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ANALYSIS OF LAND USE CHANGE IN IKEJA, LAGOS STATE, NIGERIA (2005-2015)

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ABSTRACT

Against the background of seemingly uncontrollable land use and land cover change, and its resultant implications on environmental quality in most urban centres of the developing countries, this paper analyzes the nature, spatial and temporal dimensions of land use/land cover change and its effect in Ikeja, Lagos, Nigeria. The study made use of primary data obtained from Google Earth Pro satellite imagery and questionnaire to collect data pertaining to land use and related issues. Firstly, images obtained in the Envi 5.0 were classified into three categories: developed, vegetation and open space/undeveloped. Frequency count and percentages were used to summarize the data generally, and to illustrate the nature and magnitude of change from one use to another over a period of ten years (2005-2015). The study revealed that developed area increased between 2005 and 2015 by 10.66% and open space/undeveloped land (including cleared area for anticipated physical development) by 193.06%, with a resultant decrease in vegetation land cover by 50.28 % within the period. The study also showed that there was a less controlled urbanization and unguided land use change in Ikeja local government area of Lagos state, which tends to have a negative implication for sustainable development of the area. It, therefore, recommended that the efforts of planning authority and other development control agencies should be intensified to forestall further encroachment of farmland/green space which might have been zoned for non-physical development use, and to ensure effective control of land use and physical development generally.

KEYWORDS: Analysis of Land Use Change in Ikeja

INTRODUCTION

Man is significantly altering Earth surface and this has had a profound effect on the natural environment thus resulting into an observable pattern in the land use over time (Oludayo 2011). Man continues to explore and exploit the natural resources in his environment and this has brought an immense contribution to observable changes in land and land use. “Land use involves both the manner in which the biophysical attributes of the land are manipulated and the intent underlying that manipulation – the purpose for which the land is used” (Turner et al. 1995). Land use (LU) can be considered to be reflecting the degree of human activities directly related to land and making use of its resources or having an impact (Young, 1994), which tends to vary over time.

Land use change plays a major role in the study of global change. Land use and human/natural modifications have largely resulted in deforestation, biodiversity loss, global warming and increase of natural disaster. These environmental problems are often related to land use changes, which are caused by growing population and increasing socio-economic necessities, and the resultant pressures on land and land use. These pressures and the concomitant land use alterations are generally followed by mismanagement of agricultural and forest lands, which, in most cases, particularly in developing countries, are occasioned by unplanned urban population growth and unguided physical development, which lead to severe environmental problems such as landslides, floods etc. Therefore, available data on land use changes can provide critical inputs for urban growth and development planning.

The magnitude of land use change varies with the time being examined, the geographical area, and more importantly, the nature of land cover. Land cover is defined as the observed (bio)-physical cover of the earth's surface (Di Gregorio and Jansen 1997, 1998). The definition embraces vegetation and man-made features and includes bare rocks, bare soils, and water areas. Data on land use/land cover may not, therefore, be easily obtained except with relevant remote sensing technologies and techniques.

Remote sensing and Geographical Information Systems (GIS) are powerful tools to derive accurate and timely information on the spatial distribution of land use/land cover changes over large areas. GIS provides a flexible environment for collecting, storing, displaying and analyzing digital data necessary for change detection. Remote sensing imagery is the most important data resource of GIS. The (satellite) imagery is used for recognition of synoptic data of earth's surface. Landsat Multispectral Scanner (MSS), Thematic Mapper (TM) and Enhanced Thematic Mapper Plus (ETM+) data have been broadly employed in studies towards the determination of land cover since 1972, the starting year of Landsat program, mainly in forest and agricultural areas (Selçuk Reis, 2008). The rich archive and spectral resolution of satellite images are the most important reasons for their use.

Therefore, the aim of change detection process is to recognize land use on digital images that change features of interest between two or more dates. There are many techniques developed in the literature using post classification comparison, conventional image differentiation, using image ratio, image regression, and manual on-screen digitization of change, principal components analysis and multi date image classification. A variety of studies have shown that post-classification comparison was found to be the most accurate procedure and present the advantage of indicating the nature of the changes. In this study, change detection comparison (pixel by pixel) technique will be applied to the Land use\land cover maps derived from satellite imageries. The main aim of this study, therefore, is to analyze land use/land cover changes and its effects in Ikeja Local Government using satellite imageries and GIS with a view to providing recommendations for sustainable development. Among others, it also identifies the socio-economic factors responsible for the change.

THE PROBLEM

Land use change is a popular concept and phenomenon in the existing literature of land, land use, urbanization, development control and related issues. Its resultant implications for physical fabric and socio-economic development and well-being of the affected populace are also issues of concern to scholars, policy makers and urban managers all over the world, particularly in cities of the developing countries, including Nigeria. Lagos state, Nigeria, has witnessed remarkable expansion and growth of development activities such as building, road construction, deforestation and many other anthropogenic activities over the years just like many other state capitals in Nigeria. This has therefore resulted in increased land utilization/demand and modification and alterations in the status of her land use/land cover over time without any detailed and comprehensive attempt to evaluate the extent of such changes over time with a view to detecting the land consumption rate and also make attempt to predict same and the possible changes that may occur so that planners can have a basic tool for planning. It is therefore necessary for a study such as this to be carried out in Lagos particularly in Ikeja area, where the case of land use change is high due to the impact of Airport. The questions that come to the fore, among others, are: what is the nature and quantum of land use change over the time period under consideration? What is the effect of such change? What proportion of such change is legal? How do we control and prevent illegal change in the future. These, among others, constitute the focus of this study.

