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Analysis of Landuse, Landcover Change and Urban Expansion in Akure, Nigeria *(pp. 234-248)*

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Abstract: Land use and land cover are important phenomena in understanding the interactions of human activities with its environment. In order to manage these phenomena, it is necessary to map different themes from time to time. The land use and land cover dynamics of Akure, the Ondo State capital for a period of thirty years, was analyzed using multi-temporal and multi-source satellite imageries of Land sat (MSS) images of 1972, 1986 (TM) and Land sat Enhanced Thematic Mapping (ETM^+) image of 2002. The study employed supervised digital image classification method using ILWIS 3.2 and Arcview 3.1 GIS software and classified the land use into built up area, vegetation, bare lands, exposed rocks and water bodies. The results obtained shows that the built-up area has been growing rapidly for the periods (1972-2002). The results also show increase in the bare land cultivation and exposed rock out crops while vegetation decreases, the water bodies were stable between 1986 and 2002. Based on the GIS analysis, future prediction/ trend of the urban land use and land cover and its subsequent development was modeled between 2002 and 2022. These results could help city planners and policy makers to attain and sustain future urban development.

Key words: land use / land cover, urban expansion, remote sensing, GIS

1 INTRODUCTION

The ability to forecast land use and land cover change and ultimately to predict the consequence of change will depend on our ability to understand the past, present and future state of land use and land cover change. This ability is enabled through the use of multi temporal remote sensing data and or aerial photographs which provides valuable information natural resources like land, water, forests urban areas and infrastructure facilities such as road network, river network etc (National Research Council, 2001).

The land use and land cover of any particular region is an outcome of both natural and socio-economic factors and their utilization by man in time and space. Land is becoming a scarce commodity due to immense agricultural and demographic presence. Hence

information on land use and land cover and possibilities for their optimal use is essential for the selection, planning and implementation of land uses schemes to meet the increasing demands for basic human needs and welfare.

In the South-Western Nigeria, land resources are changing at a rapid rate-at local to national scales. The ecosystems on which South-Western Nigeria societies depend are showing many signs of stress (Oyinloye, 2010). A systematic understanding of changes in land use and land cover is critical to the understanding of the ecosystem functioning and services and human welfare. A spatially explicit study of land use and land cover changes can only lead to a better understanding of the causes of change and their consequences on the environment and society. Such understanding, will improve land and water management decisions to ensure that ecosystems and changing landscapes are sustaining managed.

Several studies have been conducted with the integration of remote sensing and geographic information systems to analyze and monitor land cover changes. Musaoglu, *et al,* (2002) merged the remotely sensed data with geocoded information. This was achieved by first classifying the images, applying 5*5 neighborhood functions, then transforming the results into vector layers. The layers were imported into GIS environment for area analysis. Similarly, Zhi-Yong Yin, *et al* (2005) used image processing and analysis in a GIS environment to assess spatial change in urban land use patterns and population distribution. Here, unsupervised classification was used to classify the images into land use classes. With census data in a GIS, census polygon was constructed into various sets of units, and then comparison made with the classified image population in surface areas. In his studies carried out by 2004 in Shaoxing City in China using satellite imageries for the year 1984, 1997, and 2000, in which one of the goals of the study was to produce a landuse map of Shaoxing city and its surroundings, the result shows that there are undoubtedly a lot of changes that occurred between 1984 and 1997 when compared with those of 2000, due to the sufficient time gap. From the study, it was observed that residential area development was mainly at the expense of agricultural land use.

In similar studies Adebayejo and Abolade (2006) used satellite imageries of 1978 and 1995 and updated topographical maps of 2003 to study urban expansion of Ogbomoso town, Oyo State. Also Oyinloye (2010) studied the spatial growth of Akure, Ondo State using the satellite imageries of 1972, 1986 and 2002. The results of both cities showed that there has been a rapid conversion of agricultural areas to urban (non agricultural) land uses. Urban expansions of these cities have destroyed fertile agricultural land uses. Urban expansion of these cities have destroyed fertile agricultural land which cannot be recovered, the

residential land use continues to spread to and beyond the hitherto distant location relative to the city core.

Geographic Information System (GIS) and remote sensing provide the medium for the integration of spatial data. GIS and remote sensing have been widely recognized as an effective tool for planning and decision-making tasks. They allow for effective storage, manipulation and analysis of geographical data (Michalak, 1993; Trotter, 1991).
Satellite image data provides the potential to obtain land cover information at more frequent intervals and more economical than those obtained by traditional methods (Martin and Howarth, 1989, Treitz, Howarthand Gong, 1992, Trotter, 1991). The advantages of satellite imagery compared to aerial photography include regular repeat coverage, recovering data from the same area at the same time of the day, consistence scale and look-angle, and lower cost (Kressler and Steinnocher, 1996).

