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AN ANALYSIS OF LANDUSE/LANDCOVER CHANGE DISTRIBUTION IN KUJE AREA COUNCIL FEDERAL CAPITAL TERRITORY ABUJA NIGERIA

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Abstract
The aim of this paper is to assess landuse/landcover change distribution in Kuje area council Federal Capital Teritory Abuja Nigeria. To achieve this, the landuse/area coverage of the study area over a period of 35 years was identified. Also determined were the rate, nature and direction of urban growth in the study area. The landuse change and its effects during the time period were also determined. To obtain the necessary data for the study, seven hundred and eighty - three (783) respondents constituting about 0.2% of the total population of Kuje Area Council as projected from the census figures of National Population Commission of 2006 to 2010, questionnaire was also administered to 140 professional Urban Planners, Land Administrators and Ward heads. The secondary data were sourced from Institutions and Governmental Organizations relevant to the study. Onscreen digitization of the study area maps was employed in delineating the built-up area, hill, stream, roads, forest land, fadama land and the arable land from the various data sets for the years. Map overlay operation was performed in order to identify and detect landuse classes over the years. The mean change per year (arithmetic mean) in Km^2/year and % / year for the periods was calculated. The rate of development (increase or decrease) was ascertained. The study revealed that between 1975 and 1980, the built-up area expanded from 2.6% (47 Km^2) to 4.2% (75 Km^2) of the total area. The major road networks expanded from 7.3% (131 Km) to 8.8% (159Km). 'Fadama' landcover which is the Hausa word for irrigable land, flood plains and low lying areas decreased from 17.7% (319 Km^2) to 16.4% (310 Km^2). The research therefore concluded that the present innovations in GIS and Remote Sensing technologies make available potent instruments for detecting and mapping of transformations in landuse/land cover.

Keywords: Fadama Land, Landuse/Landcover, Arable Land, Degradation, Environment, Vegetation.

Introduction

Land use and land cover change is the quantitative change in the area extent (increases or decreases) of a given type of land use or cover type. It also includes alteration or modification and conversion from one type of use or cover to another (Briassoulis, 2000). Garba (2008) observed that land cover change provides a means of understanding and managing the problems of degradation and shortage of land and water resources. Land cover change has been described as the most significant regional anthropogenic disturbance to the environment (Roberts, *et al*, 1998). In additions, land cover change occur when one land cover type is converted to another, or is modified, such as a change in agricultural land to residential, or an intensification of existing use, such as from light to heavy industry. Land cover is continually influenced by land use due to human cultural, social, and economic activities (Lambin *et al.*, 2003; Erle and Roberts, 2010).

There is an increasing need to be able to precisely describe and classify land cover and land uses in order to define sustainable land use systems that are best suited for each place. The driving force for most land use and cover changes is population growth, although there are several other interacting factors involved (Ramankutty *et al.*, 2002).

Competing land uses (agriculture and human settlements mainly) are contributing to the decline of forest and woodland areas and the rising demand for fuel wood and charcoal is also a major cause of deforestation. Settlements represent the most profound human alteration of the natural environment through a spectrum of urban landuse activities (Ifatimehin and Ufuah, 2006).

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The activities of humans presently have been accepted as a primary factor that is restructuring the earth. All over the world, landuse and pattern of vegetative cover have undergone fundamental changes due to rapid economic development. City development has been speed up, thus causing adverse strain to the surroundings (Etim, 2013). This is particularly visible in Kuje Area Council of the Federal Capital Territory, where agricultural land is disappearing each year, as a result of urbanization occasioned by the growth of the Federal Capital Territory (FCT).

Abuja, Nigeria's Federal Capital Territory, is located almost at the centre of the country as can be seen in figure1. Since Abuja became Nigeria's Federal Capital Territory in 1976, it has been experiencing rapid expansion, urbanization and significant changes in its physical landscapes (Kuje Master Plan, 2004). Due to this expansion occasioned by the socio-economic and political factors, various studies have been carried out to determine the rate and extent of loss of vegetal cover in the area. One of such studies involve the application of remote sensing and GIS Technique to identify, mark and measure the extent of change in the various land uses from the Landsat images of 1987, 2001, and Nigeriasat-1 imagery of 2006.