CONCEPTUAL/THEORETICAL FRAMEWORK AND LITERATURE REVIEW

Land, Land Cover, Land Use and Land Use Change

Land comprises the physical environment, including climate, relief, soils, hydrology and vegetation, to the extent that these influence potential for land use. It includes the results of past and present human activities, e.g. reclamation from the sea, vegetation clearance, and also adverse results, e.g. soil salinization. A land mapping unit is a mapped area of land with specified characteristics. Land mapping units are defined and mapped by natural resource surveys, e.g. soil survey, forest inventory. Their degree of homogeneity or of internal variation varies with the scale and intensity of the study. In some cases a single land mapping unit may include two or more distinct types of land, for example, a river flood plain, mapped as a single unit but known to contain both well-drained alluvial areas and swampy depressions. Land is thus a wider concept than soil or terrain. Variation in soils, or soils and landforms, is often the main cause of differences between land mapping units within a local area: it is for this reason that soil surveys are sometimes the main basis for definition of land mapping units. However, the fitness of soils for land use cannot be assessed in isolation from other aspects of the environment, and hence it is land, which is employed as the basis for suitability evaluation.

Land use refers to the manner in which human beings employ the land and its resources. Land use involves the management and modification of natural environment or wilderness into built environment such as settlements and semi-natural habitats such as arable fields, pastures, and managed woods. It also has been defined as "the arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain it" (FAO, 1997a; FAO/UNEP, 1999). Land cover refers to the physical and biological cover over the surface of land, including water, vegetation, bare soil, and/or artificial structures (Erle Ellis & Robert Pontius Encyclopedia of Earth). It also implies the physical or natural state of the Earth’s surface.

The manner in which land use, land cover (including all forms of physical development) or human activities on the land is varied over time defines the concept of land use change, which must be thoroughly analyzed and understood for effective physical and socio-economic development control.

Application of Remote Sensing and GIS Techniques in Land Use Change

Remote Sensing can be defined as any process whereby information is gathered about an object, area or phenomenon without being in physical contact with it. Given this rather general definition, the term has come to be associated more specifically with the gauging of interactions between earth surface materials and electromagnetic energy.

A geographic information system (GIS) is a computer system for capturing, storing, checking, and displaying data related to positions on Earth’s surface. GIS can show many different kinds of data on one map. This enables people to more easily see, analyze, and understand patterns and relationships. With GIS technology, people can compare the locations of different things in order to discover how they relate to each other. For example, using GIS, the same map could include sites that produce pollution, such as gas stations, and sites that are sensitive to pollution, such as wetlands. Such a map would help determine which wetlands are most at risk. GIS can use any information that includes location. The location can be expressed in many different ways, such as latitude and longitude, address, or ZIP code. Many different types of information can be compared and contrasted using GIS. The system can include data about people, such as population, income, or education level. It can include information about the land, such as the location of streams, different kinds of vegetation, and different kinds of soil. It can include information about the sites of factories, farms, and schools, or storm drains, roads, and electric power lines (National Geographic Education Encyclopedia).

Land Use Analysis

Since the beginning of the 19th Century, vast portions of the earth’s surface have been modified, while ecosystems destroyed, and global biomass altered or eliminated (Fellmann et al 2005). The most important of the land surface changes in many parts of the developing country has been that of man’s activities, especially grazing, farming, bush burning, wood cutting and other activities such as road construction (Baltimore 1987). The knowledge about land degradation has become increasingly important as the nations plans to overcome the problems of haphazard, uncontrolled development, deteriorating environmental quality, loss of important wetlands, river encroachment, and loss of fish and wildlife habitat. Land use data are needed in the analysis of environmental processes and problems that must be understood if living conditions and standards are to be improved or maintained at current levels especially at this population exploding era (Ikusemoran Mayomi, 2009).

One of the prime prerequisites for land use control and management is information on the existing land use patterns and changes in land use through time. The knowledge about human impacts on land uses such as agricultural, recreational, as well as information on their changing proportions, is needed by legislatures, state and local Government officers to determine better land use policy, to identify future development on pressure points and areas, and to implement effective plans for regional development (Ikusemoran Mayomi, 2009).

Application of Gis in Land Use Analysis

The ability to forecast land use and land cover change and ultimately to predict the consequences of such change will depend on our ability to understand the past, present and future states of land use and land cover change (Oyinloye M. A., Kufoniyi O., 2011). This ability is enabled through the use of multi temporal remote sensing data and or aerial photographs which provides valuable information for natural resources like land, water, forests, urban areas and infrastructure facilities such as road network, river network etc (National Research Council, 2001). Remote Sensing/Geographic Information System (GIS) has been applied to land use and land cover change analysis, detection and monitoring all over the world. Mattikalli, (1995), applied Remote Sensing and GIS to the land use of the River Glen catchments in England by acquiring data from 1931 to 1989. His work revealed that much of the grassland changed to arable land during the study.