The objectives of this study include:
1. Identification of various land cover and land use classes in remotely sensed data sources;
2. Calculation and quantification of the basic land use and land cover data in the study area from 1972 to 1986 and to 2002;
3. Analysis and determination of the land use and land cover change from (1972-1986) and 1986-2002);
4. Determination of the extent of expansion within the urban and peri-urban area;
5. Modelling of the temporal and spatial pattern of land use change (urban expansion in the year 1972+1986+2002)
and
6. Prediction of future land use and land cover change using the alternative growth scenario.

2 METHODOLOGY

The Study Area

The study area is Akure which was made the Capital of Ondo State in 1976. Akure is situated on latitude $7^0 17'$ and longitude $5^0 4'$ E. It is about 370m above the mean sea level. Akure is situated within a 48 kilometer radius to major towns in Ondo State, viz Ondo to the South, Owo to the East and Iju/ItaOgbolu to the North. The easy access and geographical centrality of Akure to these towns have enhanced the growth prospects of the city (see figure1).
The population of Akure in 1963 was put at 71,006 and by 1999, the total population has risen to 239,124 according to the 1991 census. By the year 2006, the total population has increased to 340,021 inhabitants (NPC, 2006). The increase in annual growth of the

population has been tied to the administrative role of the town and its long standing role as a centre of economic activities attracting a large spectrum of immigrants into it.

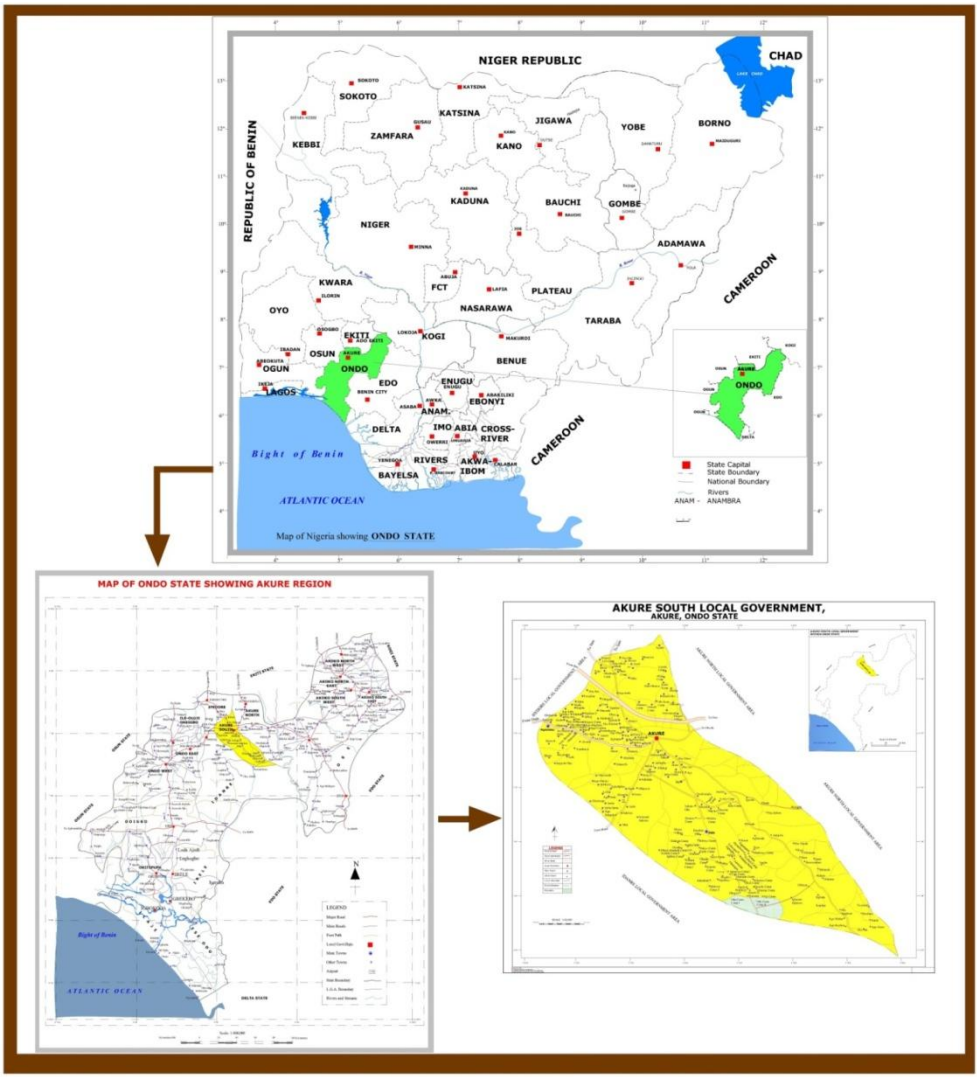


Figure 1: Ondo State showing Akure South Local Government
Source: Ministry of Works and Housing (Updated by the Author)

