APPLICATION OF GIS IN MONITORING URBAN DEVELOPMENT IN ILORIN AND ITS ENVIRONS (1986-2006)

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Abstract
This paper aims at detecting and analyzing urban-rural land use and land cover *change of Ilorin and its environs of Kwara State in Nigeria, using Remote Sensing (RS) and Geographical Information Systems (GIS). In this study three Landsat imageries were acquired. The analysis covers 1986, 2000 and 2006 due to available Landsat imageries covering the study area adopting six distinct classifications of landuse using supervised classification method. ArcGIS and ENVI software were used for data processing, while SPSS was used for the statically analysis. The marginal population and the impervious land use and land coverin thestudy area were calculated. The study reveals a 29.2% and 150% increase in built up land between 1986-2000 and 1986-2006 respectively. The rate of Land and vegetation consumption is worrisomely unsustainable, where over 155Km^2 of land and vegetation is encroached for various forms of developments within six-year period (2000-2006). It's therefore recommended as a matter of urgency a smart growth, Brownfield redevelopment strategy and a well-equipped development control mechanism in the Local Planning Authorities, out of other measures for land resources sustainability.*

Keywords: *GIS, RS, Urbanization, Urban-rural settlement, Land use and Land cover*.

Introduction

The dispersion of new homes, workplaces, retail outlets and other facilities farther and farther into suburbia and beyond now widely described by the pejorative term "sprawl" has brought with it a growing chorus of complaints about punishing traffic jams, deteriorating air quality, shrinking farmland and characterless communities. Along with the criticism have come a growing attempts and efforts to put geographic limits on the growth.

A number of scholars have attempted to examine the growth and expansion of Ilorin andits environs (Opeloyeru 1983, Adedibu 1983, Jimoh 2004), meanwhile most Authors' submissions were based on just the Township of Ilorin (excluding other parts of the region) their findings are based on manual estimation from hard copies of township maps and street guides.

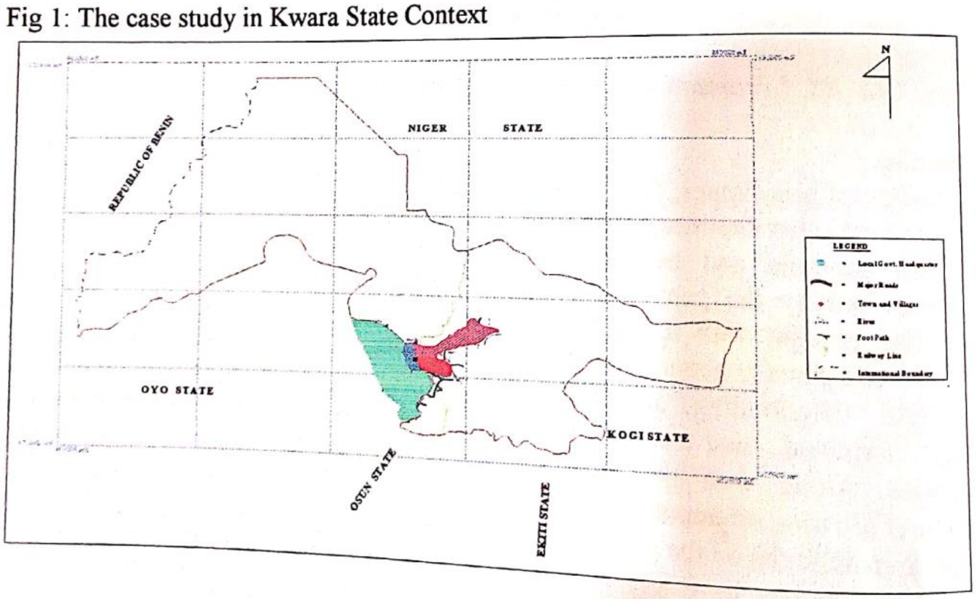
Information on the spatial spread and the dynamics of the land use and land cover change is a basic prerequisite for planning and implementing various developmental activities forms the basis of this paper. The importance of accurate and detail land use information is important for addressing changing pattern and rate in land use and land cover cannot be over emphasised. It is on this premise that this study employed Remote Sensing Satellite to study the growth rate and identify the categories of land use and land cover that changes in Ilorin Township between 1986 and 2006 with the view to determine the sprawling nature and monitoring the rate of land use conversion for different land uses at the expense of the rural landscape and vegetation in the study area. The study attempts the classification of land uses into the following: vegetation, settlements (built area), rock, dam, water body and paved surfaces. The paper concludes by recommending sustainable planning strategies for stemming all associated negativities.