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. The unsupervised classification was used to classify the images into land use classes. Census polygon was constructed into various sets of units using census data in a GIS, and then comparison made with the classified image population in surface areas. In his studies carried out by 2004 in Shaoxing City in China, Zhi-Yong Yin uses satellite imageries for the year 1984, 1997, and 2000. One of the goals of the study was to produce a land use 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.

STUDY AREA AND RESEARCH METHODOLOGY

The Study Area

Lagos is located in the south –western part of Nigeria. It served the dual purpose of the commercial and administrative headquarters of Nigeria until the mid 1990s when the administrative headquarters of Nigeria was moved to Abuja. Lagos is located around latitude 6° 27' N and Longitude 3° 24'E. This falls just above the equator on Africa continent. The metropolitan Lagos has an area of about 137,460 hectares and spreads over 3345 sq km (1292 sq mi). The islands are connected to each other and to the mainland by bridges and landfills. Lagos has a very diverse and fast-growing population, resulting from heavy and ongoing migration to the city from all parts of Nigeria as well as neighboring countries. According to Nigerian National Population Commission (NPC), its metropolitan area was about 9 million people in 2006.

Apart from its administrative function, Ikeja contains industrial areas such as Ikeja, Ogba and Oregun industrial estates. Commercial centre includes Ikeja Central Business District (CBD) at Alausa, Ipodo market at Ikeja, Ogba retail market, Alade market at Allen Avenue, among others. Residential area includes Opebi, Adeniji Jones, Omole phase 1, Agidingbi, Toyin Street, Ogba, Allen etc. and other uses.

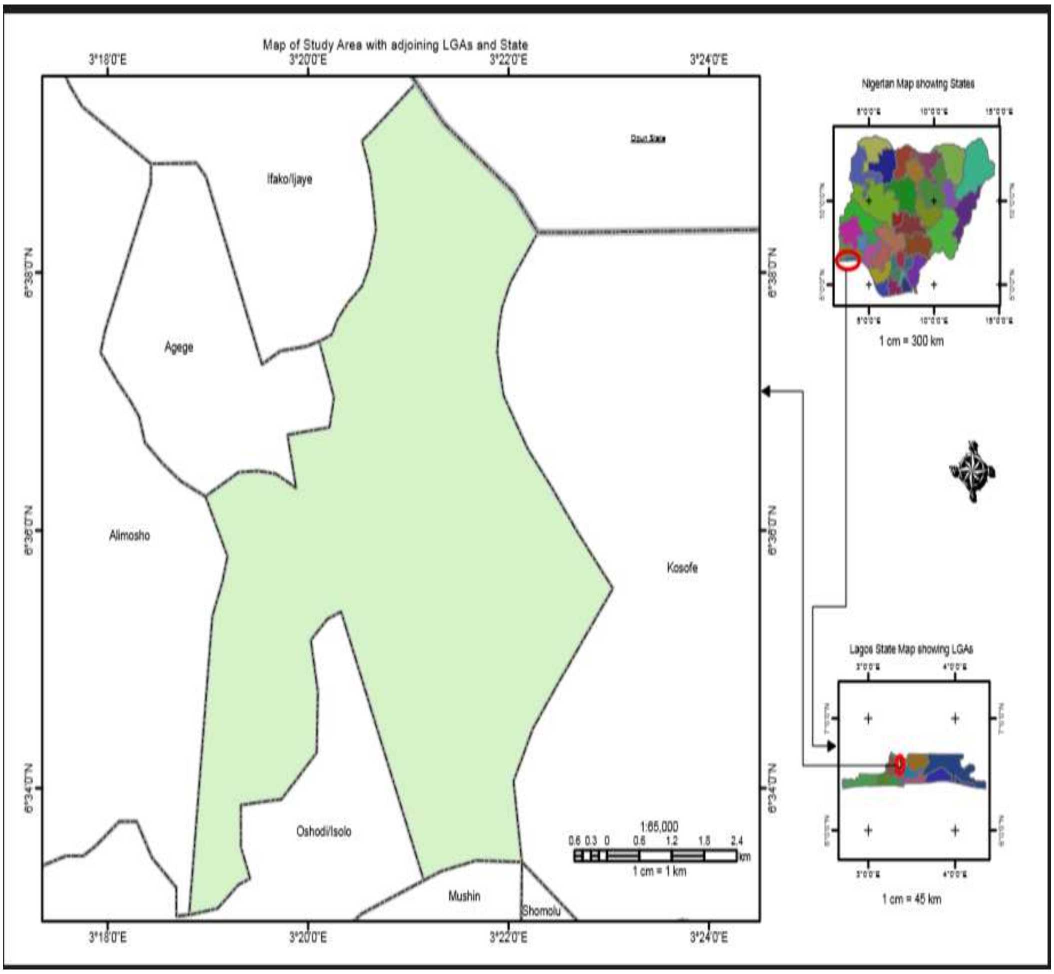

Figure 1: The Study Area within Lagos State, Nigeria

Research Methodology

Different technologies and tools were applied to collect and analyze data. These include Google Earth pro, GPS, ENVI and ArcGIS. The major source of primary data for this research study is Google Earth Pro satellite. Google Earth is a virtual globe, map and geographical information program. It maps the Earth by the superimposition of images obtained from satellite imagery, aerial photography and geographic information system (GIS).