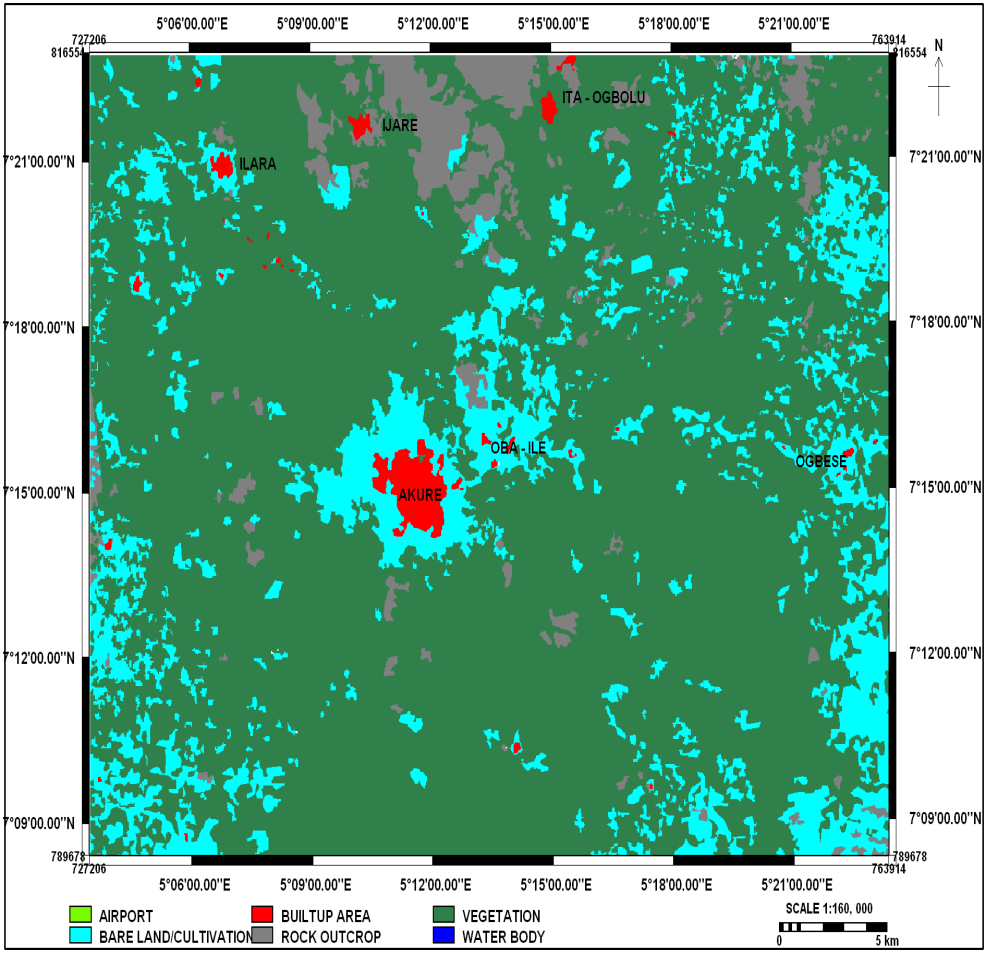
3 DATA ACQUISITION AND METHOD

The basic data acquisition include topographic map of the study area at a scale of 1:50;000 published in 1967 by the Federal Survey, Department, Lagos. Land sat Multispectral

Scanner (MSS). Thematic Mapper (TM) and Enhanced Thematic Mapper (ETM^+) images were acquired for 1972, 1986 and 2002 respectively. The images were geometrically corrected and ground control points obtained through intensive ground surveys permitted the co-registration of all images to a Universal Transverse Mercator (UTM).The satellites imageries: the land sat Multi Spectral Scanner (MSS) of 1972. Thematic Mapper (TM) of 1986 and the enhanced Thematic Mapper (ETM^+) of 2002 were made to pass through processes of image enhancement, geo referencing, re sampling, image classification and digitizing. A supervised classification was performed on false colour composites (bands 4, 3 and 2) into the following land use and land cover classes; Built-up area, vegetation, Bare land, Exposed rocks and water bodies. Information collected during the field surveys was combined with the digital topographic map which was developed for the city was used to assess the accuracy of the classification.