Ujoh (2011), explained that from the analyses of Landsat images of two epochs (1988 and 2002); and Nigeriasat-1 image of 2006, built-up areas increased, this resulted in land degradation including loss of vegetal cover, indiscriminate waste disposal, contamination of surface water etc. The land use/land cover of Abuja had undergone significant changes over time. The classification and quantification of the images of Abuja aided the detection of the changes. The static LULC distribution for 1987, 2001 and 2006 showed that as at 1987, vegetation and cultivated land constituted the largest land cover categories in the Federal Capital City-the city center (258.62 Km^2 and 212.43 Km^2, respectively) collectively occupying an area of 471.05 Km^2 (representing 56.5%) of the total land cover of the study area. Ujoh (2011) further expatiated that built-up area was the least visible land cover type in the study area with 73.6 km2 representing 8.83%. The other land use categories which include bare surface and wetland vegetation occupied 136.45 Km^2 (16.3 % and 152.61 Km^2 (18.3%) respectively.

The problem of rapid and uncontrolled urban growth and its inevitable consequences on cities and regional landscape, especially in the developing countries have been a serious concern for scholars in urban and regional affairs as well as city managers. Perhaps more worrisome is the surreptitious city encroachment on fertile agricultural land and other socio-economic implications. The scope and magnitude of the problem of urbanization transcend the city limit into the peri-urban areas, where resources consumed in the cities are obtained and where urban waste are dumped with ominous implications on vegetative cover.

First of all, in view of the fact that Kuje Area Council was envisioned as a satellite town to cushion the effect of population spill from Abuja Capital City, there is a need to focus attention on the landuse changes in the area so as to highlight the extent of vegetation that has been encroached upon by built-up areas as population surge in. Boyle (2005) suggested that "data and research at the rural setting need to be improved upon for provision of local government with the relevant data needed for making conclusions" hence the choice of Kuje Area Council for this research.

Finally, statements have been made that to comprehend the effects of fresh urban development on the populace and environment, examination of small and medium metropolitan centres is required instead of limiting our investigation to the biggest and most often extensively-studied megacities (Boyle, 2005). Thus the benefit of this work will be on the Local Area Council of Kuje, policy makers and planners in the FCT, agricultural operators as well as researchers and the general public.

Aim and Objectives

The aim of this paper is to assess landuse/landcover change distribution in Kuje area council between 1975 and 2010. In order to achieve the stated aim, the objectives are to:

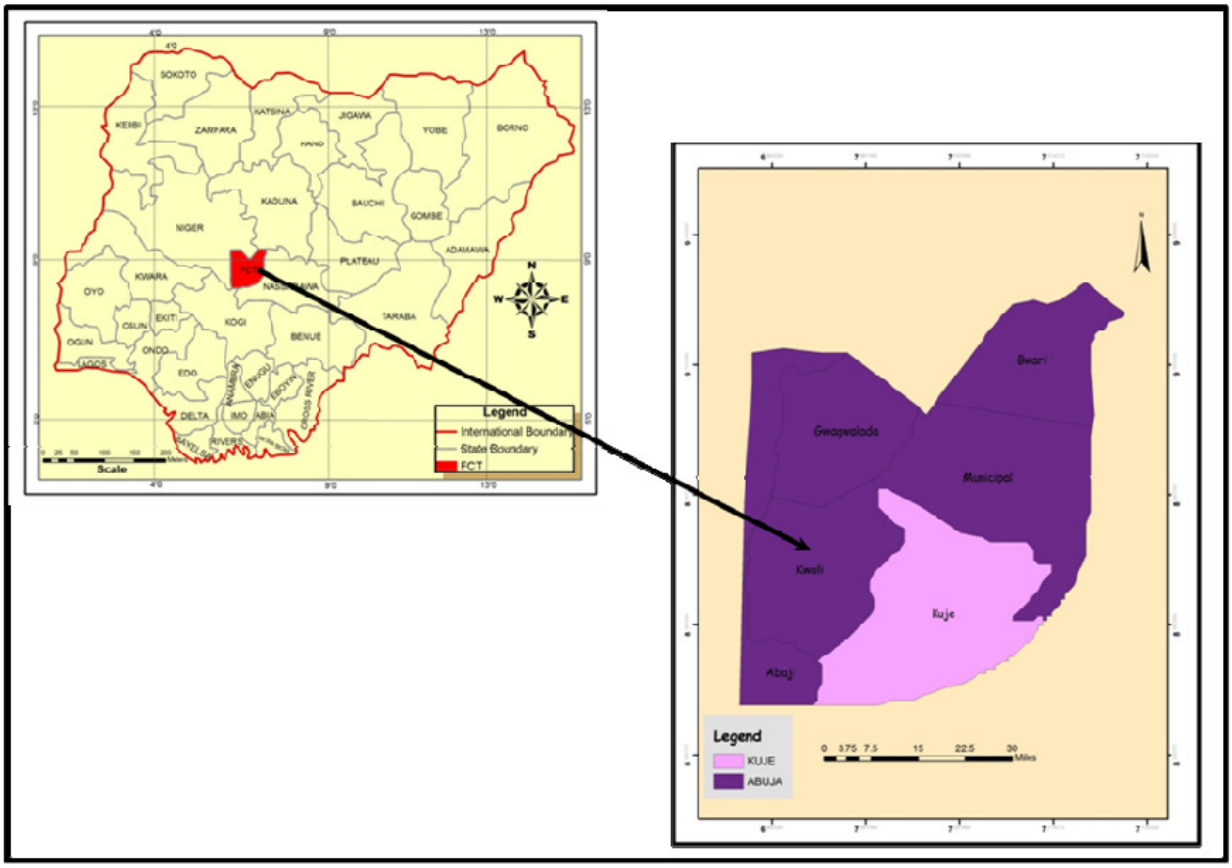
Identify landuse/area coverage of the study area over a period of 35 years.

