Application of Geographic Information System in Assessing Land use Changes In Kubwa, FCT Abuja
by
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Abstract
This study looked at the application of geographic information system in assessing land use changes in Kubwa, FCT from 1987-1997. Structured questionnaire was distributed to 300 willing respondents using the systematic sampling technique. Using geographic information system, the changes were also mapped, simple descriptive statistics, Chi-square and T-test were also employed to validate the findings and the result showed that rural/agrarians land use changed dramatically from rural residential area which occupied <l0Ha of the total area coverage (i.e 5.4%) and agric/vacant land use of l5OHa (85%) of land coverage in 1987 to < 45 Ha of land area (56.7%) built mostly for tenants probably for urban dwellers/workers in 1997. The study conclude that the major land use changes found in this study are the commercialization and capitalization of the land within Kubwa which is also a major index that affects the growth and expansion consequently the land use changes in Kubwa area.

Introduction
As early as 1960 cartography, remote sensing, global positioning systems, photogrammetry, evolved into a discipline with its own research base known as geographic information sciences. Geographic Information System (GIS) is a computer system or automated tool capable of capturing, storing, analyzing, and displaying geographically referenced information; that is, data identified according to location. Practitioners also define a GIS as including the procedures, operating personnel, and spatial data that go into the system. GIS can also be used for scientific investigations, resource management, and development planning (USGS, 2007).

Thus, since the information comes from existing maps, GIS uses the processing power of the computer to transform digital information, gathered from sources with different projections, to a common projection. Additionally, GIS produces graphics on the screen or paper to convey the results of analysis to the people who make decisions about resources.
GIS is of great benefit to fields like: environmental studies, geography, geology, planning, business, marketing ,etc. An active GIS market has resulted in lower costs and continual improvements in GIS hardware, software, and data. These developments will lead to a much wider application of the technology throughout government, business, and industry. GIS and related technology will help analyze large data sets, allowing a better understanding of terrestrial processes and human activities to improve economic vitality and environmental quality.

Landuse Changes
The description of land varies with the purpose of application and content of their uses. The agricultural economist concentrates on land as the production unit while the Food and Agricultural Organization (FAO) defines land as a delineable area of the earth's terrestrial surface, encompassing all attributes of the biosphere immediately above or below this surface, including those of the near surface climate, the soil and terrain forms, the surface hydrology (including shallow lakes, rivers, marshes and swamps), the near surface sedimentary layer and associated groundwater reserve, the plant and animal population, the human settlement pattern and physical result of past and present human activity (terracing, water storage or drainage structures, road, building etc). FAO, (1995,6).

This definitions show that land can be put into different uses such as transportation, commercial, recreation, unused space, industrial, extractive, manufacturing and for residential. Thus, many scholars consider land for the uses to which it can be put and it can be studied from different angles. Jego, (1990), Garba, (1991), Yakubu, (2004), Ndabula , (2006), and Olaleye, (2006), all defined landuse as the relationship between the land and the socio-economic activities in the society.

In the developed countries, major metropolitan areas face the problem of urban sprawling, loss of natural vegetation and open spaces and a general decline in the extent of wetland and wildlife habitat due to the various landuse found in the urban areas. This is a common phenomenon in many developing countries, even though the rate might differ for example, the deforestation in National Natural Parks, conversion of agricultural and green areas for residential and education purpose. These problems have been attributed to increasing population; cities have changed from small isolated population centers to large interconnected economic physical environment (USGS, 1999).

Africa is currently undergoing an urban transition at an unprecedented scale and pace, with an estimated population growth rate of 5 percent, the proportion of

Africa's urban residents doubles every 15 years UN, (2002, P. 2-6) urbanization in Africa is characterized by high population momentum, rural/urban migration, and the appropriation and reclassification of land around the periphery of urban areas Cohen, (2004). However, Africa's urban transition is occurring within the context of a vulnerable economic base exposed to the vagaries and pressure of global competition Kessides, (2005). Managing urban growth is one of the most important sustainable development challenges of the region in the 21st century Rakodi, (1997).

Nigeria is one of the most urbanized countries in Africa and is having the largest population in sub-saharan Africa which is about 140 million people NPC, (2007), consisting of about 250 ethnic groups Daramola, (2005). Such a growth is of great concern in terms of economic development. These changes are as a result of population growth, industrial and commercial development, establishment of educational and transport infrastructure, market and trading post.