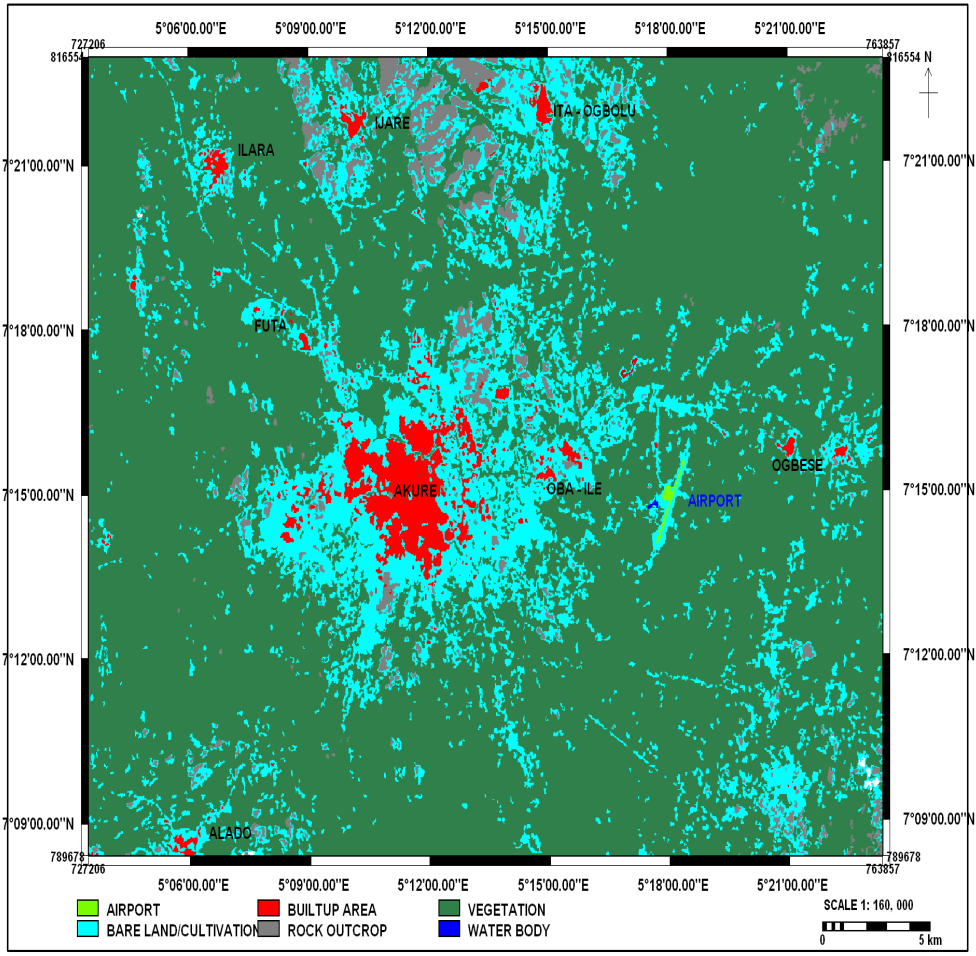
4 RESULTS AND DISCUSSIONS

Figures 2, 3 and 4 showed the results of the various processing itemized for the land sat MSS, Land sat TM and Enhanced Thematic Mapping (ETM^+) data sets. Also, tables 1, 2 and 3 showed the statistical results of the classification of the data set. Figures 5 and 6 showed the over lay of the three maps and prediction of Akure for 2002 to 2022 respectively while table 4 was used to quantify and model the land cover change based on the land use classifications.



