Analysis of Urban Land Use Change in Kano Metropolis 1962-2007

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Studies carried out on urban land use changes in Kano had concentrated on the transformation of many of the farm land, wet lands, forest, open spaces and other rural lands into urban land use. The research investigations were how population growth, growth in transportation network and land use zoning had influenced land use changes in Kano metropolis. Detailed studies were made on spatial patterns, rates of change and trends, as well as planning implications with a view of forming sound policies to guide sustainable growth. The study revealed overwhelm land use changes where residential, commercial, industrial, public and semi-public land uses gained more urban space than required space standard in a multifunctional city while parks, playfield and open space as well as agriculture land uses concealed to other land uses. The regression model was used to identify the rate of changes for each land use category and systematic evaluation of relative contributions of each land use category in relation to population growth and growth in road infrastructural development were made. The study therefore reveals that population growth and growth in transportation are among other factors influencing land use growth and land use changes in Kano.

Keywords: *Urban Land Use, Civil Planning, Population Growth, Zoning, Infrastructure*

1.0 Introduction

Nigeria is the most populous nation in Africa with a teaming population of over 150 million occupying over a land area of about 923,000 square kilometers. Lagos, Kano and Ibadan are among the first 100 largest cities in the world (World Gazetteer, 2005). Large population translates into pressures on land and thus high urban dynamics. This brings with it intractable urban problems, such as poor environmental sanitation, pollution, crime, unemployment and overcrowding among others (Oluseyi, 2006).

Urbanization is exerting very high pressure on land for urban uses and services. Such pressure is leading to rapid conversion of agricultural (rural) land in to urban uses on intense competition among various land uses. Land use in Kano has been shaped by the Master Plans of 1963-1983 and subsequent reviews in 1990. How far has Land use zoning been consistent with trends in population and land use activities, changes and demands for various services?

Studies carried out on urban land use changes in Kano particularly that of Maiwada, (2000) Lynch and Olofin (2001), Olofin and Tanko (2003) have concentrated on the transformation of many of the farm land, wet lands, forest, open spaces and other rural lands into urban land use. While these studies predicted an unprecedented rate of growth in the city, the speed of development has been attributed to spatial inequalities, poor planning and monitoring of the city growth. However, the researchers have approached urban growth as a static problem rather than as a spatial form that emerges from the urban development process. Also, the spatial patterns, rates of change and trends, as well as planning implications of these changes have not been studied in details to provide insight into how the city has developed under varying social, economic, and environmental conditions. These changes and their implications for planning are not closely monitored and hence the desire to undertake this study. There is the need to search and update land information. This information remains vital for important decision making at Local, State or Federal Levels. This research provides temporal land use database, analyses of land use change and landscape change predictions for the city of Kano, an important and fast growing city in northern Nigeria. Planners can use urban dynamics data to evaluate environmental impacts, delineate urban growth boundaries and service areas, develop land use zoning plans, and to gauge future infrastructure requirements. Policy makers can then use the information to direct future development away from most risky areas, protect the ecosystems and plan for sustainable urban environment.

The purpose of this research is to undertake Urban Land Use investigation, on rate of changes and growth factors for sustainable land use planning and decision making in Kano.
Specific objectives of the study are to:

1. Assess the rate of land use changes in Kano metropolis from 1962-2007

2. Determine planning implications of urban land use changes in Kano.
3. Identify key socio-economic and demographic causes of land use changes in the metropolis.
4. Link spatial and temporal changes in urban land uses to, population growth, growth in transportation network and land use zones in Kano.

1.1 Research Hypotheses

1. There is no relationship between population growth and the rate of urban land use changes in Kano
2. There is no relationship between spatial changes in land use and, population growth, growth in transportation network and land use zones in Kano.

Hypotheses1 and 2 will be tested using Least Square.