Profound changes have taken place in the cities and much more in Federal Capital Territory since it was created in 1976, but most especially since 1980 when physical development actually started. This period has witnessed the introduction of large number of both foreign and local socio-economic, administrative, political and developmental institution in the Federal Capital Territory Balogun, (2001).

However, between 1987 and 1997 there has been profound negative effect on facilities and infrastructure already provided and on the overall development of the Federal Capital Territory. In some cases expansion and replacement of facilities are obstructed by illegal structures indiscriminately erected. These structures not only distorted the Master Plan, they also over stretched the electricity distribution or rendered them completely inadequate. The incidence of illegal structures was further complicated by disregard to the landuse plan El-Rufai, (2004).

These abuses did not end there, other areas earlier designed by the Master Plan as green area space where redesigned for residential houses, while in some cases, residential plots were converted to commercial plots and plots that were reserved for schools were allocated for the development of housing estates Daramola, (2005).

This was followed by the El-Rufai demolition's exercise which led to loses of houses and properties,

People left the Capital City for surrounding areas like Kubwa, which has led to an increase in demand for land for illegal construction, over taxed facilities, confused grabbing and increases in costs. The above will certainly give rise to increase and changes in landscape. Therefore, there is need for proper study to determine the reasons for change in landuse development in Kubwa, and provide basis for planning for sustainable development.

However, since man also requires these lands, it becomes important to maintain a balance between environmental demands and human demands, thus, the issue of landuse planning and implementation has been imperative.

Kubwa, like every other area in Abuja, Federal Capital Territory has been earmarked for various purposes. The research using GIS intends to find out the extent to which the plans are being followed and the reasons for changes within the time frame for the study. There has been a number of studies (Determinant of landuse change pattern in the Netherlands, (Verburgh *et al.*, 2003), Landuse change analysis of three selected panchayats in Kuttanad using Remote Sensing data and GIS, (John, 1999) on reasons and impacts of landuse changes in developed countries. The few studies such as(Olaleye, 2006) in Northern Nigeria, Ndabula ,2006 conducted in developing countries addressed matters such as quality of drinking water, availability of water for agriculture, natural hazards, fresh and sea water pollution and atmospheric pollution. This diversity of concerns is associated inevitably with a diversity of disciplines being involved in these studies. But the earth and life sciences are not the only and exclusive territories of scientific activity on landuse change.

Statement of Research Problem
In the past, Kubwa used to be a small village surrounded by many farmlands with a few basic social amenities. However, in the 1990's, it has grown in status to a relatively large village. Therefore, due to these changes there is gross increase in the physical growth of the settlements, connoting increase in population and land area covered. There is also the growth and expansion of "new" social and economic landuse including educational, residential, and administrative and transportation Akubur, (1985). Thus, the thrust of this study is to find the nature of landcuse changes that have developed in Kubwa, one of the sprawling towns around the FCT using the Geographical Information Science.

Aim and Objectives of the Study

The study aims to elicit the use of GIS to identify and characterize the nature of landuse changes in Kubwa, a sprawling settlement near the FCT. To achieve this the study Characterize the various landuse changes since 1987 to 1997 using GIS and explain the factors leading to the observable landuse changes

Study Area

This study is limited to Kubwa, Federal Capital Territory. The study area is approximately 230.4 hectares and lies between latitudes 9°07'57" and 9°10'39"N and longitudes 7°18'45" and 7°22'21"E. The time period of 1987 to 1997 will be considered as this will offer a 10 year window for evaluation of the area. The various landuse changes that will be looked at, include, agricultural landuse, residential commercial, etc.
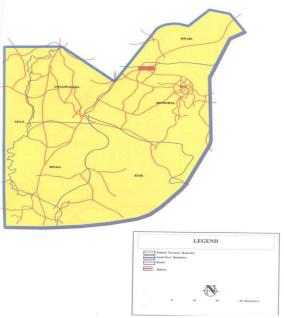

Fig 1. Federal capital territory Abuja: study area shown in red

The choice of this study area is because Kubwa is the major resettlement area close to the Federal Capital Territory (FCT). In this study both primary and secondary methods were used to elicit information from respondents. Also both inferential and non-inferential statistical techniques were used to summarize and explain information obtained.