Determine the rate, nature and direction of urban growth.

Determine the land use change of the area and its effects during the time period.

Study Area

Kuje Area Council is situated in Abuja the Capital City of Nigeria (see Figure 1). Kuje, the study area lies between latitude $8^0$27'43'' to $8^0$56'32'' North of the equator and longitude $6^0$58'13'' to $7^0$33'11'' East. It is bounded by Gwagwalada Area Council to the West, Eastward by Municipal Area Council, and Abaji Area Council to the South-West.



Source: AGIS, (2012).

Figure 1: Location of the Study Area

Materials and Methods

Three sets of questionnaire were designed and administered. The first set was administered to the residents within the wards of the Area Council constituting the study area using random sampling technique. Structured closed ended questionnaire was administered to seven hundred and eighty - three (783) respondents constituting about 0.2% of the total population of Kuje Area Council as projected from the census figures of National Population Commission of 2006 to 2010. The second set of questionnaire was administered to 100 professional Urban Planners and other professionals in Land Administration and management at the Secretariat of the Area Council and the Ministry of Lands, Housing and Urban Development, Abuja and the Federal Capital Development (FCDA). The third set of 40 questionnaires was administered to the Chiefs and the Ward heads in the 10 Wards of the Area Council.

The secondary data were sourced from Institutions and Governmental Organizations relevant to the study. These included publications such as The Kuje Area Council Master Plan, Master Plan for The Federal Capital Territory, reports, land use maps, and population data on Kuje Area Council for the period under review which was obtained from the National Population Commission, Abuja. The land use maps, and topographical maps, were obtained from the Federal Capital Development Authority (FCDA) Abuja and the Federal Surveys Kaduna.

On-screen digitizing was performed in this research. The maps were first scanned. The output of the scanning was filed in a raster format. This was then imported into ArcGIS 9.2 environment for conversion to vector format. Onscreen digitizing was employed in delineating the built-up area, hill, stream, roads, forest land, fadama land and the arable land from the various data sets for the years.

After the "onscreen" digitization, editing of the various layers that were digitized was then carried out in order to correct for errors such as overshoot, undershoot, intersections, and dead ends during digitizing. Map overlay operation was performed in order to identify and detect the increase or decrease in landuse classes that occurred over the years.

The mean change per year (arithmetic mean) in Km^2/year and % / year for the periods was then calculated. The rate of development (increase or decrease) was ascertained. This

gave the actual expansion or decrease of each landuse/ landcover for the period. The annual change in landcover was derived by dividing the total change (actual increase or decrease in landcover) in Km^2 by the total time interval in years (Dami, 2002; Aiyejina, 2008).

i.e. Annual Rate of change = Actual increase or decrease in landuse/landcover (in Km^2) / Total time interval (in Years)

The percentage change in each of the landcover types for the various years were computed by dividing the actual change in landcover by the previous size in Km^2 multiplied by 100 (Aiyejina, 2008).

