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Application of IKONOS Satellite Images in Monitoring of Urban Landuse Change in Ikeja, GRA, Lagos, Nigeria

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ABSTRACT: *African cities are experiencing uncontrolled landuse change. Since landuse and land cover change is an important component in understanding the interactions of human activities with the environment, therefore it is necessary to analyse such change. In this study of analysing the urban landuse change, 2000 and 2010 IKONOS are used in a post classification comparison analysis to map the landuse changes and identify the conversion process in Ikeja, GRA, Lagos. The landuse change statistics results obtained revealed that residential landuse has changed rapidly for the periods (2000-2010). The results also show increase in commercial landuses between the same periods. The application of urban satellite images with higher ground resolution was found to be effective in monitoring the landuse changes and providing valuable information necessary for planning and research.*

Keywords: *Urban landuse, land cover, urban satellite images, GIS.*

I. INTRODUCTION

Landuse change occurs when the use to which landuse put is different from what is was in the past. For instance open space or forested area could turn into a built up area. Therefore, landuse and landcover changes environmental condition e.g. a particular territory are linked to global environmental change (Balogun, 2009). Cities in most developing countries like Nigeria have been undergoing unprecedented changes both in population and spatial extent (Adeboyejo and Abolade, 2006) and as a result are faced with a variety of problems such as uncoordinated land development, conflicting landuses, high densities in certain parts of the Urban area and the absence of adequate road network which could ensure intra-urban mobility within the city. In most cases, these processes occurs so fact that it overtakes the capacity of planning authorities to deal with the situation and to control urban growth. Monitoring this growth and planning for its control have been made more difficult by the expanse of time involved in producing reliable and up-to-date maps.

Also existing maps are usually old, out of date and therefore difficult to be used as an effect information base for planning. This if left unchecked, will undermine sustainable urban development, hence the need for enhanced planning of urban growth and development for better management of existing urban centre (Oyinloye, 2010). Several studies have been conducted with the integration of remote sensing and geographic information systems to analyze and monitor landuse/ landcover changes. One of the methods that integrate the integration remote sensing and geographic information systems to monitor urban growth is the Post Classification Comparison Analysis (Musaoglu, et al. 2002). He incorporates remote sensing and geographic information systems to create overlays of two or more independently produced classified images of Catalca Region, USA. The results show the change detection, trend, location and amount of changes that have occurred in the region. Also similar studies was carried out by Ramadan, Peng and Cheng (2004) in Shaoxing City in China using satellite imageries for three periods, one of the goals 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 have occurred between the periods.

The application of remote sensing and geographic information systems was adopted by (Weng, 1999) in Zhujiang Delta, China to evaluate urban expansion where the extracted built up areas were also overlaid to obtain the expansion image. The buffer function in GIS was used to generate a buffer image to show the proximity of the urban expansion to the major roads of the study area. Adeboyejo and Abolade (2006) in Ogbomoso,Nigeria using satellite imageries of three periods to monitor urban expansion of the city. The result shows that urban expansion of the city has destroyed fertile agricultural land which cannot be recovered; the residential landuse continues to spread to and beyond the hitherto distant location relative to the city core. Similarly, Oyinloye (2010) studied the spatial growth of Akure, Ondo State, Nigeria using the satellite imageries of three periods. The result shows that there has been a rapid conversion of agricultural areas to urban (non agricultural) land uses.

Therefore, the application of urban satellite remote sensing and geographical information systems (GIS) for future town planning is not only sensible but utterly necessary. Arguments in favour of the use of satellite system are certainly the fast data access, the quick visual interpretation, the good representation on a planer surface and their great integrity of a map after the process of geometrical image correction (Balzerek, 2001). These technologies have also offered an important approach to spatial problem solving, and has played a very significant role in urban growth management. With these technologies, urban growth patterns and rates can be determined and quantified, and planned for alternative future scenarios (Jothiamani, 1997).

The aim of this paper therefore is use urban satellite imagery (IKONOS) to monitor landuse change of Ikeja, GRA, Lagos with a view to proffer solution to curb the environmental effect posed by such changes. The objectives of this study are to:

1) use satellite imagery to classify the Ikeja GRA into different types of use to which the land being put. determine the conformity of such changes to the existing landuses.
2) analyse the casual factors responsible for landuse change
3) identify the environmental effects of landuse changes and its planning implications
4) propose map of landuse of Ikeja GRA

II. THE STUDY AREA

Ikeja, the capital of Lagos state lies between longitude $3^0$21'24" E and latitude 6^0 35'8"N. It is located at the North-Western part of Lagos State in Nigeria (see figures 1 and 2) The local government consists of various villages and hamlets, among which are Ojota, Isheri, Oregun from Eregun and Opebi to mention a few early settlers included the Aworis whose main cash crops were cocoa, kola nut, and coffee. Ikeja currently strives as an administrative centre that is the seat of the state and of a local government. Apart from its administrative function, Ikeja contains industrial area e.g. Ikeja, Ogba and Oregun industrial estates. Commercial centre includes Ikeja CBD at Alausa, Ipodo market at Ikeja, Ogba retail market, Alade market at Allen Avenue etc. Residential area includes Opebi, Adeniji Jones, Omole phase 1, Agidingbi, Toyin Street, Ogba, Allen etc. and other uses.