Sample Population

The subjects of this study are residents of Kubwa who had lived in the area for the period under consideration. Their opinions on the reasons for landuse changes in Kubwa and their impact were sought. The primary source of data was obtained by the use of questionnaire. A total of 315 respondents were selected as sample for the study to obtained data. The questionnaire addresses socio-economic characteristics of respondents and observable landuses characteristics. Of the whole only 300 questionnaire were utilized out of the remaining as 15 were not completely filled, hence they were

discarded.

Field Measurement/Observation

Patrol survey was conducted to make observations of the nature and extent of landuse changes in the study area. Observations of the existing uses were also recorded. The secondary data like the Kubwa Master Plan, satellite imagery, and maps of Kubwa were obtained from the Federal Capital Development Authority, Parah Urban Kulsult, and Department of Land and survey. Also the National Population Commission was visited to obtain data on the last population census of Kubwa, Journals, textbooks, Internet; unpublished works were also used to beef up the literatures.

Acquisition of base map

The base map showing the coverage of Kubwa and the physical characteristics of the built environment was obtained from IKONOS satellite imagery. The Ikonos satellite images obtained were for a decade

(1987-1997) and updated. This was achieved by using global positioning system (GPS) to take coordinates in the field. The coordinates were used for geo-referencing purpose, to ensure accurate position of all facilities and services.

Scanning of base map
The updated image was scanned into CorelDraw 13- and for compatibility with the ILWIS environment, the scanned map was converted into tag image file format (TIFF)

GIS procedures used for creating data base for analysis
GIS technique was used for the acquisition of base maps, spatial, physical and landuse data. The Data collected were used to prepare a database for subsequent analysis for change in landuse spatial analysis. Database is the "backbone" of a GIS project and indeed its advantage is that information in it can easily and quickly be updated at a minimal cost. It is a technique of encoding data into the computer and storing them in a database. In other words, it is a computer file containing record information made up of spatial and attributes data.

A database containing the characteristics of these elements was created for example settlement name, list of potentials, existing situation and other variables. These were created and linked to the spatial features though show/details/make tables/form/new table module in spatial editor window of TNT maps.

Method of Data Analysis
Simple percentage, pie chart and bar graph were used to describe the data obtained from the study, chi-square was used to test the hypothesis of the study while GIS was used to show the overlay.
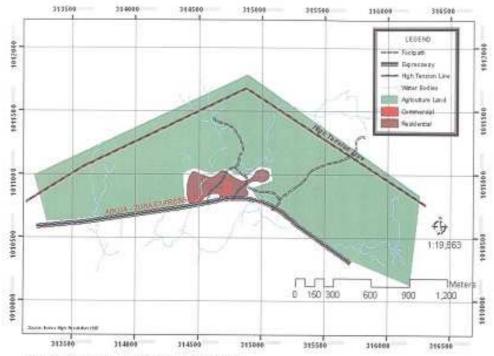
Results and Analysis

Fig. 2 : Kubwa Abuja: Existing Land use 1987

Table 1 Kubwa Landuse 1987

Landuse	Area Coverage (Ha)	Percent (%) of the Total landuse
Residential	9.6	5.44
Commercial	0.6	0.34
Agric/Vacant Land	150.1	85.04
Water bodies	16.	9.18
Road	-	-
Total	176.5	100

Source: Ikonus High Resolution Satellite Imagery

Fig. 3 · Kubwa Abuja, Existing Landuse 1996

Table 2 Kubwa Landuse 1996

Landuse	Area Coverage (Ha)	Percentage (%) of the Total Landuse
Residential	43.8	24.8
Commercial	1.7	0.9
Public	7.8	4.4
Open Space	7.0	4.0
Agric/Vacant Land	100	56.7
Water bodies	16.2	9.2
Total	176.5	100

Source: Ikonos High Resolution Satellite Imagery

From Fig 2 - 4 and Tables 1 and 2 the following changes were observed for the study period:

Residential
Between 1987 to 1997 the typical Gwari (Gbagyi) architecture of round hut housing pattern became modernized in shape and layout. The shape of houses which were either round or rectangular began to be replaced by houses with regular and well laid streets using modem building materials. Residential areas increased by 24.8% of the total area.

Commercial
The local traditional market was replaced by a more modern market structure. The commercial activities increase by 0.9%. Signifying that there is development and growth in the commercial sector.

Open Space
Some portions of erstwhile agricultural gave way to organized open spaces which are represented by 4.0% are used for motor parks, cemeteries, etc.