The 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. 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 found in the area. The Township plays host to Kwara State as the Capital. It lies along Lagos-Kaduna highway, it is approximately 306 km from Lagos, 600km from Kaduna and about 500km to the Federal Capital City .The area has been experiencing rapid urbanization since 1967 when it became the capital of Kwara State. The extent of its built-up area between 1935 and 1963 was between 2 - 5km^2, while in 1967 the land cover was about 8.37km^2 (Jimoh 2004), but it has today increased in multiple folds in the recent years.

Ilorin and its environs is one of the fastest growing areas in Nigeria. The population census (1991) put the population at 619,310. It had a population of 809,171 in 2001 and 904,102 in 2006 national census (NPC, 2006). 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 most other areas in the country (Asonibare 2010). The study area covered a total land mass of 205,088Ha (2050.88Km^2).

Fig 1: The case study in Kwara State Context



Methodology

Meanwhile, for this study, LANDSAT satellite images of Kwara State were acquired for 1986, 2000 and 2006 datasets. All imageries were obtained from National Space Research and Development Agency in Abuja (NASRDA). Ilorin andits environs was carved out and subsequently brought to Universal Transverse Mercator projection in zone 31. Global Mapper was used for displaying and subsequent processing and enhancement of the image.

Fig 2: Landsat Imagery covering of the study area

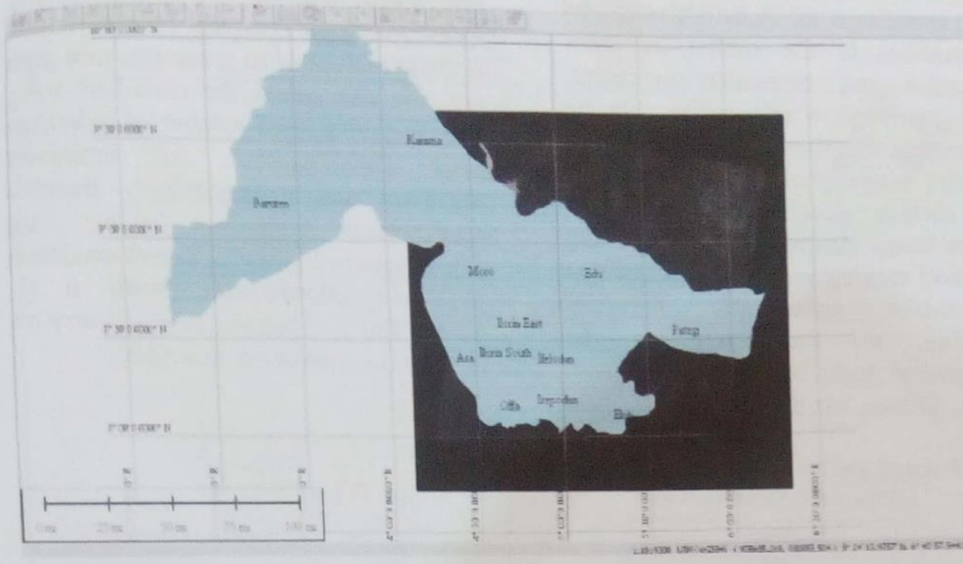
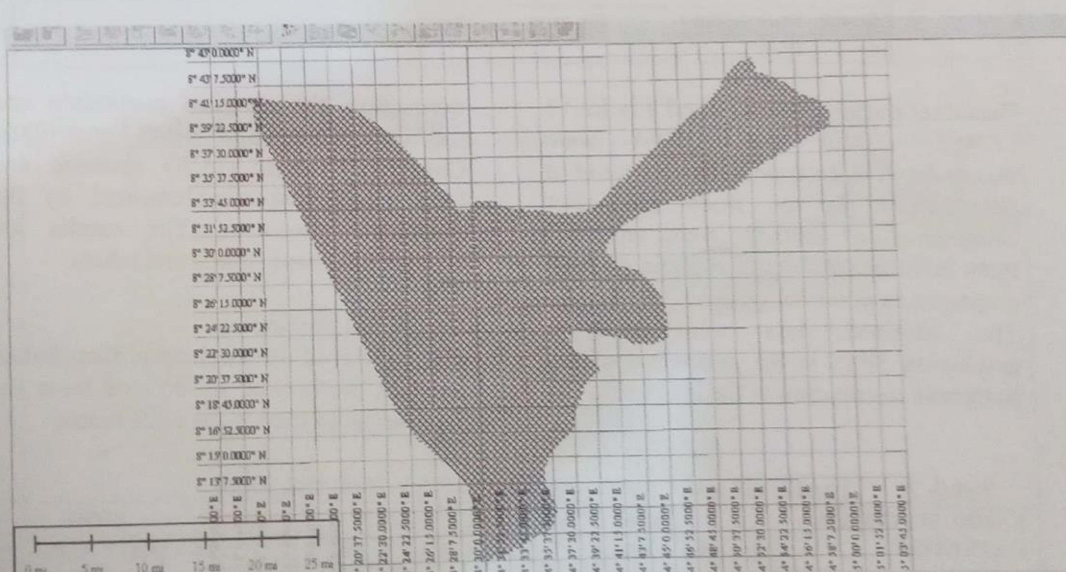


