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MONITORING ILORIN URBAN CHANGES AND DEVELOPMENT WITH REMOTE SENSING AND GIS

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ABSTRACT

This paper focused on detecting and analyzing urban land use change of Ilorin and its environs of Kwara State in Nigeria, using Remote Sensing (RS) approach. In this study three Landsat imageries were acquired to form two epochs. Analysis of land use/ Land cover for these three years was carried out. The analysis covers 1996, 2010 and 2016. Five distinct classifications were carried out to be able to analyse new development in the study area. Global Mapper was used for displaying and subsequent processing and enhancement of the image. It was also used for carving out of the study area from the whole of Kwara State imagery using both the administrative and local government maps. The study was able to analyse development more especially in the area of infrastructural development in the study area and its likely effects on planning practice in the study area.

Key words:

GIS, Remote Sensing, Urbanization, Urban, settlement, land use/ land cover.

1.0 INTRODUTION

Remote sensing and the spatial analysis technology have been recognized and used as powerful and effective tools to study and manage land for the benefit of human race. Satellite remote sensing collects multi – spectral, multi – resolution, multi – period data and provides valuable information in understanding and monitoring the process of land use change, and in constructing land use data bases. It also helps in the provisions of geographical understanding of the area it represents with respects to the roads present, the built up areas and other important geographic features (Asonibare,2010).

The impact of changes to the environment affects organizations. The business of organization's including government, involve making decisions. Citizens increasingly require these decisions to be backed by information showing that the decision will result in greater efficiency and profitability.

Due to the fact that at least 70 to 80 percent of the average organization's work involves land or geographical related issues or tasks which involves land management, this necessitate the study of our environment using satellite imageries. Also, because these may cover a wide geographical area or spread or widely separated from each other, a system of integrating the methods of change study was developed over time (Zubair, 2006). These developments eventually lead to the use of Geographic Information System (GIS) technology.

The term "GIS" is applied loosely to a large group of interrelated technologies. A GIS is a computer technology that combines geographic data (The location of manmade and natural features on the earth's surface) and other types of information (names, classification, addresses, much more to generate visual maps and reports. A GIS uses geographic location to relate otherwise disparate data and provides as systematic way to collect and manage location based information crucial to organizations.

Hence this study is not only concerned with the analysis of the use of land in Ilorin and its environs using Landsat imageries of 1996, 2010 and 2016 and existing maps. The acquired data can be modeled using modern technology that is the Geographic Information System (GIS) to produce reliable land use information for the area. More so a better understanding of the rate of development the nature of the land use change with respect to population density and the future impact of the population growth in Ilorin and its environs will be obtained. Landsat imageries has been used for analysis of natural resources of nations. The applications of these imageries are so diverse to carryout study of our environment.

Remote sensing data can be very useful to produce map/monitor/survey/manage various natural resources of the country. Several areas of application such as Agriculture, Soil, and Environment, Water Resources, Rural Development, Urban Development, and Disaster Management etc., which are of direct relevance to the nation natural resources development.

Therefore, the application of urban-rural satellite remote sensing for future town planning is not only sensible but utterly necessary. Arguments in favour of the use of satellite systems are certainly the fast data access, the quick visual interpretation, the good representation on a planar surface and their great integrity of a map after the process of geometrical image correction. A further advantage is the possibility of a qualitative as well as quantitative classification, such as the generation and analysis of, for example, urban boundaries, lay-out structures, building densities and sealing degrees (Balzerek, 2009).

Remote Sensing (RS) has proved its immense potential for inventory of urban development world over. The spatial resolution of Landsat imageries permits the study of urban development. Landsat imageries can also be used for the measure of acreage of vegetation land. Likewise it can be used in the gathering of all necessary data for carrying out precision farming which in the long run improve economic base of a nation.

The population explosion in the country has placed great strain on the environment. This along with a move towards urbanization and industrialization has placed significant pressure on the infrastructure and natural resources. Deforestation, soil erosion, water pollution and land degradation continue to worsen and are hindering economic development in rural area. Remote sensing and GIS technologies can be used to study environmental impact assessment on the environment.(Chandrasekhar,el ta 2010).

