732%) and 1654.718 hectares (5.043%) respectively. Water bodies also decreased in to 53.978 hectares (0.165%) as represented in figure11b.

By the year 2015, the coverage of urban area had greatly increased to 5668.290 hectares (17.274%). Grassland or bare surface and rocks had also increased covering 8276.692 hectares (25.223%) and 1821.667 (5.552) hectares respectively. Forests and scrubs continued to experience a decrease in area covering 9564.480 hectares (29.148%) and 7393.635 hectares (22.532%) respectively as represented in figure11c.

Table 5 Overall amounts and extent of land cover classes from 1986 to 2015

	1986		2000		2015	
Land Cover Type	AREA (ha)	%	AREA (ha)	%	AREA (ha)	%
Forest	12145.818	37.022	10640.228	32.431	9564.480	29.148
Scrubs	13897.679	42.362	9215.100	28.087	7393.635	22.532
Urbanarea	1572.435	4.793	3130.515	9.542	5668.290	17.274
Grassland/Bare surface	3713.932	11.321	8114.467	24.732	8276.692	25.223
Rock	1370.672	4.178	1654.718	5.043	1821.667	5.552
Water	106.080	0.323	53.978	0.165	88.808	0.271
Total	32806.615	100.000	32809.004	100.000	32813.573	100.000

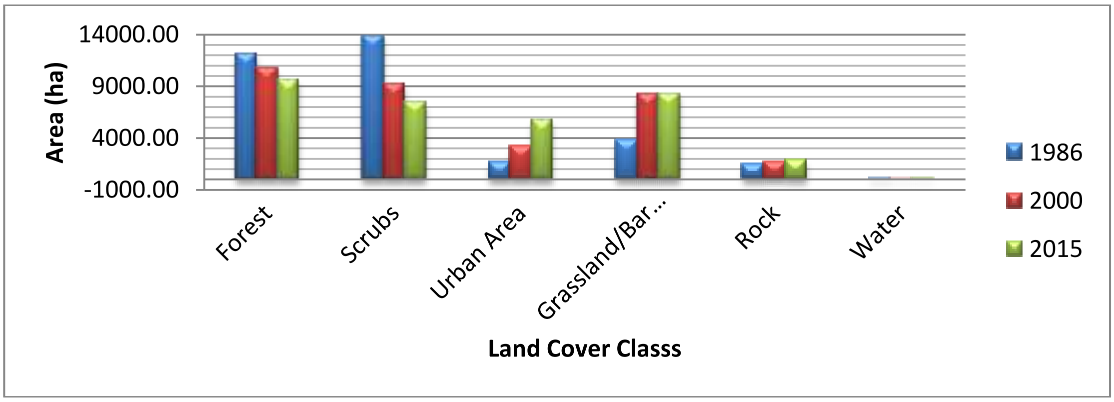


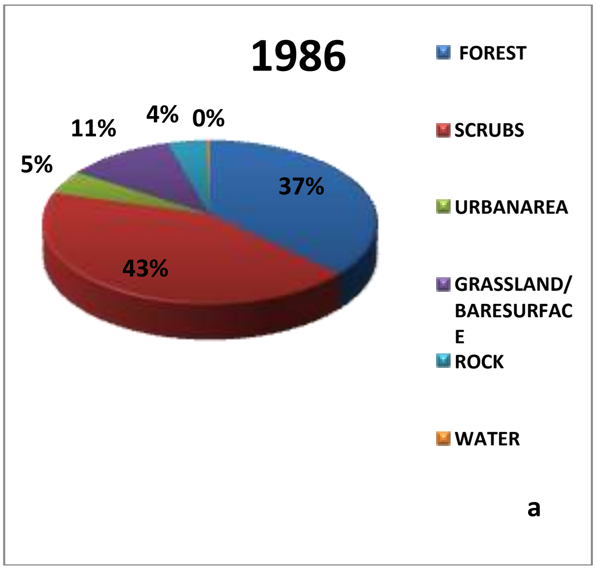
Figure 10: Natures of Relative Land Cover Changes 1986 to 2015

Figure 10 represents the nature of the relative land cover changes. It shows that from 1986 to 2000 and then to 2015 (represented by the blue, red and green bars respectively) forest and scrub areas kept decreasing while the urban area increased. Grassland or bare surface/soil also increased through the years with only a minimal increase in 2015. The exposed rock surfaces also increased through the years.

Table 6 Projected extent of Land Cover in 2030

LANDCOVER	AREA(ha)	PERCENTAGE
Forest	3,515.13	10.76
Scrubs	8,060.13	24.68
Urban Area	8,422.11	25.79
Grassland/Bare surface/Soil	11,413.30	34.95
Rocks	1,177.83	3.61
Water	66.24	0.20

Tables 6 was obtained from the analyses of Projected Land Cover map, which predicted that urban area would have increased to approximately 8,422.11 hectares in 2030 from 5668.290 hectares in 2015 with a percentage increase of 8.52 an 18.38% decrease in forest area was also predicted to occur while the scrubs and grassland were predicted to increase by 2.15% and 9.73% respectively as represented in the figure below. This increase and decrease was probably as a result of clearing of forests for developments to meet the demand of the increasing population.