Fig 3: Clipped out map of the study area.



ArcGIS was also used to compliment the display and processing of the data extraction of Study area from Nigeria LGAs shape files using. ENVI was used for enhancement of the clipping out the study area. Based on the reconnaissance survey with review of literature of previous research in the study area, Based on previous knowledge of the study area and a brief reconnaissance survey along with additional information from previous research in the study area, a classification scheme was developed using a supervised method. The land-use types classified are: built-up, paved surfaces, vegetation, water body, dam and bare soil. Image classification assigns the decision making process to the computer. The intent is to replace sometimes the vague or ambiguous interpretations of the analyst by more quantitative and repeatable processes. Image classification of satellite data by computer has the potential for efficient and consistent mapping of large areas of the earth's surface.

Because image classification is essentially a decision making process with data that can exhibit considerable statistical variability, we must rely on the mathematical tools of statistical decision theory. At best, the decision to classify a pixel into any particular classes is referred to as statistically intelligent "guess", which has some associated probability error. Consequently, it is logical for the decision made at each pixel to minimize some error criterion throughout the classified areas, that is, over a large number of individual pixel classifications. An intuitively satisfying and mathematically tractable classification theory having the aforementioned property shows maximum likelihood classification (Brito et al., 2006). This is what was used to carry out the classification under this study.

Table 1: Land use land cover classification scheme

S/No	CLASSIFICATION
1	Built up
2	Paved surfaces
3	Vegetation
4	Water Body
5	Rock
6	Dam

Resultant images Band 1, 2 and 3 in ENVI (1986), (2000) and (2006) were manipulated to determine the new trend of development in the study area. For instance paved surfaces were separated from built area for detail analysis on road construction in the study area.

The obtained data were analysed employing SPSS in the generation of the percentile distribution of the land use occupation, the marginal population and the impervious land cover and Land Consumption Rate (LCR) obtained and Land Coefficient complemented by the descriptive measures. The results are presented in maps, charts and tables.