Ikeja G.R.A is an integral part of Ikeja. The Government Residential Area (GRA) was originally designated as residential, according to the 1973 GRA scheme; it indicated that GRA is meant to be a purely residential area. The conception was that of a model residential area that would be peaceful and free from environmental pollution. It is bounded in the north by Mobolaji Bank Anthony Way, in the south and equally in the west by Agege Motor Road and in the east by Ikeja Military Cantonment. These two major roads provide access into this exclusive residential suburb (see figure 3).

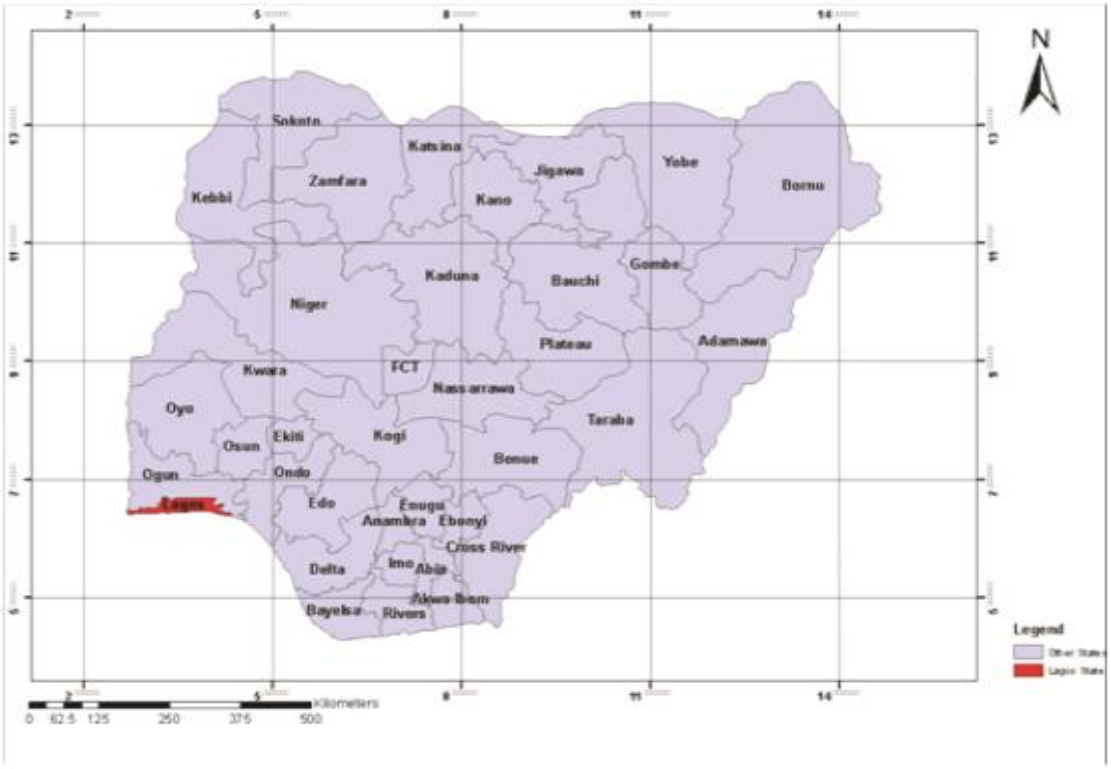

Fig. 1: Map of Nigeria Showing Lagos State

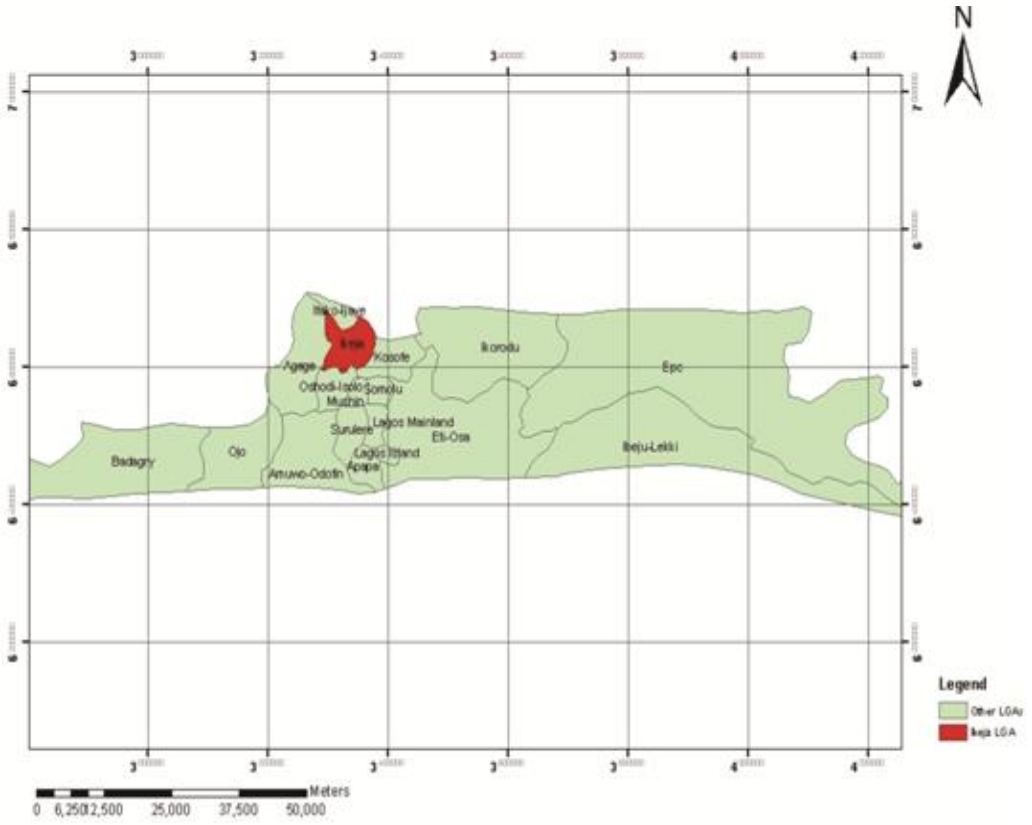

Fig. 2: Map of Lagos State Showing Ikeja Local Government

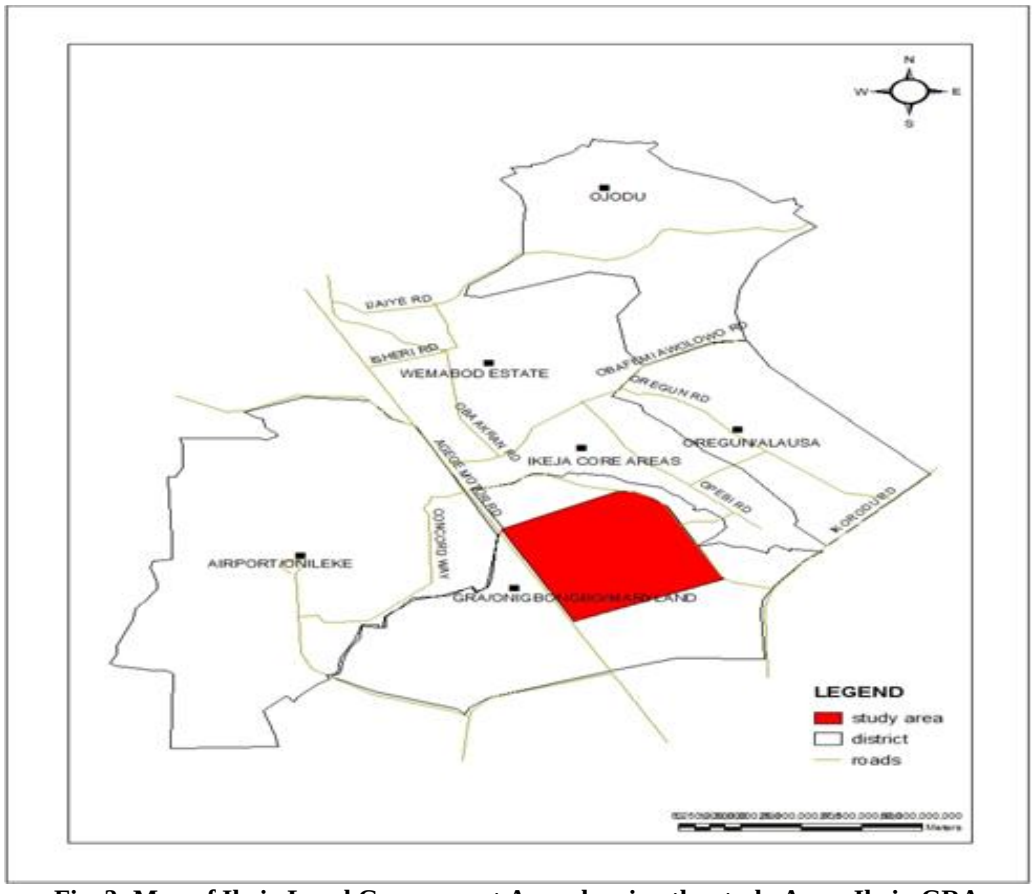

Fig. 3: Map of Ikeja Local Government Area showing the study Area: Ikeja GRA

III. DATA ACQUISITION AND PREPARATION

The main approach adopted in this landuse change analysis was the Post-Classification comparison which is a GIS approach of overlaying two or more produced images. It also seeks to use the capabilities of GIS and remote sensing to monitor the landuse change in the study area. To achieve this, IKONOS images of