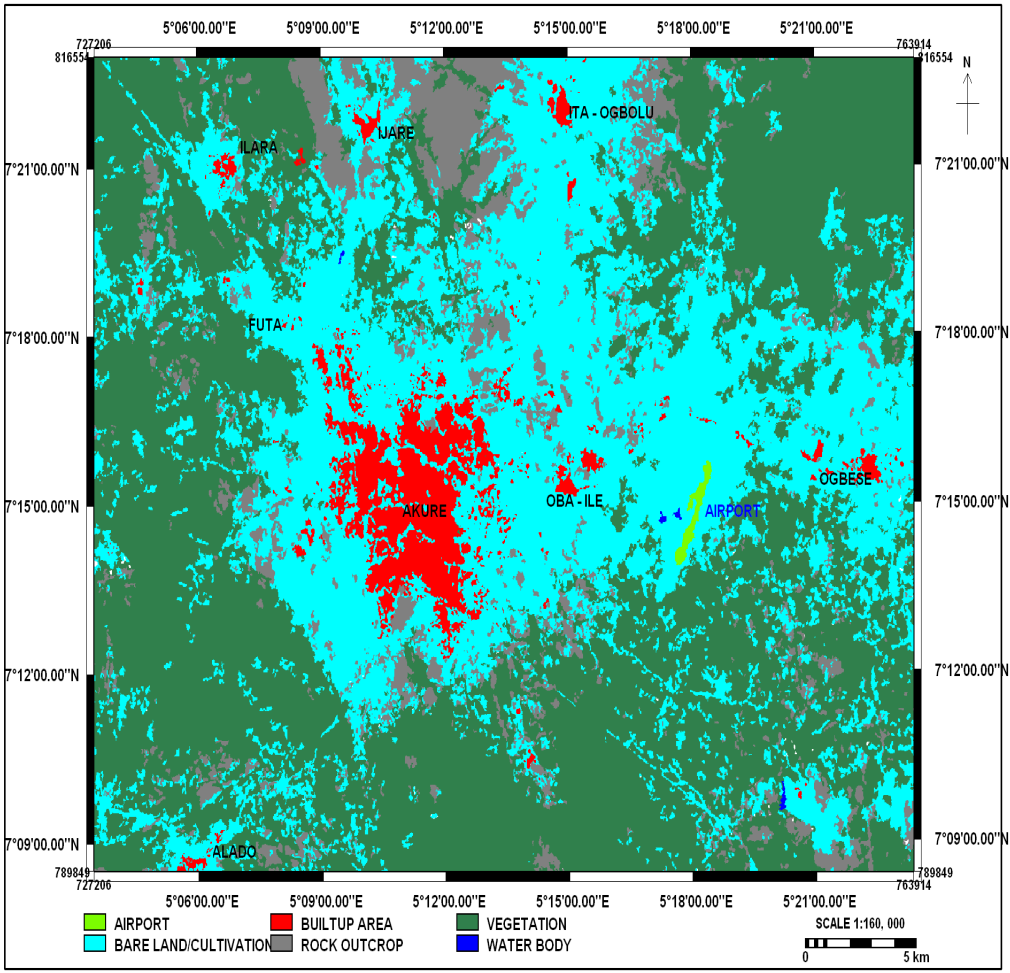
Source: Author's fieldwork

Figure 2: Supervised Classification of Landsat MSS 1972 Image of Akure and Environs



Source: Author's fieldwork

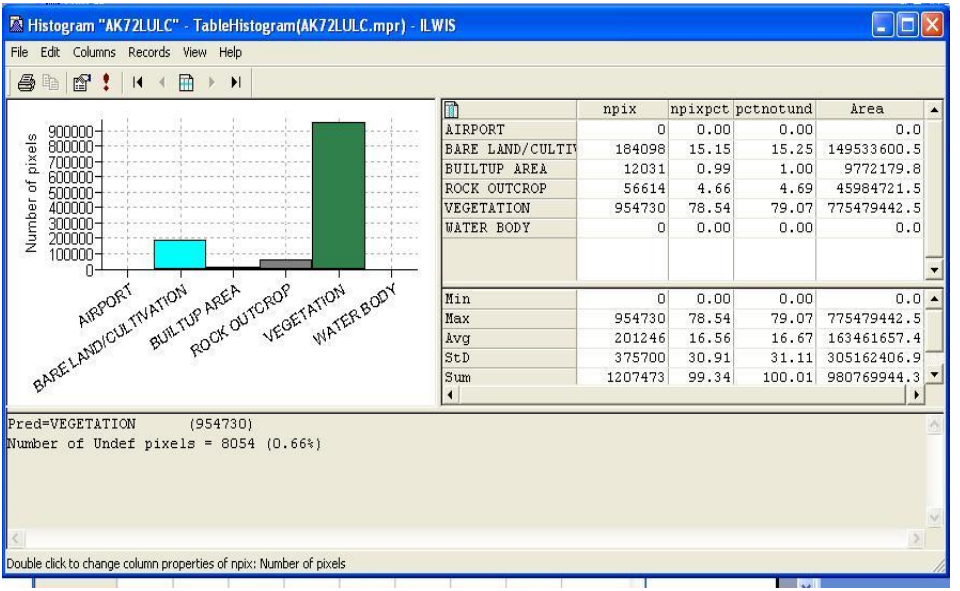
Figure 3: Supervised Classification of Landsat TM 1986 Image of Akure and Environs



Source: Author's fieldwork

Figure 4: Supervised Classification of Landsat ETM$^+$ 2002 Image of Akure and Environs

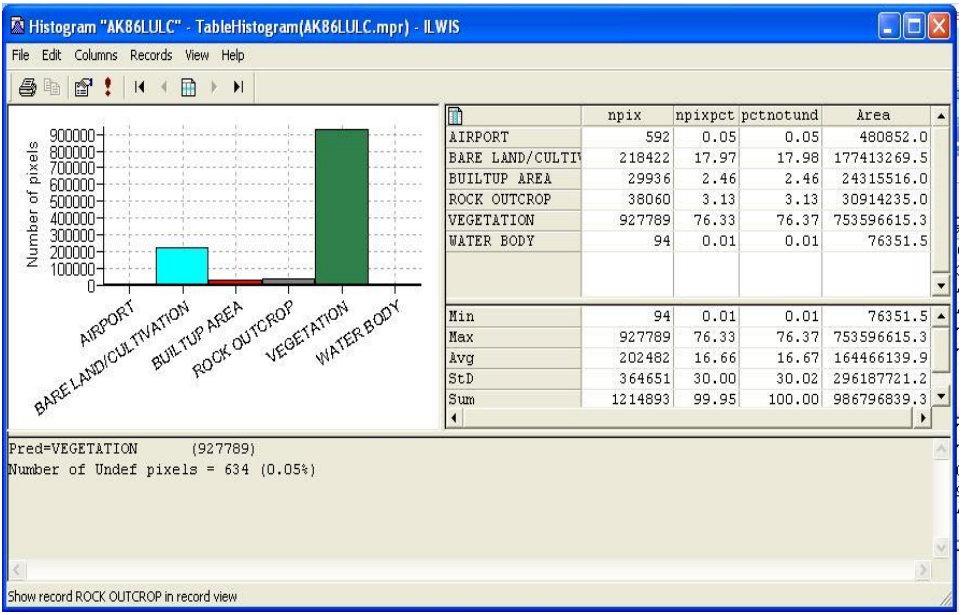
Table 1: Statistical Result of Classified Landsat MSS Data of Akure in 1972