Result and Discussion

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 (1986, 2000 and 2006)

LANDUSE/ COVER CATEGORY	1986		2000		2006	
	AREA (Ha)	AREA (%)	AREA (Ha)	AREA (%)	AREA (Ha)	AREA (%)
Built – up	7091	3.46	9158	4.47	18086	8.82
Paved surfaces	85	0.05	187	0.09	407	0.20
Vegetation	177663	86.62	176317	85.96	167813	81.82
Water Body	3117	1.52	2251	1.10	2251	1.10
Rocks	16160	7.88	15331	7.48	14687	7.16
Dam	972	0.47	1844	0.90	1844	0.90
Total	**205088**	**100**	**205088**	**100**	**205088**	**100**

Source: Author's Computation 2012

The figures presented in the above table 2 represent the static area of each land use / land cover category for each study year. The Built-up in 1986 occupies 3.46% of the total classes while it increased to 8.82% in the year 2006.

Fig4: Land use land cover in 1986

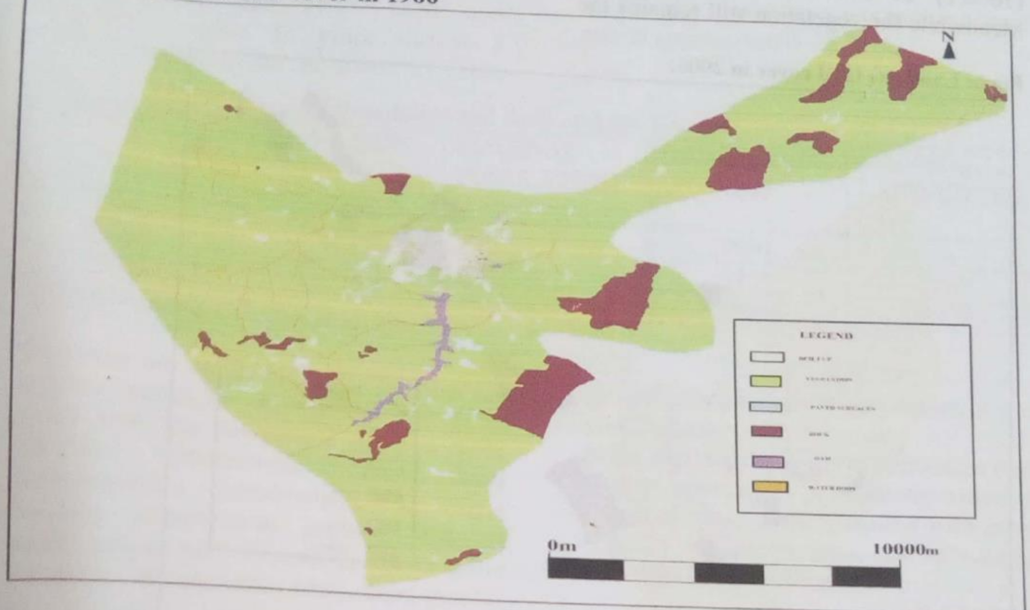
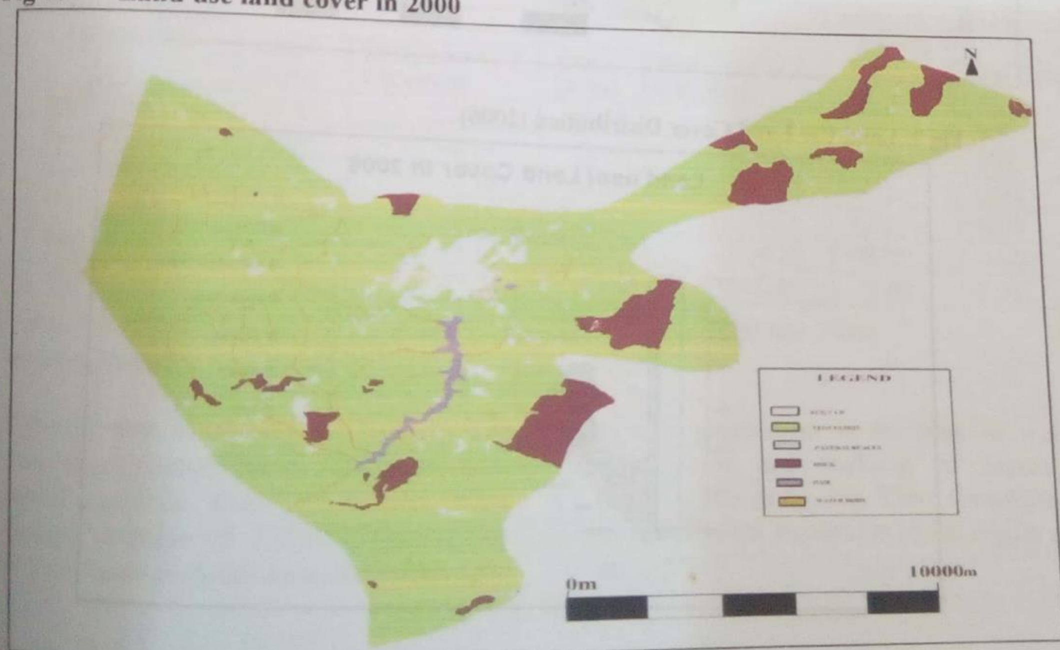