Ikeja, GRA, Lagos were acquired for 2000 and 2010. The images are geometrically corrected and ground control point obtained through intensive ground surveys permitted the co-registration of all images to Universal Transverse Mercator (UTM). The Urban Satellite imageries were made to pass through process of image enhancement, geo referencing, resampling, image classification was performed on false colour composites into the following landuse: residential, commercial, mixed use, public, industrial, open spaces and underdeveloped. Information collected during field surveys was combined with the digital topographic map which was developed for the study area was used to assess the accuracy of the classification. The questionnaire method was used to generate attribute data to further enhance our information on the study area. For the purpose of this study, a sample frame of 30% buildings of various uses was sampled using a simple random method. Some of such streets in change of use are more pronounced include: Oba Dosumu, Adeyemo Alakija, Oduduwaway, Isaac-John,Joe Ogunnaike, Sasegbon and Remi Fani Kayode streets. The study area has a total number of 21 streets and 605 buildings. For the sake this study 30% of the estimated total buildings of the study area which is totalled at 182 buildings were sampled. Table 1 shows the streets and the number of questionnaires administered per street.

Table 1 Questionnaire administration

Name of streets	No of questionnaires administered	No of questionnaires retrieved
Oba Dosunmu	**26**	**20**
Adeyemo Alakija	**26**	**25**
Oduduwa Way	**26**	**21**
Isaac-John	**26**	**15**
Joel-Ogunaike	**26**	**19**
Sasegbon	**26**	**20**
Remi-Fani Kayode	**26**	**18**
Total	**182**	**138**

The demographic and socio-economic question specifically focused on the age, marital status, educational, income and employment status of respondents. In additional, the questions on physical characteristics focused on the type of building, former user of building, present use of building, age of building, ownership status of respondents and building plan approval before construction. All these questions were carefully analysed and considered in addition to spatial information from GIS analysis to arrive at our conclusion.

IV. RESULTS AND DISCUSSION

Figure 4 and table 2 show the area covered by different land use classes in Ikeja GRA during the year 2000.

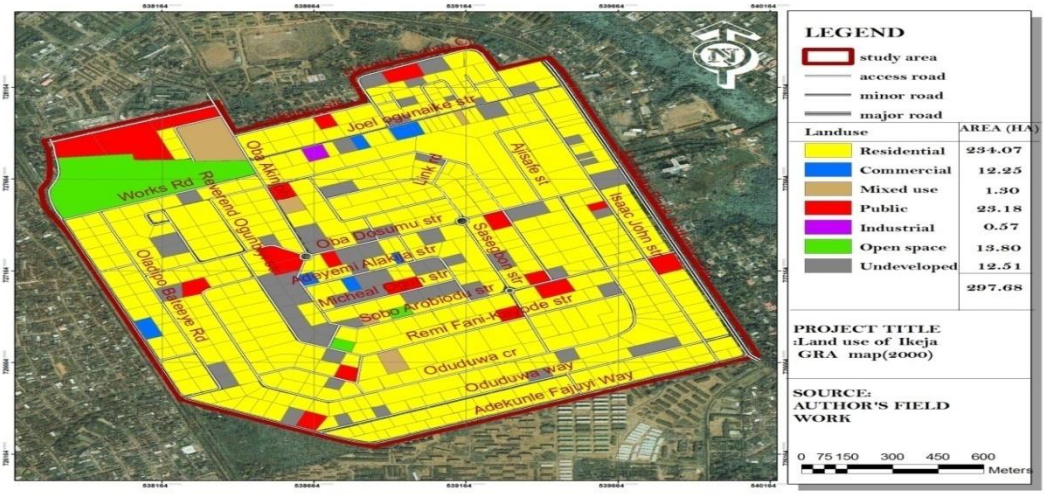

Figure 4: Land Use Classification of IKONOS 2000 Image of Ikeja.