Remote Sensing technology is extremely useful to study and manage the natural ocean resources. Studies on chlorophyll, aerosol distribution, and coastal pollution address the global warming and pollution issues. While studies on Potential Fishing Zone (PFZ), oil slicks, mineral deposits and tourism have economic significance, studies on coastal zone, mangrove degradation, coral bleaching, etc., are useful in maintaining the eco-system intact. In spite of having economic importance, aqua culture development and construction of ports inappropriately may disturb the ecology. Strategic applications like ship identification and their velocity estimation are also critical. Various other studies like influence of tropical cyclones on chlorophyll-a concentration, estimation of primary productivity have also been carried out using satellite data.

Remote sensing and Geographical Information System (GIS) were accepted as effective tools in water resources development and management to complement and supplement ground data. Space borne remote sensing data provides timely and reliable information on available water resources and its utilization. Remote sensing inputs have been significantly contributing in water management in India, both in its conservation and control aspects. This can also be applied to our own environment.

With the advent of remote sensing and Geographical Information System (GIS), the city planners have begun to evaluate the resources in a multi-disciplinary approach for timely results and with less preparation cost and manpower support. Remote sensing data has been widely used in preparation of perspectives plan and development plan. It includes mapping of present land use, infrastructure network (roads, railways and settlements), hydrological features (river/stream, lakes), etc., useful for preparation of regional level landscape, updating of base maps, urban sprawl, land use change and population growth and master plan proposals.

1.1 Remote Sensing Data and GIS for the study of Ilorin and its Environs

Information on the spatial spread and monitoring the dynamics of the land use/land cover is a basic prerequisite for planning and implementing various developmental activities. Apart from this, nationwide land use information becomes important for addressing changing pattern in land use/land cover.

Under this study remote sensing satellite was used to study five categories of land use of Ilorin and its environs. The study carried out is classified into the following: vegetation, settlements, bare land, tarred surfaces and water body.

1.2 Study area

Ilorin is located within longitude 08°29’ 21”E latitude 04°30’ 50”N and 08°30’ 43”E latitude 04°33’ 01”N. It housed the capital of Kwara State. It has been experiencing rapid urbanization since 1967 when it became the capital of Kwara State. The extent of its built-up area in 1967 was about 8.37km² but it has today increased by about sixty percent in the year

2010.

The study area is located within the guinea savanna region of the country. It is characterized by deciduous trees of mixed traits e.g. silk-cotton, locust bean tree, tall grasses also grow in the area.

Ilorin is one of the fastest growing area in Nigeria. The population census (1991) put the population at 619,310. The city had a population of 809,171 in 2001 and 904,102 in 2006 national census. This trend in population growth rate shows a rapid growth in population. The growth rate between 1991 and 2006 is at 5.11 which is higher than many other areas in the country. The study area covered a total land mass of 28,946sq Km.

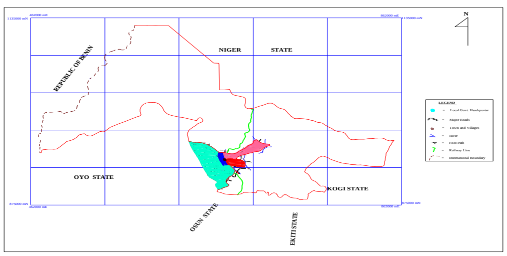

Fig 1 Map of the study area

2.0 METHODOLOGY

2.1 Data Manipulation

For the study, Landsat satellite images of Kwara State were acquired for two Epochs; 2000, 2006 and 2012. All imageries were obtained from National Space Research and Development Agency in Abuja (NASRDA).

Global Mapper was used for displaying and subsequent processing and enhancement of the image. It was also used for the carving out of Ilorin from the whole of Kwara State imagery using both the administrative and local government maps.