Fig 5: Land use land cover in 2000



Also, paved surfaces increase steadily from the year 1986-2006. Likewise, farming and other vegetation seems to be on a moderate changes this may be due to development of mechanized agriculture which hinders built-up development to have significant effect on the vegetation. Vegetation is occupying 86.62% (1176.63) in 1986, 85.96% (1763) in 2000 and 78.41 (1608.1) of the total land in 2006. Meanwhile the vegetation still remains the most vulnerable category of land uses as reflected in the above table with annual conversion rate of about 26 KM^2 (2600Ha) between 2000 and 2006.

Fig 6: Land use land cover in 2006.

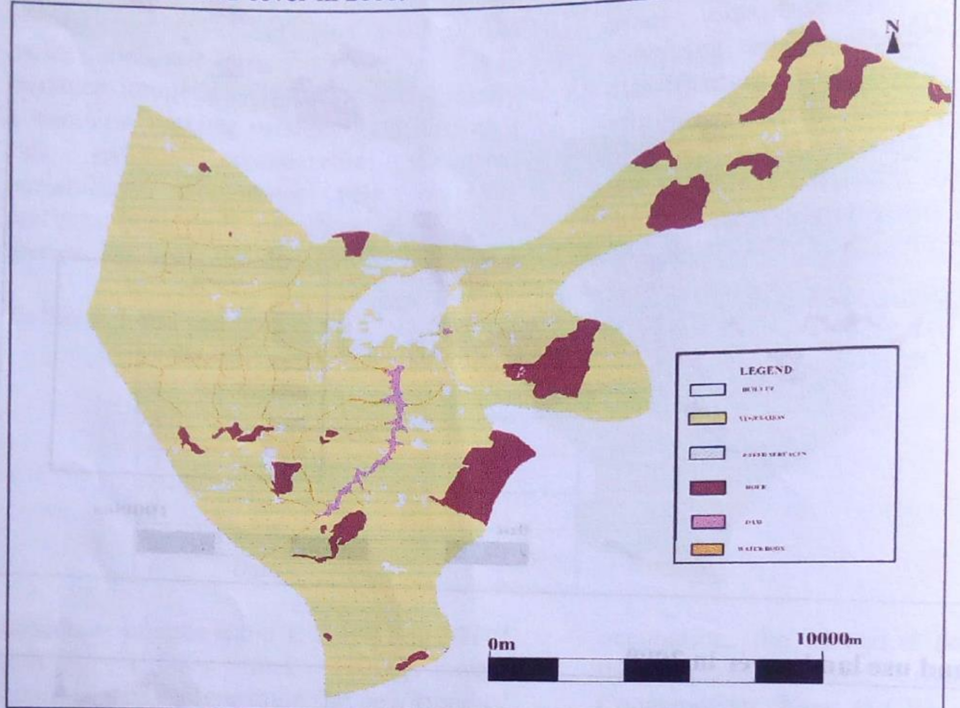
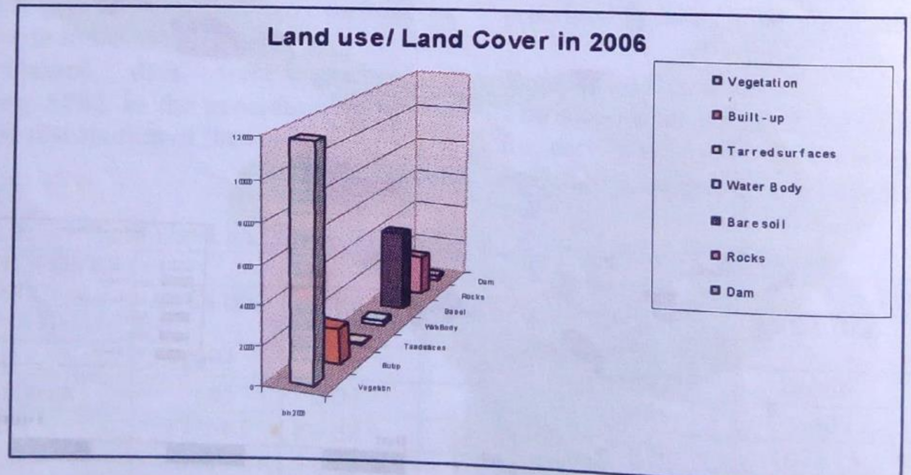