Table 2: Land use classification in hectares/year and %/year.

Land use (2000)	Area in hectares(H)	%
Residential	**234.07**	**78.63**
Commercial	**12.25**	**4.11**
Mixed use	**1.30**	**0.42**
Public use	**23.18**	**7.79**
Industrial	**0.57**	**0.19**
Open space	**13.90**	**4.67**
Underdeveloped	**12.51**	**4.20**
Total	**297.68**	**100.00**

Figure 4 and table 2 showed that residential was the dominant land use class in 2000, taking about 78.63% of the total area. This is followed by public land use, which covers an area of about 23.18 hectares about 7.79% of the study area. Commercial covered about 12.25 hectares about 4.11%, which show that, as at the year 2000, commercial activities were still minimal. Also, mixed use covered about 1.30 hectares about 0.42% of the study area, which also shows that conversion of buildings had not really started at that time and the residents still maintained their buildings. Industrial covered 0.57 hectares about 0.19%, open spaces 13.80 hectares about 4.67%, undeveloped land 12.51 hectares about 4.20%.

Figure 5 and table 3 showed the area covered by different land use classes in Ikeja GRA during the year 2010.

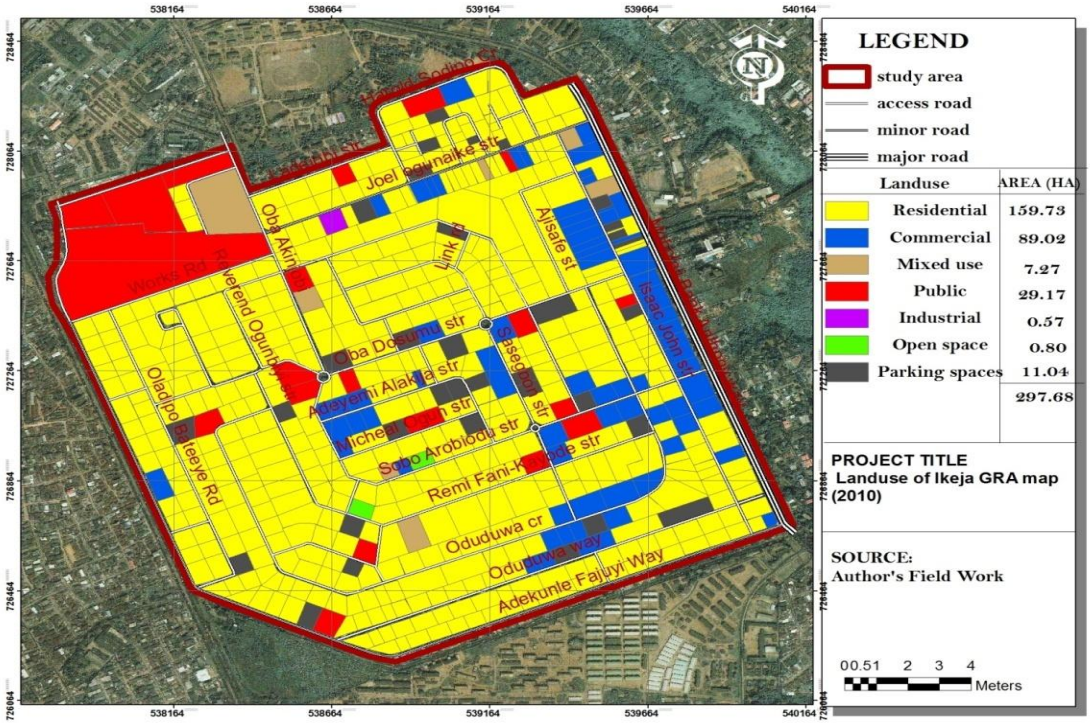

Figure 5: Land Use Classification of IKONOS 2010 Image of Ikeja.

Table 3: Land use classification in hectares/year and %/year.

Land use (2010)	Area in hectares(H)	%
Residential	**159.73**	**53.66**
Commercial	**89.02**	**29.90**
Mixed use	**7.27**	**2.44**
Public	**29.17**	**9.80**
Industrial	**0.57**	**0.19**
Open spaces	**0.80**	**0.27**
Undeveloped	**11.04**	**3.71**
Total	**297.68**	**100.00**

Figure 5 and table 3 show that a substantial number of residential buildings were converted to either mixed use or commercial buildings. Although the residential land use still has the largest percentage with 53.66%, both the commercial and mixed land use increased significantly, with 29.90% and 2.44% respectively. The industrial still covers 0.19% to show that industrial activities are not dominant. The open spaces reduced to 0.27% and also undeveloped land reduced to 3.71%.