1.2 Justification of the Study

The process of urban expansion is more alarming today in all directions of the city. These changes are evidence of a growing city with far reaching environmental consequences. These problems often assumed complex dimensions, consequently reducing the capacity of the city. The growth rate shows no signs of slowing, and the master plan proposals have not kept pace with physical developments. This is because there is a gap in knowledge about land use changes and human activities, and environmental features and processes. This gap in knowledge was covered in the study and in addition, the research provided temporal urban land use database, analyses of land use change and landscape change predictions.

1.3 Location and Scope of the Study

Kano city is state capital of Kano state established in 1967. It is largest city in northern Nigeria and second largest town in Nigeria. It is located between latitudes $10^0$30'N and 13^0 N and between longitudes $7^0$40'and $10^0$35'E, and is 1549feet above sea level. The master plan of 1963-1983 established the spatial dimension of Kano metropolis. The areas of coverage include urban Kano and the district of Ungogo and Kumbotso. Today metropolis has expanded beyond that and covers six Local Government Areas (Municipal, Nassarawa, Fagge, Wale, Trami, Dalla) and Part of Tofa Local Government Area, Dawaki Kudo, Gezawa and Mejibre.

Figure 1 : Map of Nigeria Showing Kano State and Kano Metropolis

The scope of the study is limited to urban land use changes in Kano metropolis from 1962 to 2007. This period is chosen for a number of reasons: First there are a set of data available at an appropriate scale. Secondly, Kano has undergone political transformation and was declared as the Kano state's capital in 1967 thus, attracting more administrative functions and population in the city. Thirdly within this period the city experienced accelerated economic growth with the peak in 1973-1978 oil boom periods, which brought about accelerated urbanization of the population and physical growth of the city. Government expenditure in the city created tremendous numbers of urban base jobs in construction, administration, commerce, industry, and etcetera. By the early 1980s, following the collapse of the world oil market, the ability of the Nigerian state to continue to finance the import needs of industry was severely undermined as its foreign exchange earnings were drastically reduced. The State's oil revenues fell from 10,000 billion naira (N) in 1979 to N 5,161 billion in 1982, at a time when the raw materials and capital goods import requirement of industry was put at well over N5.7 billion and the total import requirements of the entire economy exceeded N13 billion (The Odama Report, 1983). From 1982 until date the city has been faced a downward trend in its economy due to the structural adjustment programme, initiated in the 1980s, yet high rate of urbanization has continued unabated. The study examines spatial changes in land uses such as conversion from one type of use to another (that is changes in the mix and pattern of land uses in an area and modifications in of land uses within the city due to socio-economic and demographic causes in Kano.

Factors, such as employment opportunities, land prices and the million of personal decisions people make was not considered in the analysis. Simulation technique was not use despite its popular application for the analysis of land use change. Because analysis of land use change is an aggregate, macroscopic modeling approach as it does not account for any of the causes of land use change; instead, it assumes that all forces that worked to produce the observed patterns and governed their transition probabilities will continue to do so into the future.

2.0 Methodology

This section provides information on the materials utilized in the study. It also presents the methods used in research and data analysis

2.1 MATERIALS

Information used this study includes:

- Maps: Kano Master Plan 1962-1981 Maps/Plans and Road Network Maps/Plans of the Metropolis;
- 1981 Landsat Thematic Mapper (TM);
- SPOT Multi-spectral Imagery of 2005, 5m Resolution free of clouds;
- Global Positioning System (GPS) tracking of Kano metropolis;
- Geographical Information System (GIS) Environment and Application software: ArcGIS and ERDAS IMAGINE.

The above materials was used to achieve objective one, which is essentially to measure the rate, trend and the pattern of land use change.

- Population data from national census;
- Timeline of historical event from state archives;
- Time series statistics

This data set was used to achieve objectives two, three and four. Which are essentially to identify key socio-economic and demographic causes of land use changes within the metropolis, Link spatial and temporal changes in land use to population growth, growth in transportation network and land use zoning.

Field survey was conducted using Global Positioning System (GPS) to track building activities and changes which cannot be depicted by satellites in Kano metropolis.