Results and Discusion

Landuse/Landcover Change Distribution in Kuje Area Council (1975 – 1980)

The study revealed that between 1975 and 1980, the built-up area expanded from 2.6% (47 Km^2) to 4.2% (75 Km^2) of the total area. The major road networks expanded from 7.3% (131 Km) to 8.8% (159Km). 'Fadama' landcover which is the Hausa word for irrigable land, flood plains and low lying areas decreased from 17.7% (319 Km^2) to 16.4% (310 Km^2). These changes are numerically analyzed on Table 1 which shows the percentage changes and the extent of the landcovers/landuses for the various years.

Other landcovers also showed appreciable changes within the period. These include: Arable land which decreased from 32.3% (582 Km^2) to 32% (576Km2); Forest landcover also decreased from 19% (342 Km^2) to 17.9% (323 Km^2). Hill and waterbody landcovers also changed from 12.7% (228Km^2) to 12.2% (218Km^2) and 8.4% (151 Km) to 7.7% (139Km) respectively.

Landuse / Landcover Change Distribution in Kuje Area Council (1985 – 1990)

The comparison as indicated on Table 2 shows the built-up area which was 111 Km^2 (6.2% of the total area) expanded to 143 Km^2 (7.9%) in 1990. Road network also showed an increase from 184 Km (10.2%) in 1985 to 221 Km (12.3%) in 1990. However, the other landcover classes showed a decrease in their areal extent with fadama land decreasing from 295Km^2 (16.4% of the total area) in 1985 to 285 Km^2 (15.8 %) in 1990; Arable land decreased from 566 Km^2 (31.4%) to 551 Km^2 (30.6%); Forest landcover also decreased from322 Km^2 (17.9%) to 314 Km^2 to (17.4%).

Table 1: Percentage Change Distribution of Landuse / Landcover in Kuje Area Council between 1975 - 1980

SN	Landuse/Landcover	1975 Area (Km^2)	Area (%)	1980 Area (Km^2)	Area (%)
1	Built –up	47	2.6	75	4.2
2	Road	131	7.3	159	8.8
3	Fadama	319	17.7	310	17.2
4	Arable land	582	32.3	576	32
5	Forest	342	19	323	17.9
6	Hill	228	12.7	218	12.2
7	Waterbody	151	8.4	139	7.7
	Total	1800	100	1800	100

Source: Derived from Landsat and NigeriaSat-1 Imageries.

Table 2: Percentage Change Distribution of Landuse / Landcover in Kuje Area Council between 1985 - 1990

SN	Landuse/Landcover	1985 Area (Km^2)	Area (%)	1990 Area (Km^2)	Area (%)
1	Built –up	111	6.2	143	7.9
2	Road	184	10.2	221	12.3
3	Fadama	295	16.4	285	15.8
4	Arable land	566	31.4	551	30.6
5	Forest	322	17.9	314	17.4
6	Hill	201	11.2	198	11
7	Waterbody	121	6.7	88	5
	Total	1800	100	1800	100

Source: Derived from Landsat and NigeriaSat-1 Imageries.

Hill landcover also showed decrease from 201 Km^2 (11.2%) in 1985 to 198 Km^2 (11%) in 1990. This decline in the hill is most likely due to anthropogenic activities in the area such as strip farming and road construction in the area which most times necessitates the leveling of hilly areas within the region through cut and fill construction technique.

Waterbody which was 121 Km (6.7 %) in 1985 was reduced to 88Km (5% of the total area) in 1990. The change in waterbody could generally be attributed to climate change which has become obvious in recent years and the different seasons within which the images were captured leading to seasonal variations in the volume of water in the streams, rivers, ponds and other forms of waterbody within the area council (Balogun and Salami, 1995; Salami, 2007; Aiyejina, 2008).

Landuse / Landcover Change Distribution in Kuje Area Council (1995 – 2010)

Specifically, the built – up area which covered 10% (180 Km^2) in 1995 expanded to 16.8% (302 Km^2) in 2000, 25.7% (462 Km^2) in 2005 and 33.1% (596 Km^2) in 2010 (Table 3). Similarly, the major road networks within the Area Council increased from 14.8% (266 Km) in 1995, to 15.3% (276 Km) in the year 2000, 17.1% (310 Km) in 2005 and 18.4% (331 Km) in 2010 (Table 3).