Public utilities
Public utilities like electricity and pipe borne water emerged and it is representing 4.4%. Footpaths have also been replaced by good roads which creates an inter connection of all villages and inter residential access routes. It also provides adequate accessibility from homes to farm lands.

Agriculture
Many agricultural farmlands have been replaced by residential and commercial areas, which are represented by 56.7%. This indicates the emergence of new forms of landuse rather than agriculture.

Table 3 : Landuse Changes in Kubwa between 1987 – 1997

Landuse	Area Coverage 1987 (Ha)	Area Coverage 1996 (Ha)	Percentage Increase (Ha)	Change/ Difference (Ha)
Residential	9.6	43.8	24.8	34.2
Commercial	0.6	1.7	0.96	0.1
Public	-	7.8	4.4	7.8
Open Space	-	7.0	4.0	7.0
Agric/Vacant land	150.1	100	56.7	50.1
Water bodies	16.2	16.2	9.2	0
Total	176.5	176.5	100.0	100.2

Source: Ikonus High Resolution Satellite Imagery

There is an increase in the residential area coverage between 1987 and 1997. In 1987 the area coverage was 9.6 while it became 43.8 in 1997 giving a difference of 34.2 showing a percentage increase of 24.8.

The commercial centers have increase from 0.6 Ha in 1987 to 1.7 (Ha) in 1997 with a difference of 1.1 with a percentage increase of 0.96.

In 1987, there were no public utilities but in 1997 there is, and it shows the difference of 7.8 with an increase of 4.4 percent. In 1987 there were no open spaces, but in 1997 the emergence of open space is evident with a difference of indicating an increase of 4.0 percent. There is a decrease in agricultural areas in 1997 compared to that of 1987 with a difference of 50.1 showing that other landuses are replacing Agriculture in the area. The decrease is shown by 56.7 percent. The water bodies showed no difference

The results obtained from the field were subjected to chi-square analysis, to determine the relationship between factors like population growth, availability of land, closeness to Federal Capital City, availability of electricity and water etc, and it is presented on Table 3

The result obtained from the analysis showed that the observed chi-square was 195.38. The score was then converted to t-test values. This t-test value was able to test the strength of the relationship which shall be used to know the level of significance of the chi-square value. In that process the score of 19.14 was obtained. The result also revealed that the T-value is greater than the t-critical value obtained from the t-table meaning that there is a good significant relationship between landuse change and other factors like population growth, availability of and, closeness to Federal Capital City, availability of electricity, water, and transport etc.

Table4 : Summary of Chi-square Test on Landuse Changes in Kubwa

Variables	α	Df	x^2	$+^2$
Factors leading to landuse changes in Kubwa	0.05	299	195.38	19.14

t (300) <0.05 = 1.96

Table 5: Factors for Landuse Change in Kubwa

Factors Leading to Change	Frequency	Percentage (%)
Population growth	252	10.3
Competition for scarce resource	150	6.1
Closeness to Abuja	202	8.3
Cheap rentage	94	3.9
Affordable transportation	110	4.5
Availability of land	207	8.5
Availability of welfare facility	246	10.1
Increased rural urban migration	268	10.9
Land capitalization and commercialization	265	10.9
Good road condition	225	9.2
Closeness to work	105	4.3
Ease in owing a personal land	107	4.4
Job growing population	54	2.2
Proximity to children school	156	6.4
Total	2441	100

Source: Field Survey, 2008.

The total responses on this table is not the same with the number of question administered because some responded more than once.

From table 5 above, the factors leading to change in landuse in Kubwa are population density, rural urban migration; land capitalization and commercialization, availability of welfare facilities, good road condition are the major reasons for the change in landuse in Kubwa. This is because they have the highest percentage calculated given by 10.3%, 10.9%, 10.9%, 10.1% and 9.2%.

The study established that there are changes in the use of land in Kubwa. The changes in the use of land are due to many factors such as population growth 85%, closeness of Kubwa to Abuja city 67.3%, shortage of land in Abuja 50%, availability of land in Kubwa 89%, availability of electricity and water 82% and cheap and affordable rentage.

Conclusion

On the basis of the results of this study, the following conclusions are therefore drawn.

1. There are changes in landuse in Kubwa as shown in the Geographic Information System (GIS) analysis.

2. These changes can be attributed to: population growth, availability of land, availability of social amenities and infrastructures, closeness of Kubwa to city centre, and good transport that is cheap and affordable.

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