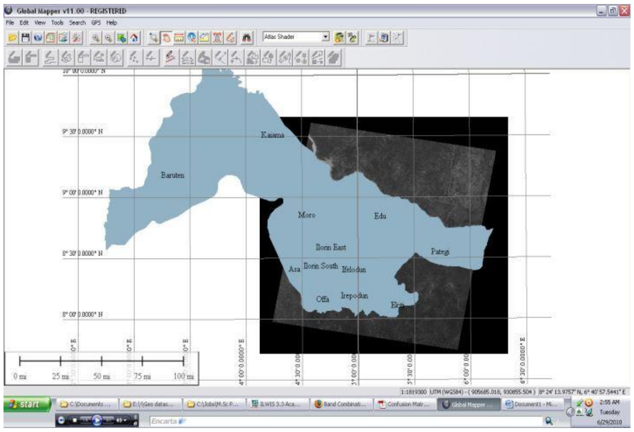

Fig 2 Overlay of Kwara state LGAs on the Landsat Image of the study area

2.2 Development of a Classification Scheme

Based on the priori knowledge of the study area for over 20 years and a brief reconnaissance survey with additional information from previous research in the study area, a classification scheme was developed for the study area after Anderson et al (1976). The classification scheme developed gives a rather broad classification where the land use land cover was identified by a single digit.

Table 1 Land use land cover classification scheme

S/No	CLASSIFICATION
1	Built up
2	Tarred surfaces
3	Vegetation
4	Water Body
5	Bare soil

The classification scheme given in table 3.2 is a modification of Anderson's in 1967.

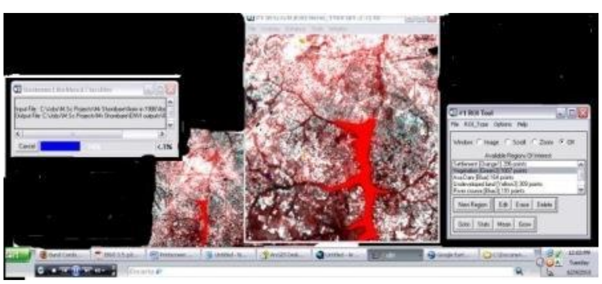

Fig 3 Classification process using region of interest as the training set.

The choices of the above land used categories were chosen in order to carry out new trend of development in the study area. For instance tarred surfaces were separated from Bare land in order to carry adequate analysis on road construction in the study area.

3.0 DATA ANALYSIS

The objective of this study forms the basis of all the analysis carried out in this write up. The results are presented inform of maps, charts and statistical tables. They include the static, change and projected land use land cover of each class.

3.1 Land Use /Land Cover Distribution

The static land use land cover distribution for each study year as derived from the maps are presented in the table below

Table 2 Land Use Land Cover Distribution (1996, 2010,2016)

LANDUSE/LAND COVER CATEGORIES	1996		2010		2016	
	AREA (Ha)	AREA (%)	AREA (Ha)	AREA (%)	AREA (Ha)	AREA (%)
Built - up	7091	24.49	8057	27.84	10500	36.27
Tarred surfaces	75	0.26	98	0.33	110	0.38
Vegetation	10661	36.84	10494	36.26	10011	34.59
Water Body	2117	7.31	2117	7.31	2117	7.31
Bare soil	9002	31.10	8180	28.26	6208	21.45
Total	**28946**	**100**	**28946**	**100**	**28946**	**100**

The figures presented in table 2 above represents the static area of each land use / land cover category for each study year.

Built-up in 1996 occupies 24.49% of the total classes while it increased to 36.27% in the year 2016. This may be unconnected to civil unrest in the northern part of the country which forced some people to move down to Kwara state which is a bit peaceful and conducive for living.

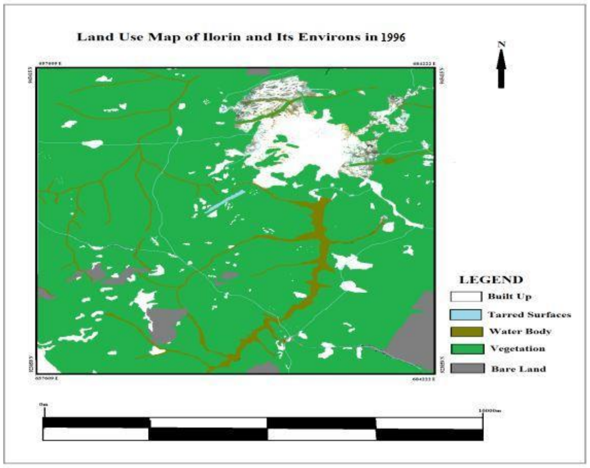

Fig 4 Map of study area and its land use land cover in 1996

Also, tarred surfaces increase steadily from the year 1996-2016. This development can also be due to the interest of civilian government in the state which place more emphasis on road construction. More importantly, developments of roads in the study area also increase tremendously during the study years.