Conversely, fadama land which is suitable for the cultivation of rice, sugarcane and irrigation farming in the dry season decreased from 261 Km^2 representing 14.5% of the total area in 1995 to 196 Km^2 (10.9%) in 2000; 120 Km^2 representing 6.7% of the total area in 2005 and 112 Km^2 (6.2 %) in 2010. Arable land as presented in Table 3 which covered a total area of 547 Km^2 (30.4%) in 1995, decreased to 533 Km^2 (29.6%) in 2000, 480 Km^2 (26.7%) in 2005 and 412 Km^2 representing 22.9% in 2010.

Forest land cover decreased from 311 Km^2 (17.3%) in 1995 to 291 Km^2 (16.2%) in 2000. It decreased further to a total area of 244 Km^2 representing 13.6% of the total area in 2005 and 200 Km^2 representing 11.1% of the total landmass in Kuje Area Council in 2010. Hill and water body land covers also showed decrease from 1995 to 2010. Hill decreased from 180 Km^2 (10%) in 1995 to 164 Km^2 (9.1) in 2000; 152 Km^2 (8.4%) in 2005 and 125 Km^2 representing 6.9% in 2010. Water body decreased from 55 Km (3%) in 1995 to 38 Km (2.1%) in 2000; 32 Km (1.8%) in 2005 and 24 Km representing 1.3% of the total landmass in Kuje Area Council in 2010.

Table 3: Percentage Change Distribution of Landuse / Landcover in Kuje Area Council between 1995 - 2010

SN	Landuse/ Landcover	1995 Area (Km^2)	Area (%)	2000 Area (Km^2)	Area (%)	2005 Area (Km^2)	Area (%)	2010 Area (Km^2)	Area (%)
1	Built –up	180	10	302	16.8	462	25.7	596	33.1
2	Road	266	14.8	276	15.3	310	17.1	331	18.4
3	Fadama	261	14.5	196	10.9	120	6.7	112	6.2
4	Arable land	547	30.4	533	29.6	480	26.7	412	22.9
5	Forest	311	17.3	291	16.2	244	13.6	200	11.1
6	Hill	180	10	164	9.1	152	8.4	125	6.9
7	Waterbody	55	3	38	2.1	32	1.8	24	1.3
	Total	1800	100	1800	100	1800	100	1800	100

Source: Derived from Landsat and NigeriaSat-1 Imageries.

Urban Expansion in the Kuje Area Council (1975 – 2010)

Figure 2 shows the areal extent of the built – up area in Kuje Area Council in 1975 while figure 3 shows the extent of the built - up area in the later year 2010. Figure 4 shows a mosaic of all the built – up areas that where digitized from the satellite images from 1975 – 2010. The expansion of the built –up areas of the various settlements in Kuje Area Council over the past 35 years can easily be appreciated from this map. As represented by the legend, the yellowish - brown colour shows the extent of the built – up area in 1975 while the light brown portion represents the extent of development in the year 2010. Comparison of the two years shows the expansion in the past 35 years.

In addition, figure 4 which is an overlay of the built-up area in 1975 on the built – up area of 2010, shows not only the extent of the expansion of the settlement in the past 35 years but also the direction and pattern of urban expansion. A close look on Figure 2, 3 and figure 4 show that the direction of growth of the settlement is towards the North where the Area Council Secretariat is situated. Furthermore, the existing road networks in the settlements have also served as attraction nodes for rapid

development in the area. A close examination shows that the settlements expanded from the yellowish - brown portion which represents the extent of development as at 1975 to the light brown colour of 2010 respectively.

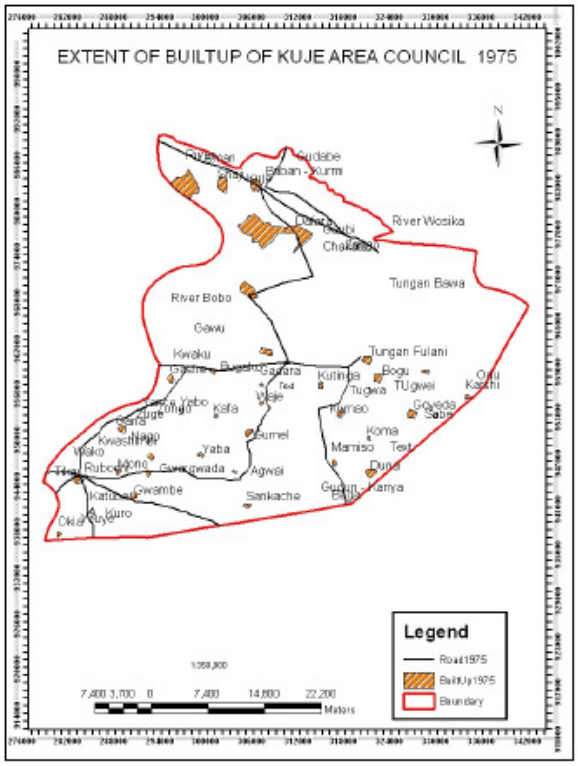
Percentage Change in Built – up Area in Kuje Area Council (1975 – 2010)