Fig 7: Land Use Land Cover Distribution (2006)



The pattern of land use land cover distribution in 2006 also follows the same pattern in 2000. Land and vegetation still occupies a major part of the total land but there exist an increase by half in the total built-up. Still, paved surfaces maintain the least position in the classes whilst built-up occupies 5.11% of the total class.

Land Use Land Cover Change and the Occurrence of Sprawl

From table 3 below, there is negative change i.e. a reduction in vegetation cover between 1986 and 2000. Land and Vegetation within 14 years witness a massive consumption of about 21.75Ha, representing an annual rate of approximately 1.6Ha. Meanwhile, as high as 91.48Haof Land and vegetation were converted just within 6 years (2000-2006). This figure represents a worrisome annual rate of approximately 15.25Ha.

Tab 3: Total and Marginal Population and Built up Land Cover

PERIOD	POPULATION	MAGINAL POPULATION	LAND COVER (Ha)	MAGINAL LAND COVER (Ha)
1986	554,282	-	7091	-
·2000	736,360	182,078	9158	. 2067
2006	904,102	167742	18086	8928

Source: Autor's Computation 2012

This may not be unconnected to improved welfare packages during the period of study and the favourable gesture from Lending Institutions and State Government's involvement in mass housing construction projects and its collaboration with Private Sector in Ilorin township. On the other hand, demographic change is another prominent factor of this development.

More importantly, surge in population may also be attributed to the peaceful nature of the study area when compared with other areas in the country. Low cost of building materials in the study area.

LAND USE / LAND COVER CATEGORIES	1986-2000		2000-2006		ANNUAL RATE OF CHANGE	
	AREA IN(Ha)	PERCENTAGE CHANGE	AREA IN (Ha)	PERCENTAGE CHANGE	1986-2000	2000- 2006
Built – up	20.67	22.57	89.28	49.36	1.61	8.23
Tarred surfaces	1.02	54.54	2.16	53.98	3.90	9.00
Land/Vegetation	-21.75	-2.18	-91.48	-13.45	-0.15	-2.11
Water Body	6.00	0.15	4.00	0.10	0.01	0.02
Rocks	-8.29	- 5.13	-6.44	-4.20	- 0.59	-1.07
Dam	8.72	89.71	0.00	0.00	0.62	0.00

Table 4: Land use change of Ilorin and its Environs in 1986, 2000 and 2006

Source: Authors' Computation 2012.