	npix	npixpct	pctnotund	Area
AIRPORT	0	0.00	0.00	0.0
BARE LAND/CULTIV	184098	15.15	15.25	149533600.5
BUILTUP AREA	12031	0.99	1.00	9772179.8
ROCK OUTCROP	56614	4.66	4.69	45984721.5
VEGETATION	954730	78.54	79.07	775479442.5
WATER BODY	0	0.00	0.00	0.0
Min	0	0.00	0.00	0.0
Max	954730	78.54	79.07	775479442.5
Avg	201246	16.56	16.67	163461657.4
StD	375700	30.91	31.11	305162406.9
Sum	1207473	99.34	100.01	980769944.3

Source: Author's fieldwork

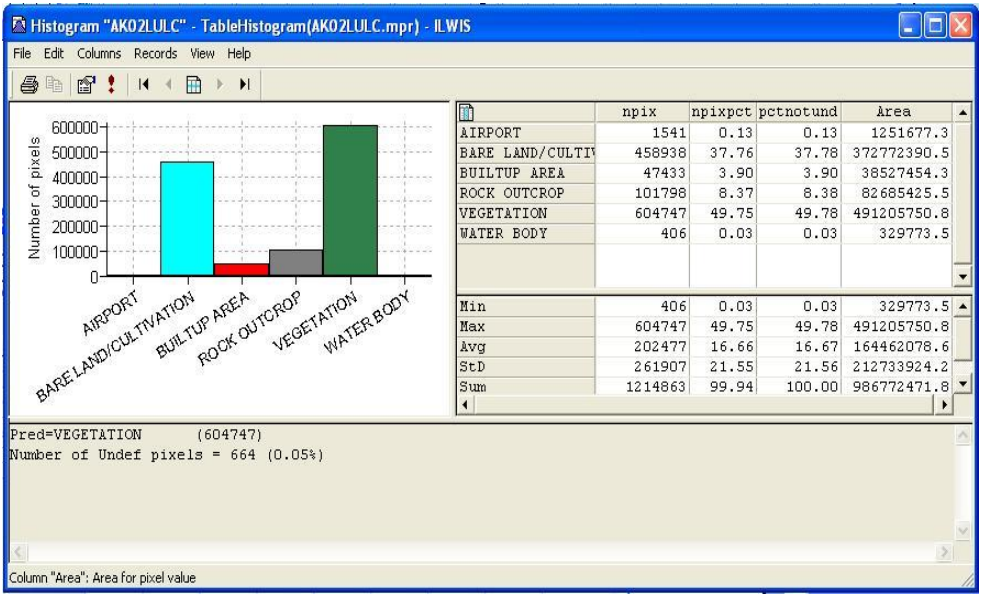
Table 2: Statistical Result of Classified Landsat TM Data of Akure in 1986



	npix	npixpct	pctnotund	Area
AIRPORT	592	0.05	0.05	480852.0
BARE LAND/CULTIV	218422	17.97	17.98	177413269.5
BUILTUP AREA	29936	2.46	2.46	24315516.0
ROCK OUTCROP	38060	3.13	3.13	30914235.0
VEGETATION	927789	76.33	76.37	753596615.3
WATER BODY	94	0.01	0.01	76351.5
Min	94	0.01	0.01	76351.5
Max	927789	76.33	76.37	753596615.3
Avg	202482	16.66	16.67	164466139.9
StD	364651	30.00	30.02	296187721.2
Sum	1214893	99.95	100.00	986796839.3