As can be seen in Table 4, expansion of the built - up area within Kuje Area Council for the period under study stood at 28 Km^2 between 1975 and 1980. This gave an average of 5.6 Km^2 (12%) annually. The highest change was recorded between 1995 and 2010 when the built – up area expanded by 302Km^2 (68%) which translated to 24.4 Km^2 (13.6%) annually. The last row / third column shows that the built up area in the Area Council expanded by 549 Km^2 (1,168%) within the 35 years period. This gave arithmetic mean change of 15.7 Km^2 annually which translates to an average increase of 8.9% annually. This has implications for sustainable food policy of the government.

Table 4: Urban Expansion in Km^2 per Year and Percentage / Year in Kuje Area Council (1975 – 2010)

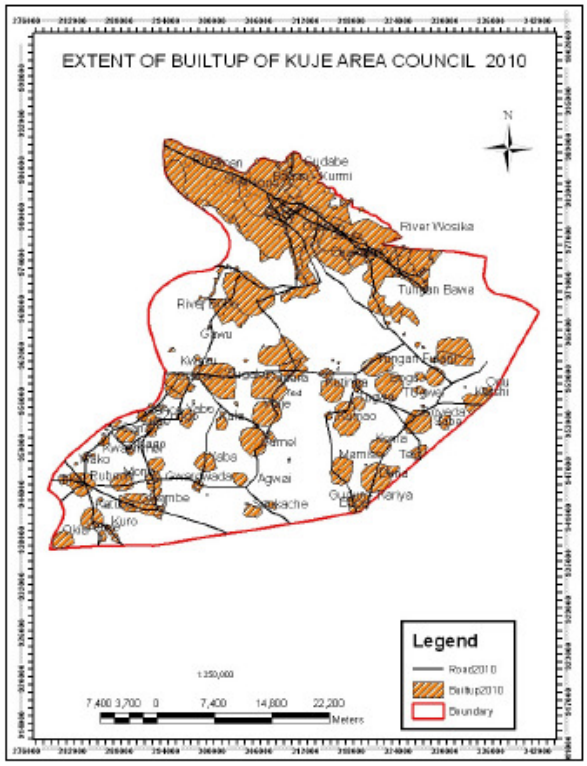
Period (Year)	Urban Area (Km^2)	Change (Km^2)	Change % Area	Time Span	Arithmetic Mean change (Km^2)	Arithmetic Mean change (%)
1975	47					
1975 – 1980	75	28	60	5	5.6	12
1980 – 1985	111	36	48	5	7.2	9.6
1985 - 1990	143	32	29	5	6.4	5.8
1990 - 1995	180	37	26	5	7.4	5.2
1995 - 2000	302	122	68	5	24.4	13.6
2000 - 2005	462	160	53	5	32	10.6
2005 - 2010	596	134	29	5	26.8	5.8
1975 - 2010	596	549	1168	35	15.7	8.9