The available imageries for the study area were extracted from Google Earth pro version 7.1.2.2041 (TM), imagery date March 5, 2005 and January 1, 2015. Ground resolution for this image is 1km. The Google Earth has spectral information of three bands. These bands are broken down into Red, Green and Blue. From these bands, a great deal of information about the land use/ land cover can be displayed and analyzed.

The use of 108 copies of questionnaire (administered randomly) was also employed to generate data on socio-economic characteristics of the people and use of building.

The secondary data used in this study included the administrative boundary map of Nigeria, the topographic map covering the study area and a regional map of Lagos were obtained from the Office of the Surveyor General of Lagos State.

More recently, the Google Earth (GE) tool has quickly developed and been widely used in many sectors globally. The high spatial resolution images available in GE, as a free and open data source provide great supports for the traditional land use/cover mapping. They have been either treated as ancillary data to collect the training or testing samples for land use/cover classification and validation or used as a visualization tool for land use/cover maps. However, very few land use land cover classification studies/research have been undertaken to use GE images as the direct data source for land use/cover mapping. If GE images can achieve relatively satisfactory classification, it may provide some opportunities for detailed land use/cover mapping by costing little.

The classification was done in Envi 5.0 relatively new GIS software) using maximum likelihood algorithm. The main approach adopted in this study is Post-Classification comparison, which is a GIS approach of overlaying two, or more produced images.

Two main methods of data analysis adopted in identifying changes in the land use types are:

- Calculation of the Area in hectares of the resulting land use/land cover types for each study year and subsequently comparing the results to identify percentage of land use change within the period over consideration
- Overlay Operations

Data obtained from the questionnaire administration were analyzed using Statistical Packages for Social Sciences (SPSS) for data analysis. The data collected for this study were presented in tabular form.

FINDINGS AND DISCUSSIONS

The presentation here is divided into sub-sections including: supervised classification results for 2005 and 2015 imagery used, change detection result through overlay of classified results and the effect of the observed change.

Google Earth Pro Satellite Images of Ikeja (2005 and 2015)

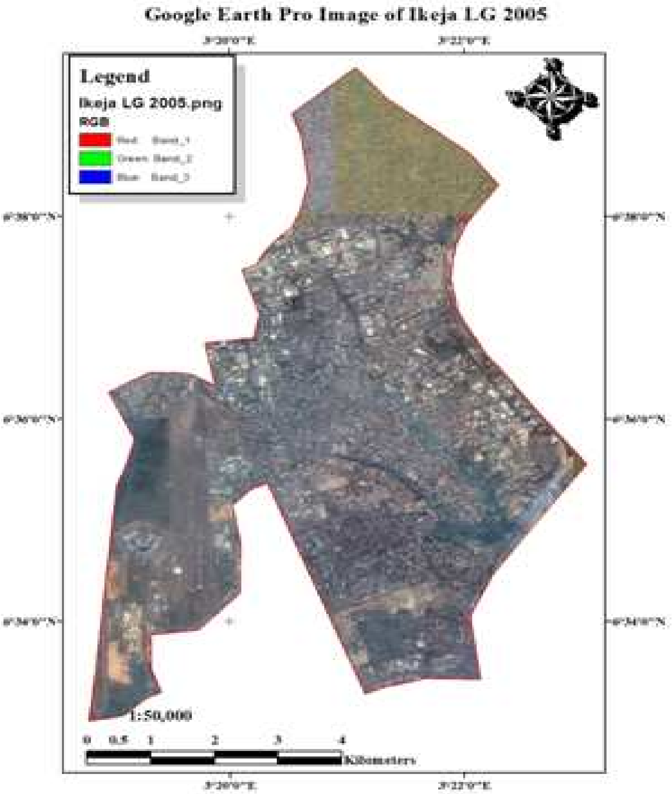

Figure 2: Google Earth 2005 Image of Ikeja LG

Figure 3: Google Earth 2015 Image of Ikeja LG

The imagery used in this project was extracted from Google Earth pro version 7.1.2.2041 (TM) using historical imagery option in toolbar, the time slider was used to move between imagery dates in which March 5, 2005 and January 1, 2015 respectively were extracted with ground resolution of 1km. The images extracted(Figure 2 and Figure 3)were geometrically corrected and ground control points obtained. The Satellite imageries were made to pass through process of image enhancement, geo referencing, resampling and classified into the following: Developed, open space/undeveloped and Vegetation.