An overlay of 2000 and 2010 was done to display the landuse changes that have occurred. Figure 6 and the corresponding table 4 clearly showed the trend in all the landuse changes.

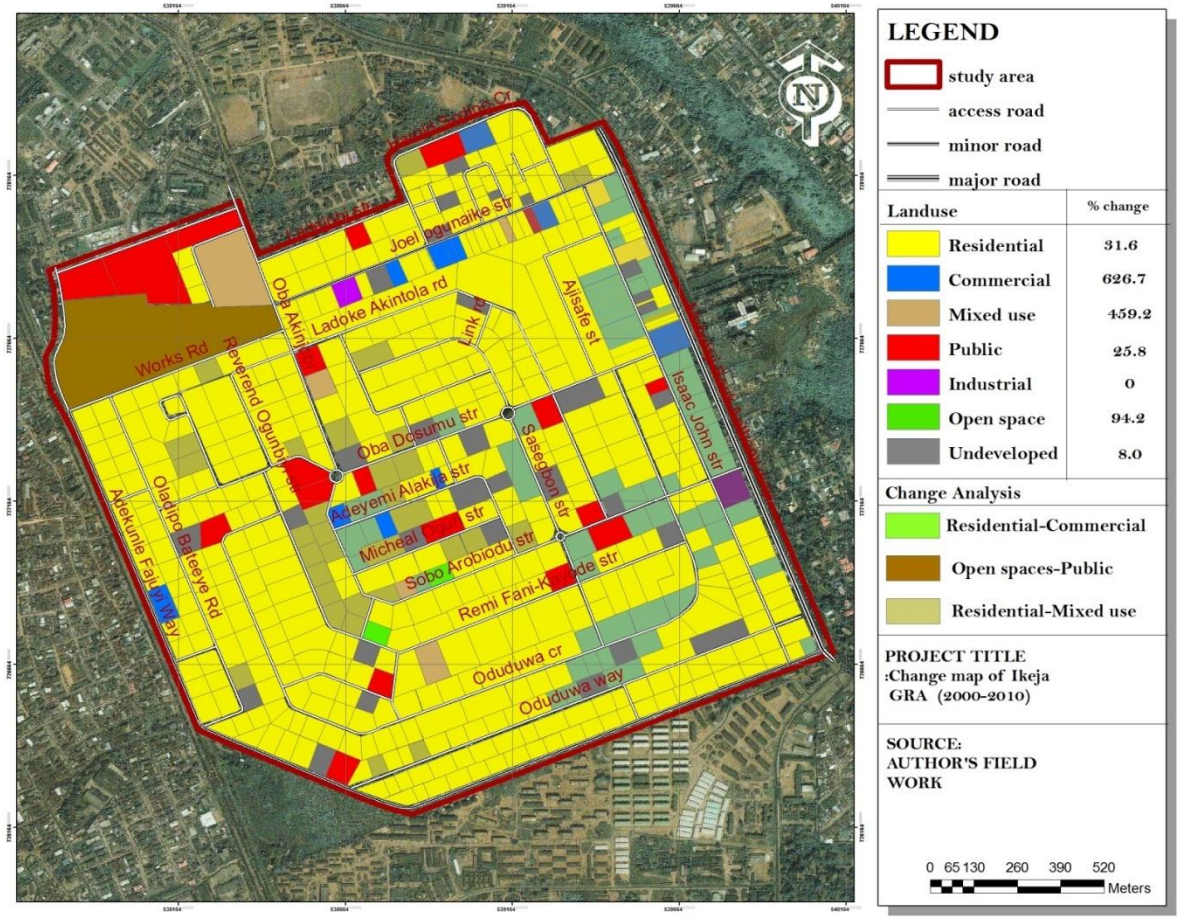

Fig 6: Land Use change between years 2000-2010.

Table 4: Land use change between years 2000-2010 in hectares/year and %/year.

Land use	Area in hectares 2000	Area in hectares 2010	Area in hectares 2000-2010	% of change
Residential	**234.07**	**159.73**	**74.34**	**31.6**
Commercial	**12.25**	**89.02**	**76.77**	**626.7**
Mixed use	**1.30**	**7.27**	**5.97**	**459.2**
Public	**23.18**	**29.17**	**5.99**	**25.8**
Industrial	**0.57**	**0.57**	**0**	**0**
Open spaces	**13.90**	**0.80**	**13.1**	**94.2**
Undeveloped	**12.51**	**11.04**	**1.47**	**8.0**

In other to address the problems faced in the study area in relation to the change of use of building the proposed land use are hereby offered to rescue the situation before if finally goes out of hand.