Source: Derived from Landsat and NigeriaSat-1 Imageries for the various Years



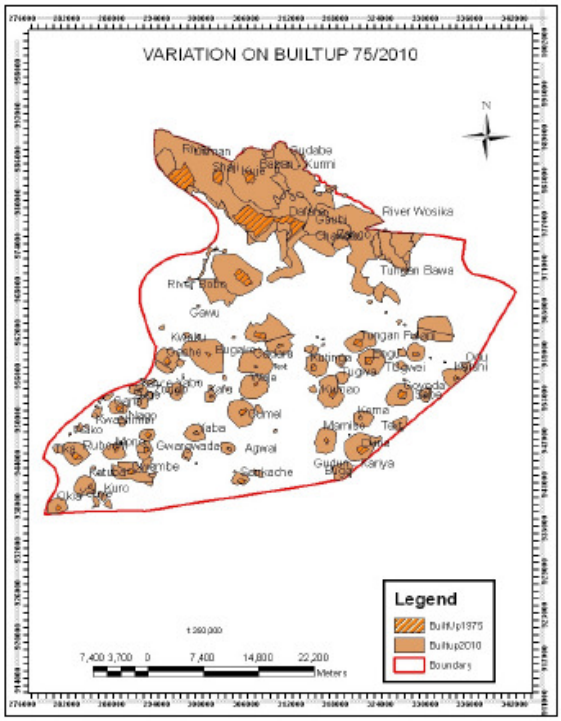
Source: Processed Landsat Image TM

Figure 2: Extent of Built – up of Kuje Area Council 1975



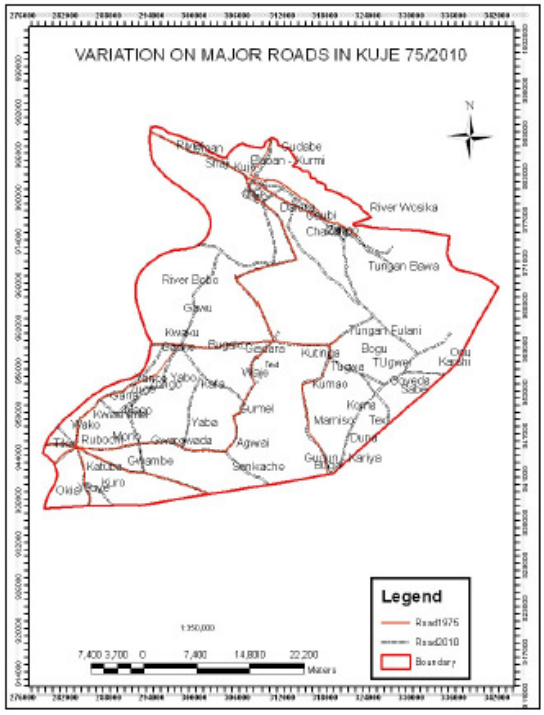
Source: Processed NIG-SAT1 Image

Figure 3: Extent of Built up of Kuje Area Council 2010



Source: Processed Landsat TM/NIG-SAT1 Image

Figure 4: Variation on Built – up Area in Kuje Area Council (1975 –2010)



Source: Processed Landsat/NIG-SAT1 Images

Figure 5: Variation on major Roads in Kuje Area Council (1975 and 2010).

Percentage Change in Transportation Landuse in Kuje Area Council (1975-2010)

Figure 5 is an overlay of the extent of the major roads in Kuje Area Council in 1975 on the major roads in 2010. As represented on the legend, the red lines shows the extent of the road in 1975 while the black doted lines shows the extent of the major roads in 2010. This comparison shows vividly, the expansion of the major road network in the area council within the period under study.

Table 5 shows that about 200 Km of major road network were constructed between 1975 and 2010 which amounted to about 153% percentage change. The average rate of road construction recorded was 5.7 Km annually which represented 4.4% rate of road construction annually.

Table 5: Percentage Change in Transportation Landuse in Kuje Area Council (1975 – 2010)

Period (Year)	Length of Road (Km)	Change (Km)	Change %	Time Span	Arithmetic Mean change (Km)	Arithmetic Mean change (%)
1975	131					
1975 – 1980	159	28	21.4	5	5.6	4.3
1980 – 1985	184	25	15.7	5	5	3.1
1985 – 1990	221	37	20	5	7.4	4.0
1990 – 1995	266	45	20.4	5	9	4.1
1995 – 2000	276	10	3.8	5	2	0.8
2000 – 2005	310	34	12.3	5	6.8	2.5
2005 – 2010	331	21	6.8	5	4.2	1.4
1975 – 2010	331	200	153	35	5.7	4.4

Source: Derived from Landsat and NigeriaSat-1 Imageries for the various Years

Conclusion

It can be concluded that the present innovations in GIS and Remote Sensing technologies makes available potent instruments for detecting and mapping of transformations in landuse/land cover. This research further demonstrated that these recent technologies in combination with observations of the field could be an excellent instrument in

displaying both land cover modifications and conversion.

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