Source: Author's fieldwork

Table 3: Statistical Result of Classified Landsat ETM$^+$ Data of Akure in 2002



Source: Author's fieldwork

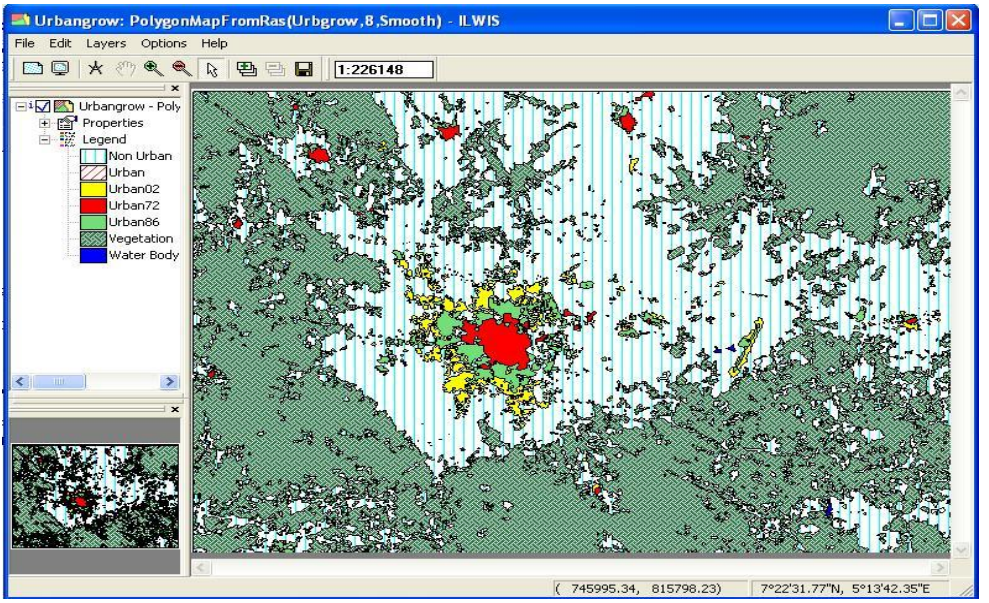


Figure 5: Overlay Maps (Landcover changes) of Akure between 1972, 1986 and 2002
Source: Author's fieldwork

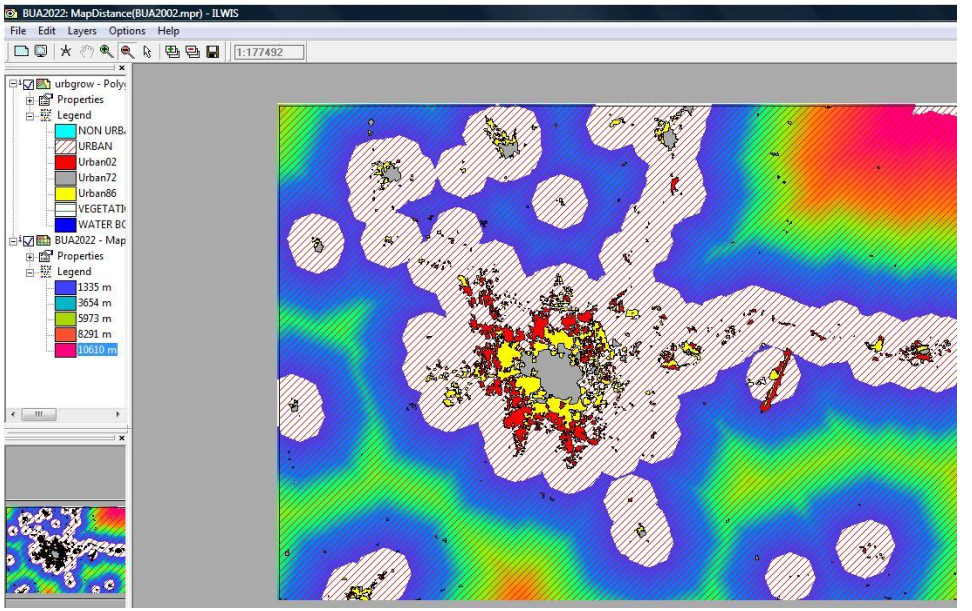
Table 4: Landuse Changes in (Ha/year) and (%/year)

Year	Land cover area (ha) Bareland	Change		Time span (years)	Arithmetic mean change		Period
		(ha)	(%)		(ha/year)	(%/Year)	
1972	14,953.40	2,787.90	18.64	14	199.14	1.33	1972-1986
1986	17,741.30	19,535.90	110.12	16	1,220.99	6.88	1986-2002
2002	37,277.20	40,230.86	107.92	20	2,011.54	5.40	2002-2022
2022	77,508.06						

Year	Land cover area (ha) Built-up	Change		Time span (years)	Arithmetic mean change		Period
		(ha)	(%)		(ha/year)	(%/Year)	
1972	977.2	1,454.40	148.83	14	103.89	10.63	1972-1986
1986	2,431.60	1,421.10	58.44	16	88.82	3.66	1986-2002
2002	3,852.7	2,010.96	52.20	20	100.55	2.61	2002-2022
2022	5,863.66						

Year	Land cover area (ha) Vegetation	Change		Time span (years)	Arithmetic mean change		Period
		(ha)	(%)		(ha/year)	(%/Year)	
1972	77547.90	-2,188.20	2.82	14	-156.30	0.20	1972-1986
1986	75,359.70	-26,239.10	34.82	16	-1,639.94	2.18	1986-2002
2002	49,120.60	-45,176.27	91.97	20	-2,258.81	4.60	2002-2022
2022	3,944.33						