The proposed land use is analyzed using figure 7 and table 5.

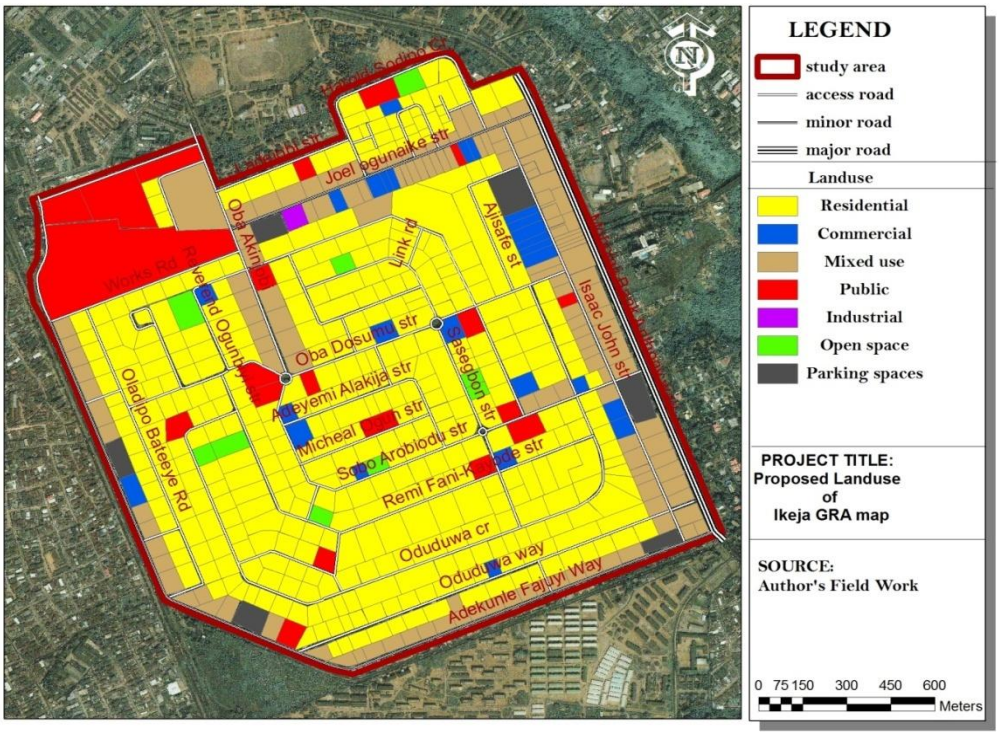

Figure 7: Proposed land use map

Since most of the changes are occurring along the Ikeja GRA corridor, the uses along the corridor should be commercialized. From figure 7, it can be seen that buildings along Isaac John Street, Adekunle Fajuyi way, Joel Ogunaike and Oba Dosunmu has been proposed to be changed to mixed uses. Also, some plots are been proposed to be opened up for parking lots and open spaces, so as to create a serene environment. The table 5 shows the analysis of these.

Table 5: Analysis of proposed land use map

Proposed Land use	Area in hectares(H)	%
Residential	160.73	54.0
Commercial	10.27	3.50
Mixed use	88.4	29.7
Public	27.11	9.10
Indusrial	0.57	0.19
Open spaces	5.20	1.75
Parking Spaces	5.40	1.80
Total	297.68	100.00

Apart from these, a certain height should be maintained for buildings along the corridor (see table 6)

Table 6: Height of Buildings

S/N	STREET NAME	EXISTING HEIGHT	PROPOSED HEIGHT
1	**Oba Dosunmu**	**2**	**15**
2	**Adekunle Fajuyi**	**2**	**15**
3	**Isaac-John**	**2**	**15**
4	**Joel-Ogunaike**	**4**	

V. PLANNING IMPLICATIONS OF LANDUSE CHANGES.

The implication of these changes is that environmental problems will be heightened. These problems ranges from traffic build up on the road; overstretch of infrastructures and social amenities, noise pollution, shortage of water, uncontrolled land use, poor waste disposal and dirtiness of the environment as the study area was not planned to accommodate these land use changes (Olukemi, 2011). With the rapid rate of land use change, the decline in the standard of living and in the standard of the environment, it has become increasingly evident that there is an urgent need for action oriented efforts aimed at advocating and inducing the acceptance of appropriate and workable planning strategies that could facilitate the combating of the problems of the change and the dysfunctions of physical planning (Oyinloye, 2010).