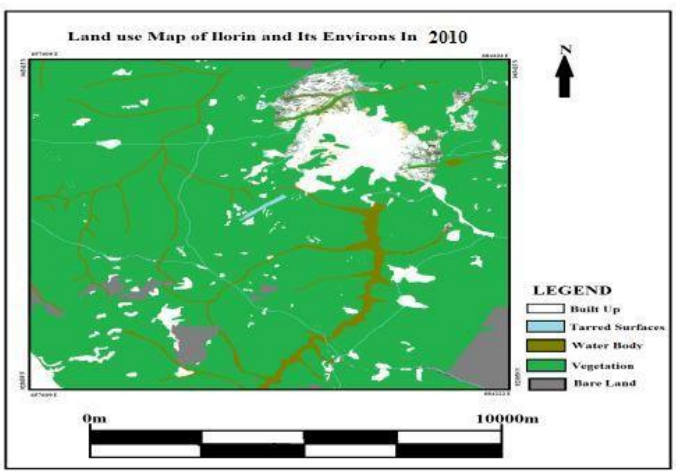

Fig 5 Map of study area and its land use land cover in 2010

The pattern of land use land cover distribution in 2010 also follows the pattern in 1996. Bare soil still occupies a major part of the total land but there exist an increase by half in the total built-up. Still, tarred surfaces maintain the least position in the classes whilst built-up occupies 36.27% of the total class.

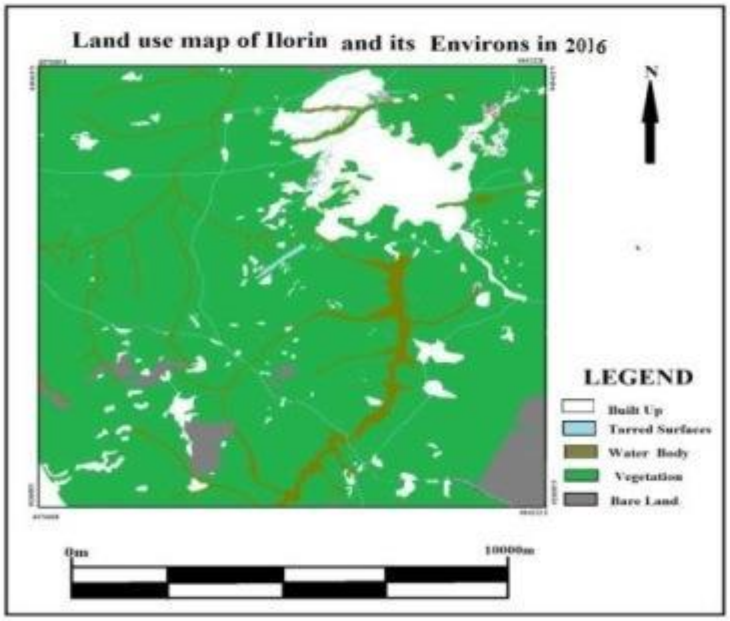

Fig 6 Map of study area and its land use land cover in 2016.

3.2 Land Use Land Cover Change for planning purpose

From table 4.4 below, there seems to be a negative change i.e. a reduction in vegetation cover between 1996 and 2016.