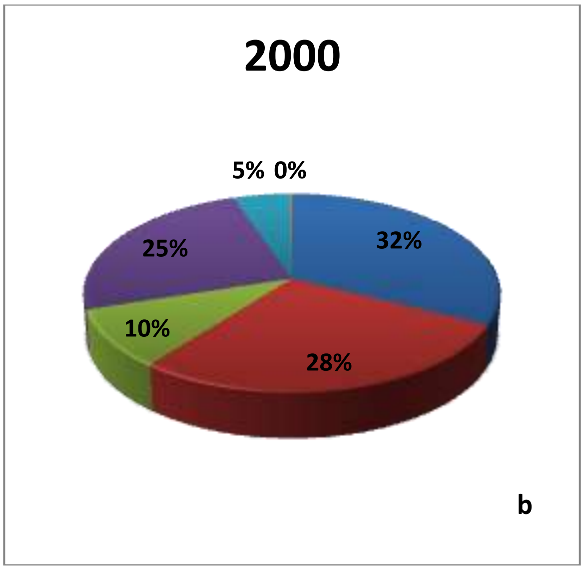
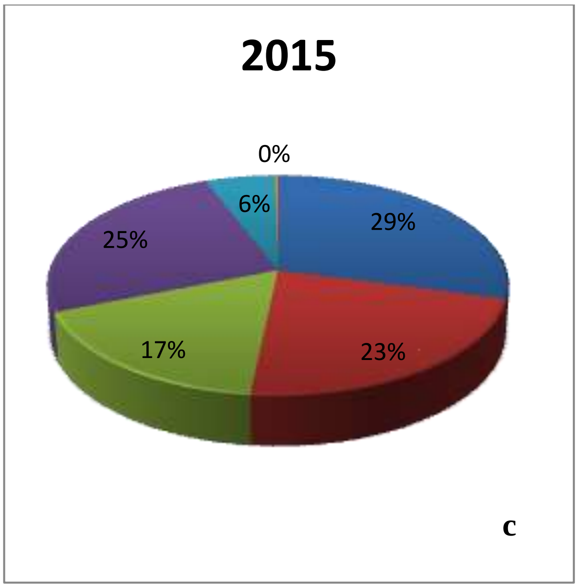


Figure 11a- Pie chart showing percentage of area covered by each class from 1986-2000



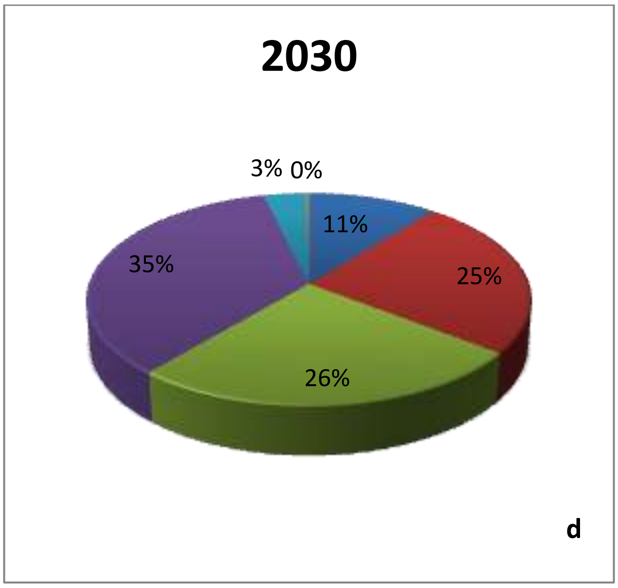


Figure11b- Pie chart showing percentage of area covered by each class from 2015-2030

CONCLUSION

The study gives a clear indication of unguided expansion of urban growth in Akure South metropolis which affects the pattern of land uses in the city and its surrounding areas. There were incompatible conversions of land uses and undue encroachment into green areas in the adjoining settlements due to favourable economic situation in the area.

From the analysis of the result, it shows that the urban areas were increasing throughout the years from 1572. 435 hectares with a percentage of 4.793 in 1986 to 5668.290 hectares with a percentage of 17.274 in 2015 while in 2030 it increases to 8,422.11 hectares with a percentage of 25.79. The forest areas keep on decreasing from 12144.818 hectares in 1986 with a percentage of 37.022 to 3515.13 hectares with a percentage of 10.76. Rocks, water and scrubs keep on increasing as well.The increase and decrease was probably as a result of clearing of forests for developments to meet the demand of the increasing population (see table 5 and 6).

In order to lessen the dramatic land use/land cover change and adverse environmental impacts of urban expansion and increasing built up surfaces, the current growth pattern needs to be managed through effective land use planning and management. This would be useful to preserve the forest and other vegetation types (especially agricultural lands) in the region and further reduce environmental degradation in the form of soil erosion and pollution.

It is therefore recommended that detailed and regular analysis should be carried out regularly to progressively study the rate and pattern growth in an urban area.

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