The factors that are responsible for change in landuse include: building type; the use of building and reason for change in the use of building among others (see table 7-11).

Table 7 showed that the bungalow type of building is the most occurring type of building with 42.5%, followed by duplex with 23.2%, block of flats also having 20.3% and lastly storey buildings with 7.2%. This is an indication that the other building types meant to accommodate large number of people are springing up and this will give rise to population of the study area and other urban problems such as overstretch of infrastructures will then be experienced

Table 7: Building types

	Frequency	%
Bungalow	**58**	**42.0**
Storey Building	**10**	**7.3**
Duplex	**32**	**23.2**
Block of Flats	**27**	**19.6**
Others	**11**	**7.9**
Total	**138**	**100.0**

The result of table 8 describes the previous uses of buildings in the study before they were converted into new uses. This result is a true reflection of what the area is ought to be in its real nature as planned. The survey conducted shows that residential covers about 69.6%, commercial 6.5%, institutional 1.52%, recreational 3.6% while industrial is 5.1% respectively. This shows the use at which the study is purposely meant for from inception.

Table 8: Former Use of Building

	Frequency	%
Residential	**96**	**69.6**
Commercial	**9**	**6.5**
Institutional	**21**	**1.5**
Recreational	**5**	**3.6**
Industrial	**7**	**5.1**
Total	**138**	**100.0**

Table 9 shows the results of the present uses of building in the study area. The result shows that the most dominant use of land is the residential is 43.5%, with commercial 26.1%, institutional 11.6%, recreational 10.1%and industrial 8.7%. This survey reveals that the extent at which changes have occurred in the study area, this occurrences have not actually stop, so there is possibility that the area will attain another state of commercially developed area in the nearest future. This is an implication that one might not actually be able to ascertain the use of this area in the future to come if the government do not find measure to stop the ongoing change.

Table 9: Present Use of Building

	FREQUENCY	%
Residential	**60**	**43.5**
Commercial	**36**	**26.1**
Institutional	**16**	**11.6**
Recreational	**14**	**10.1**
Industrial	**12**	**8.7**
Total	**138**	**100.0**

Table 10 gives an insight on how the buildings are converted from their previous use to their current use. From the survey carried out it is shown that most conversion are actualised by addition of uses to the previous use that is having mixed-use and this accounts for about 36.2%, followed by change in use from their original use which also account for 26.1%, also alteration of buildings also account for about 11.6%, partial demolition and renovation accounts for 10.1% while reconstruction and total demolition accounts for 8.7% and 7.3% respectively. The implications of all these indicate that buildings are being converted at an alarming rate.

Table 10: Building Conversion

	FREQUENCY	%
Mixed use	**50**	**36.2**
Change in use	**36**	**26.1**
Alteration in buildings	**16**	**11.6**
Partial demolition and renovation	**14**	**10.1**
Reconstruction	**12**	**8.7**
Total demolition	**10**	**7.3**
Total	**138**	**100.0**

Table 11 shows that most of the conversion, alteration and addition have been in form of corner shops, from bungalow on a plot to terrace building of many household, eateries, schools and so on which could be attributed to lack of period check for this reason in the state. The various views and opinions of the people are as follows: 52.2% has been in conversion due to change in market value, another 28.2 % due to demand while 19.6% is due to taste of the property owners. All these reasons will result into overpopulation that may not be controlled later.

Table 11: Reasons for change in use of building

	Frequency	%
Taste	**27**	**19.6**
Change in market value	**72**	**52.2**
Demand	**39**	**28.2**
Total	**138**	**100.0**

VI. CONCLUSIONS AND RECOMMENDATIONS

The study has revealed that there is absolutely (about 74.6%) change in the use of building. It has identified the type of building that dominated the area, which is an indication of the type of design the area was previously planned for specifically. The magnitude of change of use in the study area really occurred around Isaac John, Adeyemo Alakija, Oba Akinjobi and Oba Decemo Streets. Most of the changes that occurred there are mostly from residential to commercial land use.

This study therefore advances some recommendations as a way of rescuing the situation before it finally goes out of hand. It was recommended from the proposed map in figure 16 that buildings along Isaac John Street, Adekunle Fajuyi way, Joel Ogunnaike and Oba Dosumu has been proposed to be changed to mixed uses. Also, some plots are being proposed to be opened up for parking lots and open spaces, so as to create a serene environment. Also the town planning authority should always carry out a routinely check on the change of use with reference to the master plan of the study. Finally demolition should be carried out on an illegal and unapproved change on the use of building, this will definitely serve as penalty for any unauthorized person who is taking part in the change of use of building without following the right process.

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