Subsequently, increasing the built-up land percentage change by 49.36% while both tarred surfaces also has a percentage change increase of 53.98%. During this period, many projects were embarked upon by the government in the area of road construction and building of housing estates in the study area. These contributed to the physical expansion of the region as an

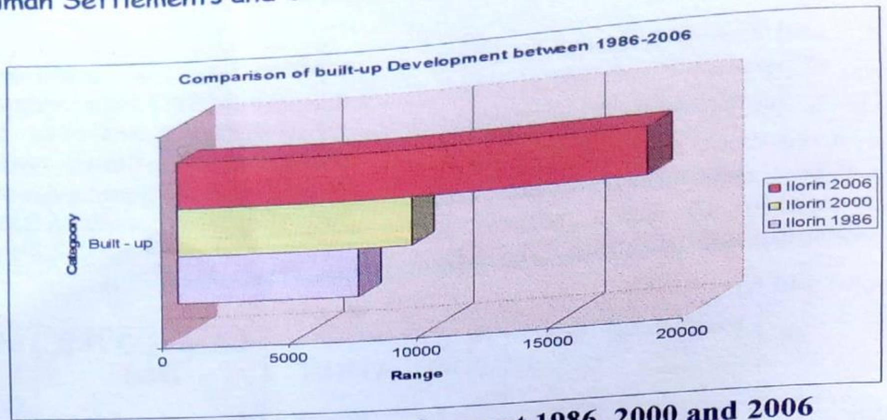


Fig 8: build-up Area Development 1986, 2000 and 2006

evident in the increase in land consumption rate from 0.005 to 0.02 and land absorption coefficient by 0.09 between 1986 and 2000. Some of these projects include Irewolede Housing Estate, Harmony estate I and II, Royal Valley estate and numerous other private estate which did not only encourage migration into the region but also an internal movement to the suburbs.

Factors of Growth in the Region

While probing into reasons the residents of the region prefer their current own house location various reasons ranging from cheap land, cheap rent, social environmental-friendliness were out of other factors that serve as centrifugal forces (see table 4 below) .

Table 5: Reasons for own House Location

			CORE	PERIPHERY	Total
REASON S FOR OWN HOUSE LOCATION	CHEAP LAND	Count	10	11	21
		% within REASON FOR OWN HOUSE LOCATION	47.6%	52.4%	100.0%
		%within LOCATION OF RESIDENT	4.4%	4.7%	4.6%
		%Total	2.2%	2.4%	4.6%
	CHEAP RENT	Count	18	19	37
		% within REASON FOR OWN HOUSE LOCATION	48.6%	51.4%	100.0%
		%within LOCATION OF RESIDENT	7.9%	8.2%	8.0%
		%Total	3.9%	4.1%	8.0%
	SOCIAL ENVIRONMENTAL FRIENDLINESS	Count	47	97	144
		% within REASON FOR OWN HOUSE LOCATION	32.6%	67.4%	100.0%
		%within LOCATION OF RESIDENT	20.6%	41.6%	31.2%
		%Total	10.2%	21.0%	31.2%
	CHILD FRIENDLINESS	Count	33	24	57
		% within REASON FOR OWN HOUSE LOCATION %within LOCATION	57.9%	42.1%	100.0%

	OF RESIDENT	14.5%	10.3%	12.4%
	%Total	7.2%	5.2%	12.4%
PROXIMITY TO WORK	Count	36	26	62
	% within REASON FOR OWN HOUSE LOCATION	58.1%	41.9%	100.0%
	%within LOCATION OF RESIDENT	15.8%	11.2%	13.4%
	%Total	7.8%	5.6%	13.4%
INHERITED	Count	78	54	132
	% within REASON FOR OWN HOUSE LOCATION	76.6%	23.4%	100.0%
	%within LOCATION OF RESIDENT	34.2%	23.2%	28.6%
	%Total	17.9%	11.7%	28.6%
WILLINGNESS	Count	6	2	8
	% within REASON FOR OWN HOUSE LOCATION	75.0%	25.0%	100.0%
	%within LOCATION OF RESIDENT	2.6%	.9%	1.7%
	%Total	1.3%	.4%	1.7%
TOTAL	Count	228	233	461 100.0%
	% within REASON FOR OWN HOUSE LOCATION	49.5%	50.5%	100.0%
	%within LOCATION OF RESIDENT	100.0%	100.0%	100.0%
	%Total	49.5%	50.5%	100.0%

Source: Author's field survey (2012)

Meanwhile factors such as increased affluent and private sectors and Government involvement in the provision of "affordable houses" and infrastructural provision such as road are other factors with meaningful influence on the phenomenon.