Source: Author's fieldwork



Source: Author's fieldwork

Figure 6: Predicting Modelling Urban Expansion of Akure to 2022

A supervised classification was performed on these false colour composite (bands 4, 3 and 2) into the following land use classes. Built up area, vegetation, Bare land, Exposed rocks and water bodies. The classification results of Figures 2, 3 and 4 however show remarkable differences as evidenced on Tables 1, 2 and 3. On comparing the figures 2, 3 and 4 and tables 1, 2 and 3, it was observed that the built-up area covered 977.20 hectares (1.0%) in 1972, 2431.60 hectares (2.46%) in 1986 and increased to 3852.70 hectares (3.90%) in 2002. Furthermore, vegetation decreased gradually from 77547.90 hectares (79.07%) in 1972 to 75359.70 hectares (76.36%) in 1986 and further decreased drastically in 2002 to 49120. 60 hectares (49.78%). The bare land on the hand due to massive cultivation of land and population increase had also increased from 14953.40 hectares (15.25%) in 1972 to 17741.30 (17.98%) in 1986 and further to 37277.20 hectares (37.78%) in 2002. Also rock outcrop due to encroachment and quarry activities had increased from 4598.50 hectares (4.69%) in 1972 to 5002.90 hectares (5.07%) in 1986 and further increase to 8268.50 hectares (8.38%) in 2002. Water bodies are not well discernible in 1972 due to vegetation cover until 1986; it increased from 7.60 hectares (0.01%) to 33.00 hectares (0.03%) in 2002. This was probably as a result of massive encroachment and farming activities. Table 4 was used to quantify and model the land cover change based on the land use classifications. It was observed that the city expanded from 9772 hectares in 1972 to

2431.60 hectares in 1986 (1972-1986). Between 1986 and 2002, the built-up area had increased from 2431.60 hectares to 3,852.7 hectares. The built-up area changed at the rate of 88.2 hectares (3.66%) per year during the period (1986-2002) which was used to compute and predict the likely change in 2022. This indicates that urban expansion could increase probably to about 5863.66 hectares in 2022. Likewise all the three maps were overlaid on each other to produce one composite thematic map that clearly showed the stages of expansion and their extent in figure 4.4. While figure 4.5 shows the predicting future expansion of Akure for 2002 to 2022. The expected total built-up area after 20 years is 5863.66 hectares.

5 IMPLICATIONS OF URBAN EXPANSION IN AKURE

The tremendous expansion that this city (Akure) experienced has created environmental degradation consequent to the growth. There are dense agglomerations of people and economic activities associated with urban expansion impose pressure on the environment that can shape the physical landscape and the functioning state of the ecosystem. Also there are social ills such as unemployment, poor quality of housing, traffic congestion, poverty, poor quality of standard of living, overcrowding which put pressures on the state and local governments to provide basic social amenities and infrastructures for the growing population.

Another consequence of urban expansion is loss of open space which has been eaten up by this rapid expansion.

Deforestation and colonization of adjacent farm lands through uncontrolled urban expansion is another serious problem. This is likely due to population increase and therefore pressure on lands for food crops.

6 CONCLUSIONS

The major problems of most of our city planners and administrators in developing countries particularly in Nigeria is lack of necessary required knowledge particularly (The GIS and Remote Sensing tools) to enhance their efficiency. Akure as a capital state has been allowed to expand in haphazard form leading social, economic and environmental degradation (Oyinloye, 2010). Therefore, in order to enhance the functionality of the city and to reduce its social problems, the following recommendations should be given attention. - There is need to control urban spreading-out to agricultural land as this will have serious repercussions on food productions. – Various development and legislative measures should be adopted as to regulate growth and associated sprawl in the study area. – It is also necessary to embark on the regional development planning to make other surrounding areas more conducive living, thus, discouraging the sprawl unnecessarily. – Public and Private Partnership to create housing schemes particularly for low-income

schemes should be encouraged. – Newly City Concept in planning should be adopted in developing small towns around Akure. This will absorb the excess population of Akure, and reducing spatial expansion of this city to adjoining agricultural lands.

This paper employed the use of Remote Sensing and Geographical Information System (GIS) to study the land use and land cover change and urban expansion of Akure.
Land use / Land cover features are discernible on the processed image therefore, the quality of the image is acceptable for land use / land cover mapping.

Land sat MSS, Land sat TM and Land sat Enhanced Thematic Mapping (ETM^+) imageries of 1972, 1986 and 2002 were used to analysis the land use/land cover change of Akure. The result of the city (Akure) will increase from 977.20 hectares (1.0%) in 1972 to 3852.70 hectares (3.90%) in 2002 while vegetation will decrease from 77547.90 hectares in 1972 (79.07%) to 49120.60 hectares (49.78%) in 2002. Also the analysis shows that the change in the land use and land cover was noticed as the encroachment of built-up area into the cultivation area due to the demand for shelter and cultivation replacing the vegetation due to farming activities. The implications of the urban expansion of the Akure include loss of open space, deforestation and colonization of adjacent farmlands, overcrowding, poor quality of housing, traffic congestion and poor standard of living.

The results of the findings will assist in providing information for city planners and decision makers, also to support sustainable urban development initiative.

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