Supervised Classification

The first attempt was made to classify the various land uses in ENVI 5.0, image processing software using supervised classification techniques. In supervised classification, spectral signatures are developed from specified locations in the image. These specified locations are given the generic name 'training sites' and are defined by the user. Generally a vector layer is digitized over the raster scene. The vector layer consists of various polygons overlaying different land use types. The training sites will help ENVI develop spectral signatures for the outlined areas. The first category of interest used for this classification are Developed, open space/undeveloped and Vegetation. Multiple polygons are created for each land use category to help ensure that Envi has sufficient information to create the spectral signatures.

(Anderson, Hardy, Roach, and Witmer 1976) land use land cover classification system guided the supervised classification used in this study. The land use and land cover classification system used in this study includes only the more generalized first and second levels. The system satisfies the three major attributes of the classification process, it gives names to categories by simply using accepted terminology; it enables information to be transmitted; and allows inductive generalizations to be made. The classification system is capable of further refinement on the basis of more extended and varied use.

In this study, classes used were generalized and summarized to three, which are developed, vegetation and open space/undeveloped. The developed class is urban or built-up land and consists of residential, commercial and services industrial and others as specified in Table 1 below. The vegetation is agricultural land and forestland and contains cropland, pasture and others (Table 1) below while open space/undeveloped land contain bare exposed rock, transitional areas and others.

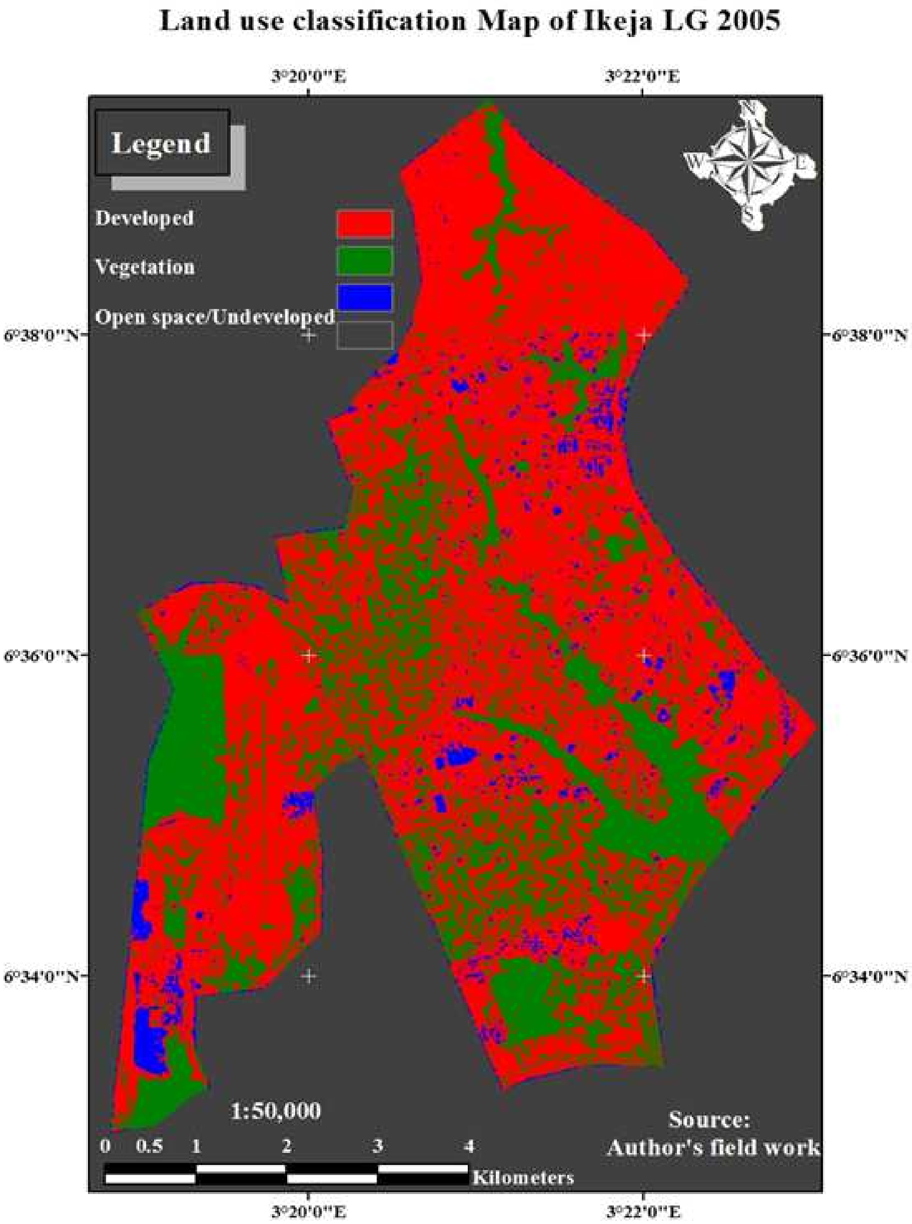

Figure 4: Land Use Classification of Google Earth 2005 Image of Ikeja LG

Table 1: Land use classification 2005 in Hectares/Year and %/Year

Land use Land use Land cover 2005	Area in hectares	%
Developed	2,999.17	65.32
Vegetation	1,394.78	30.38
Open space/undeveloped	197.34	4.30
Total	4591.29	100.00

Source: Authors' Field Survey, 2015

Fig 4 shows the thematic map of land use/cover derived from GE imagery 2005 of the study area. The statistics of each land use/cover are listed in Table 1. It can be seen that the largest land cover type is the built-up\developed area with a total area of 2,999.17 hectares, accounting for about 65.32% of the total study area. This is followed by vegetation, which covers an area of about 1,394.78 hectares, accounting for 30.38% of the study area. By contrast, open space/undeveloped has relatively lower area proportion, (4.30%), accounting for about 197.34 hectares of the study area.