Summary of findings

The findings reveal an important aspect of change, detection of land use changing to the other (desirable and undesirable) and those that are "relatively" stable overtime. This information is considered a vital tool in urban management decisions involving a pixel to pixel comparison of the study year images.

(i) Attempt was made to capture as accurate as possible six land use land cover classes as they change through time. However, the result of the work shows a rapid growth in built-up land between 1986 and 2006. This development is an indication for the municipal governments to prepare ahead for provision of both preventive and corrective strategies in the core for necessary amenities, the absence of which serves as a push factor for its inhabitant to the periphery in the study area. It was also noted that there has been no new development of water facilities in the study area since 2000, this may in the nearest future lead to water scarcity in the area.

(ii) While other land uses gained in prominence, Land and vegetation record tremendously loss in an unsustainable manner. Change is inevitable, but yet it has to be sustainably achieved, attention has to be paid as a matter of urgency to put on check the rate of farm land and vegetation wanton consumption, especially at this era of Global warming that vegetation plays a crucial role in mitigation and adaptation to climate change scourge.

Conclusion and Recommendations

The result of the study shows a promising trend in the unsustainable growth in the study area and its resultant consumption of the natural vegetation if the trend remains unchecked. This could be achieved through acquisition of more tools to monitor this phenomenon and increased and release of budget for planning especially, inner city regeneration. Development Control should adopt the enforcement of 10-15% (gross) green area with Shrubs, within residential development, as a prerequisite for Building Permit and approval.

The establishment of the Brownfield Unit in the Development Control Department of Planning Authorities to engage in "Brownfield redevelopment and infill" strategy of inner-city regeneration, an approach considered a smart-growth strategy that do not only create an environmental friendly neighbourhood but also resultantly discourage exodus of population from urban core to the fringe and enhances retaining tendency of the inner city and discourages sprawl, is hereby strongly recommended.

It is also considered important to monitor and manage the township growth in partnership with private sector with adequate involvement of the public, so that the burden of development control will be shared for effective and sustainable environment.

Finally, monitoring of urban growth could be challenging and frustrating especially with lack of up . to date information 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 used and frequently update, of on-spot change detection in the study area with prompt action taken.

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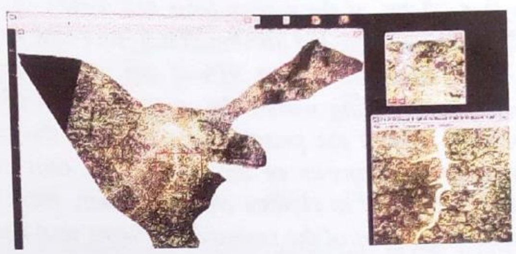
Appendix 1: Classification using region of interest as the training set.

Appendix 2 Resultant image: Band 1, 2 and 3 in ENVI (1986)



Appendix 3: Resultant image: Band 1, 2 and 3 in ENVI (2000)

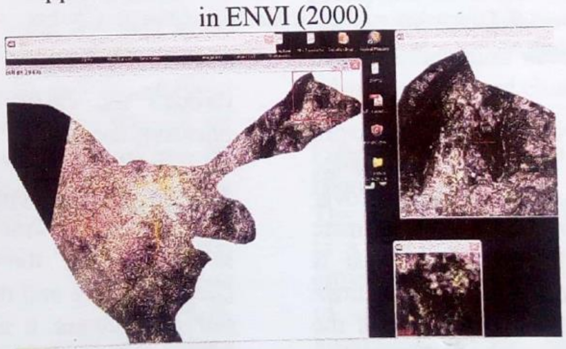


Fig 8 Resultant image: Band 1,2 and 3 in ENVI (2006)