Table 3 Land use change of Ilorin and its environs in 2000 , 2006 and 2012

LAND USE / LAND COVER CATEGORIES	1996-2010		2010-2016		ANNUAL RATE OF CHANGE	
	AREA IN (Ha)	PERCENTAGE CHANGE	AREA IN (Ha)	PERCENTAGE CHANGE	1996-2010	2010-2016
Built - up	966	11.99	2443	23.27	1.85	3.88
Tarred surfaces	23	12.24	12	10.97	2.04	1.82
Vegetation	-167	-1.59	-483	-1.66	-0.27	-0.80
Water Body	0	0.00	0	0.00	0.00	0.00
Bare soil	-822	-10.05	-1972	-31.77	-13.70	-0.35

Subsequently, built-up land percentage change increased by 11.99% while both tarred surfaces also has a percentage change increase of 12.24%. While there is a decrease of 10.05% on the Bare soil which may be unconnected to the development that is been carried out in the area. The period between 2010 and 2016 witnessed a steady increase in the rate at which the physical expansion of the area was going along 1996 and 2010. For instance, the built-up land alone increased to 23.27% as against 11.99% increase between 1996 and 2010.

This is also evident in the rise observed in the land absorption coefficient from 1.85 between 1996 and 2010. Indeed, the security situation in the north eastern part of the country seriously contributed in no small measure to the developmental process in the study area, since the study area is the gateway between the north and southern part of Nigeria.

3.3 Nature and Location of Change in Land Use Land Cover

An important aspect of change detection is to determine what is actually changing to what i.e. which land use class is changing to the other. This information will reveal both the desirable and undesirable changes and classes that are "relatively" stable overtime. This information will also serve as a vital tool in management decisions. This process involves a pixel to pixel comparison of the study year images.

In terms of location of change, the emphasis is on built-up land this change between 1996 and 2016. This is shown map generated for land use land cover for each year are shown in figure 4-figure 6.

On the other hand, looking at the nature of change under stability i.e. areas with no change and instability- loss or gain by each class between 1996 and 2010 particularly in the change in hectares as observable in table 3, stability seems to be a relative term as no class is actually stable during this period except when observed from the percentage change.

Thus, between 1996 and 2010, Vegetation has a loss of 0.27% likewise a decrease of 0.80% between 2010 and 2016. Bare land also decreases by 13.70% between 1996 and 2010 and a further decrease of 0.35% between 2010 and 2016. Built-up land increased i.e. gained by 1.85% between 1996 and 2010 which is incomparable with the increase of 3.88% between 2010 and 2016. This is an evidence of rapid development in the study area. Vegetation land dropped by 1.59% between 1996 and 2010 and a minimal increase of 1.66% between 2010 and 2016, while water bodies and tarred surfaces almost remain constant when compares with each other.

4.0 CONCLUSION

This study demonstrates the ability of Geographic Information System and Remote Sensing data in analysis of spatial-temporal information.

- Attempt was made to capture as accurate as possible five land use land cover classes as they change through time. The five classes were distinctly produced for each study year but with more emphasis on built-up land as it is a combination of anthropogenic activities that make up this class; and indeed, it is one that affects the other classes.
- However, the result of the work shows a rapid growth in built-up land between 1996 and 2010. This is an indication of development which the government should prepare ahead for provision of necessary amenities in the study area. The result of this study can also be used by the government to access their contribution to the society.

Recommendations

- There is likely going to be more built-up in Ilorin and its environs in the later years. This situation will have negative implications in the area because of the associated problems of crowdedness like crime and easy spread of diseases.
- Bare land seems to be reducing between 1996 and 2016 and between 2016 and 2025 thus signifying a desirable change of development. Vegetation land has been on steady reduction between 1996 and 2016; this may likely be the trend in the nearest future. It will be in the good of the State and in deed, the Nation as a whole if the moderate reduction in vegetation land observed between 1996 and 2016 is upheld, so that food production will not be adversely affected.
- The monitoring of rapid urban growth as evidenced by changes in land use in this study is a major concern that has been frustrated by lack of up to date data/ information on changes in urban land use. Such information is necessary to provide a basis for a more effective understanding and management of the urban environment. It is therefore recommended that geospatial information should be readily available for use. This may be by creating outlet for sale in each state capital of the federation. More importantly, the federal government should make it as a point of duty to develop more platforms for acquisition of geospatial information in the country.
- It is also recommended that there is need to carry out frequent updating of the study area database using Geographic Information System and Remote Sensing systematically

(every 5 years for example) to detect the new changes, which depend mainly on the frequency and occurrence of urban changes and the socio-economic development of the area.

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