Land use Land Cover Classification of the Study Area 2015

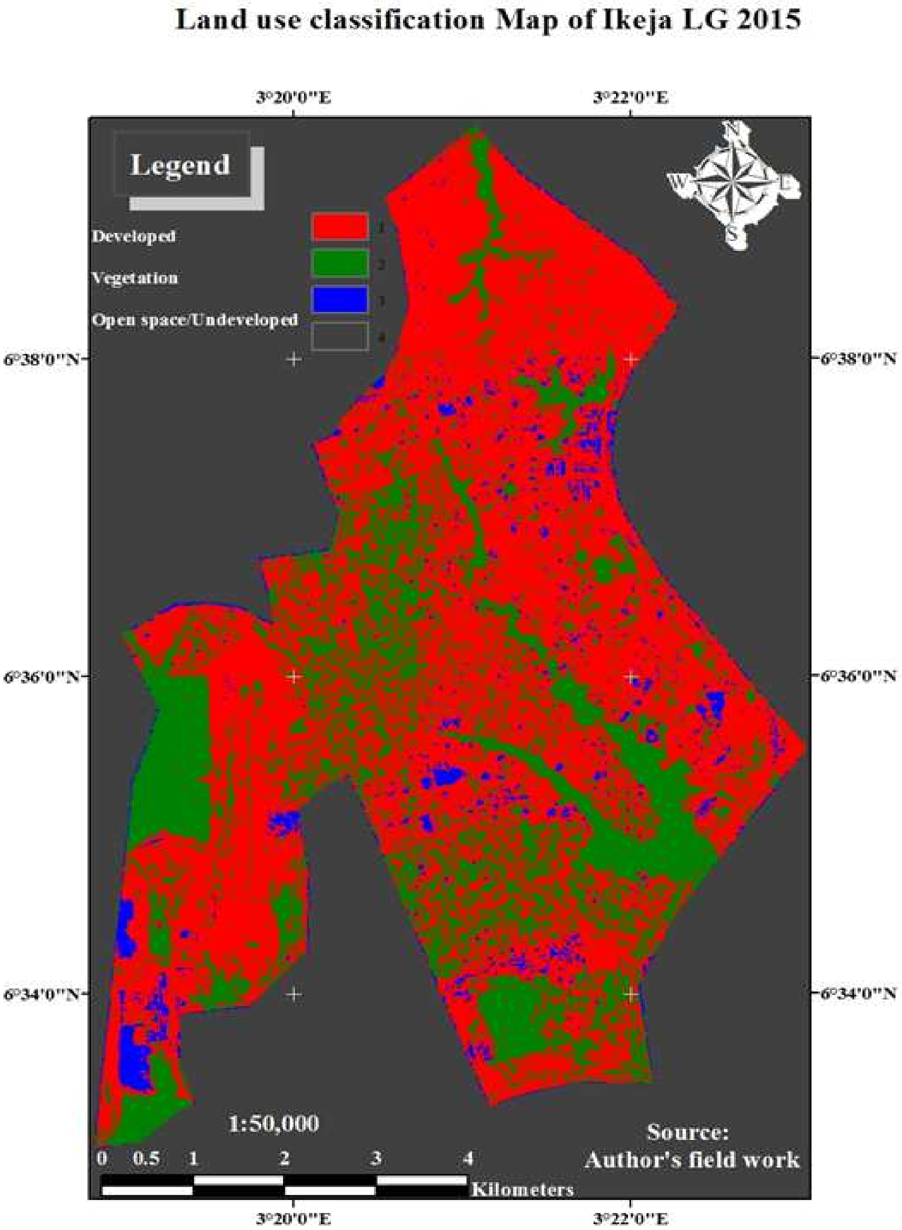

Figure 5: Land Use Classification of Google Earth 2015 Image of Ikeja LG

Table 2: Land Use Classification 2015 in Hectares/Year and %/Year

Land use Land cover 2015	Area in hectares	%
Developed	3,318.81	72.29
Vegetation	693.56	15.10
Open space/undeveloped	578.33	12.60
Total	4591.29	100.00

Source: Authors' Field Survey, 2015

Figure 5 and Table 3 show land use/cover analysis as derived from GE imagery 2015 of the study area. It can be seen that substantial amount of vegetation area was converted/encroached into either developed or open space/undeveloped.

Although the developed area still has the largest percentage with a total area of 3,318.81, accounting for about 72.29%. The vegetation and Open space/undeveloped area have similar areas of 693.56 and 578.33 hectares, accounting for 15.10 and 12.60% respectively. It can be deduced from classification statistics for GE 2015 imagery that vegetation land cover was greatly encroached, which drastically increased developed area from 65.32% in 2005 to 72.29% in 2015 and Open space/undeveloped area from 4.30% in 2005 to 12.60% in 2015.

Classification output for year 2005 and 2015 were overlaid to show how and where exactly changes occurred overtime.

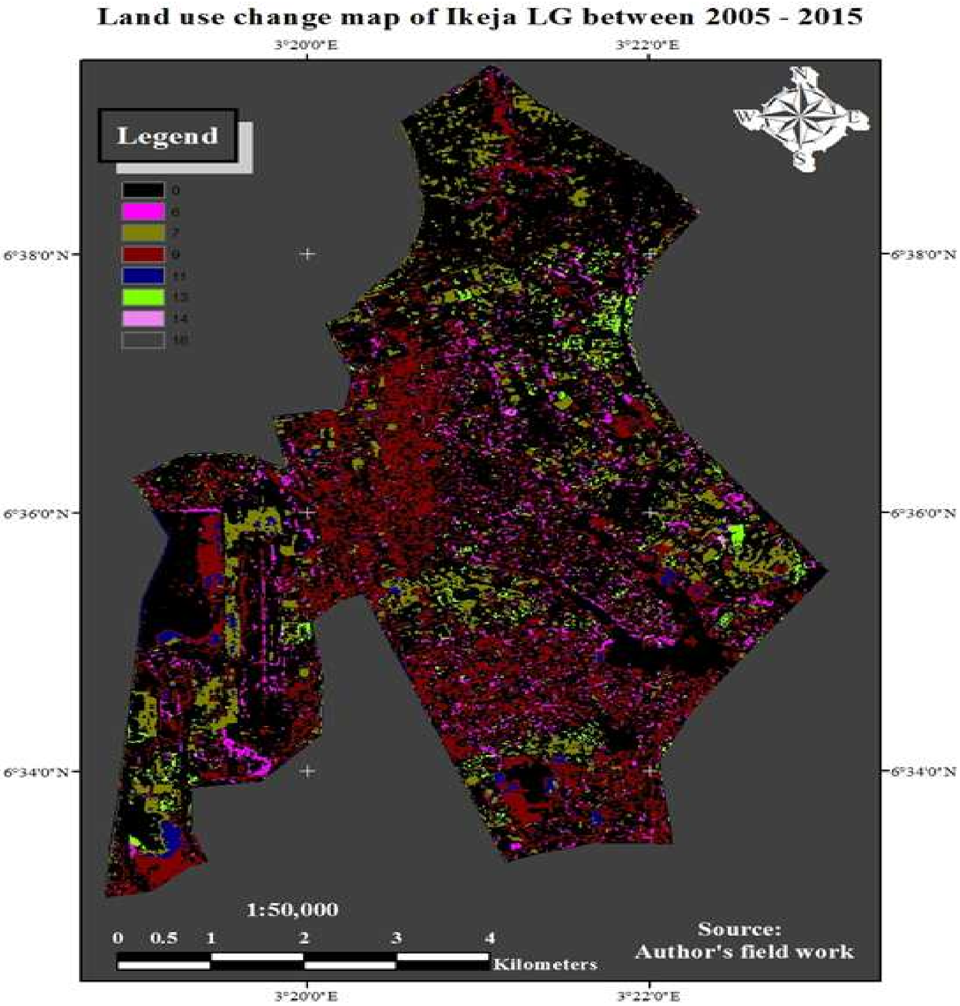

Figure 6: Change Detection Map 2005 and 2015

Table 3: Change Detection between 2005 and 2015

S/N	Change Detection
0	No change
6	Developed to vegetation
7	Developed to open space
9	Vegetation to developed
11	Vegetation to open space
13	Open space to developed
14	Open space to vegetation

Source: Author's Field Survey, 2015

Table 4: Land Use/ Land Cover Change between Years 2005 – 2015

Land use Land Cover	Area in Hectares 2005	Area in Hectares 2015	Area in Hectares 2005 – 2015	% of Change
Developed	2,999.17	3,318.81	319.64	10.66
Vegetation	1,394.78	693.56	701.22	50.28
Open space/undeveloped	197.34	578.33	380.99	193.06
Total	**4591.29**	**4591.29**	**1,401.85**	**100**

Authors'Field Survey, 2015

Ikeja LG government area of lagos State has undergone a series of changes in land use between 2005 and 2015. Table 4 shows how different land uses change over time from one land use/land cover to another. It is observed from the table that within the period of ten years (2005-2015) developed area increased by 10.66 percent, while vegetation reduced by over 50 percent. Open space/undeveloped land, however, witnessed an astronomical increase of 193.06 percent! This nature and magnitude of change was not unconnected with the massive urban development, which necessitated: (1) increasing clearing of green area for physical development, (2) increased built up area, and (3) yet to be developed, but already cleared spaced for the anticipated physical development.

The serious implications of this trend are: (1) reduced farmland, and the resultant effects on rural hinterland dwellers, who are mostly farmers, as well as food security threat for the affected urban populace (2) local climate change, and its resultant negativities such as increased temperature, sea level, etc.

SOCIO-ECONOMIC CHARACTERISTICS OF RESPONDENTS

The socio-economic characteristics examined here include gender, age, marital status; educational status, occupation, ethnicity and income level.

Table 5: Basic Socio Economic Variables of Respondents

Variables	Category	Frequency	Percent
Gender	Male	62	57.9
	Female	45	42.1
Age distribution	25 years and below	4	3.7
	26 - 40 years	40	37.4
	41 - 55 years	36	33.6
	56 - 70 years	27	25.2
Marital status	Married	86	80.4
	Single	13	12.1
	Widow	4	3.7
	Single parent	4	3.7
Occupation	Civil servant	52	48.6
	Trader	23	21.5
	Student	8	7.5
	Self employed	19	17.8
	Retired	5	4.7
Educational status	No formal Education	13	12.1
	Primary school	1	1.0
	Secondary school	12	11.2
	Tertiary level	81	75.7
Income level	N10,000-N30,000	4	3.7
	N30,000-N50,000	6	5.6
	N50,000-N100,000	36	33.6
	N100,000 and above	61	57.0

Ethnic group	Yoruba	75	70.1
	Igbo	7	6.5
	Hausa	25	23.4

Source: Author's Field Survey, 2015

Table 5 shows that 57.9 and 42.1% of the respondents were male and female respectively; 37.4% of them were in the age group of 26 – 40, 3.7% were below 25, 33.6% were between the age group of 41 – 55, while 25.2% of them were between 56 and 70. This implies that majority of the respondents were adults.

The table also shows that 80.4% of respondents were married, 12.1% were single, while 3.7% were widow/widower. This shows that a large percentage of respondents were married most likely with kids. Over 48% of respondents were civil servants, 21.5% were traders, 7.5% were students, while the self-employed and retired categories were 17.8% and 4.7% respectively. This implies that majority of the respondents were government workers.

Table 5 also shows that 75.7% of respondents had tertiary education qualifications, while only 12.1% had no formal education at all. Those with and primary and secondary education qualifications were 1.0 and 11.2% respectively. This shows that a larger percentage of respondents were well educated and informed, this would help them understand their environment better and aware of negative effects of their actions in relation to land use change.

On income distribution, it is shown that 57.0% of respondents earned N100,000 and above monthly, while 3.7%, 5.6%, and 33.6% of them earned N10,000-N30,000, N30,000-N50,000, and N50,000-N100,000 respectively, which is a clear indication that majority of them are middle-income earners.

Land Use Conversion

This section deals with and analyzes how land uses under developed category of classification have changed overtime in the selected streets of the study area. Comparison was made between how residential land use changes to mixed use and how mixed use change to residential use in Table 6 below.

Table 6: Former and Present use of Building

Former use of Building		Present use of Building		Total
		Residential	Mixed Use	
Residential	Count	68	35	103
	%	63.6%	32.7%	96.3%
Mixed use	Count	0	4	4
	%	0.0%	3.7%	3.7%
Total	Count	72	35	107
	%	63.6%	36.4%	100.0%

Source: Author's Field Survey, 2015

Table 6 shows that 63.6% of buildings whose former use was residential still retained their status as residential buildings, 32.7% of them were converted to mixed use, while all the buildings that were formerly of mixed use still retained their mixed use in the study area. This implies that the formerly residential use was being converted to mixed use for commercial purposes and no case(s) of mixed converted to residential. The reason for this may not be far-fetched. Most low and middle income households in most Nigerian cities do attempt to take advantage of the required informal services in the urban centres to supplement their meager incomes from both the formal and informal sectors. This is why it is being advocated that efforts should be made to find means of integrating the informal sector activities into the formal land use planning.

CONCLUSIONS AND RECOMMENDATIONS

This study has attempted the land use change analysis of Ikeja Local Government Area of Lagos State for the period between 2005 and 2015. It was observed that the land use change witnessed over the ten-year period is not only significant, but also has a lot of implications for land use planning and development control, and more importantly for sustainable development. It is opined here that unless concerted efforts are made to ensure effective land use planning that would anticipate the nexus between physical development and other socio-economic factors on one side, and land use change, adjustment and readjustment on the other, urban development in Ikeja may consume all available vegetation/green area in less than a few decades.

It is essentially recommended that a comprehensive land use plan of the area should be put in place and integrated with the general land use plan of Lagos State and implemented effectively. Such land use plan should as a matter of concern, anticipate the informal sector activities, which are a major factor of land use change, and integrate them accordingly. It is also recommended that more studies be carried out to indicate at what time in the foreseeable future will what land use changes to what, and what would be the major drivers of such change. Studies like this could be facilitated by the affected local or state government through its agency, or contracted out to relevant consulting firm or institution with the main goal of utilizing the results in the comprehensive land use plan to be so prepared.

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