Ground Control Points (GCPs) were established using GPS readings and download in to computer system. Specifically for QuickBird 2.4m resolution, Ground Control Points and Digital Elevation Model (DEM) was provided to the Digital Globe the main supplier before Orthorectified imagery was supplied.

2.3 Methods of data Analysis

The physical planning documents create land use changes in urban fabric and therefore, data layers of urban land use and urban land use changes are based on decisions about the physical development of Kano metropolis development area. This is different from land uses changes derived directly from aerial photographs and satellite images' density types, weighting in reflected and infrared images generally used by scholars for land use changes. Urban land uses of Kano metropolis development area was digitized and classified as shown in Table 1. Using ArcGIS and ERDAS IMAGINE softwares, data layers of each class of urban land use was digitized with respective attributes tessellated to form a grid of cells. The respective code and attributes are maintained throughout in identifying the nature of the urban land use changes of the cell.

The nature of the land use change of a cell is design as shown in Table 1. Urban land use maps were produced from Kano master plan of 1960s, 1981 Landsat TM, SPOT 5m Resolution 2005 and Quick Bird 2.4 Resolution, 2007; Table 2 show twenty seven (27) categories of urban land uses that has been consistently maintained in various time periods.

2.3.1 Imagery Registration

Land use mapping involved registration of Landsat TM of 1981, SPOT multi-spectral 5m resolution imagery of 2005, 2.4m resolution of QuickBird of 2007 and master plans were available in the catalogue. The adopted interpretation technique, which is preferred to the standard classification, is base on photo-interpretation or visual interpretation assisted by computer. The process consist of displaying the rectified/registered imagery on the screen and digitizing polygons representing different land use categories, base on image characteristics such as pattern, which are translated into land use attributes. The process was guided by ground observations and local knowledge. The polygons were identified by independent labels attached to the centriod of each polygon. The technique employed for ground truthing aims at localizing and characterizing field observations land use categories and delimitation of classes using Global Positioning Systems (GPS) facilities. The result of visual interpretation technique, in this study was a digital coverage layer, in which polygons represent different land use categories. A full database was attached to this coverage, in which every polygon is characterized by many attributes like, the category number, area and perimeter of polygons.
After the initial image processing and rectification, the images was enhanced in order to enable visual interpretation and better comprehend the tonal presentations, the nature, types and characteristics of the land use discernable from the images. Four data sets were concurrently displayed to check the registration. The procedure was repeated until the data sets were registered properly. Land use classification scheme was developed inline with Kano Town Planning classification scheme.

2.3.2 Land Use Change Detection: There is a wide range of techniques used for land use change detection of urban areas. These techniques according to Jensen's (1996) include: Image algebra, Post Classification Comparism, multidate composite, Spectral change vector analysis, Use of a binary change mask, Onscreen digitization(Visual Interpretation), and Change detection by image display.

Onscreen digitization was adopted because Arc GIS and ERDAS IMAGINE software permits the analyst to view both images side by side on the screen and to outline changed areas manually using on screen digitization, based upon visual interpretation. Land use change information was visually interpreted more or less directly from evidence visible on satellite images of 1981, 2005 and 2007.Objects was seen in the context of the neighboring features. This method's has been used primarily, if not exclusively, with large-scale digital images (Campbell, 2002). Belaid, (2003) applied this method in urban rural land use change detection and analysis in three cities in Morocco and Ahsaosis in Saudi Arabia.

The nature of the land use change of a cell is design as shown in Table 1 below. The actual changes were obtained by a direct comparism between classification results from 1962 to 1981, from1981 to 2005 and from 2005 to 2007. Changes that have occurred between the four dates were measured by performing a change matrix. The technique has been successfully applied by many authors for the study of land use /land cover change (Howardth and Wickweare, 1981). The technique has been found to be less restricted in terms of the algorithms used when compared with other change detection techniques.

The following products were achieved:

- Land use change maps and corresponding statistics inventory for each period.
- A pair-wise comparism of land use maps, as well as their statistical inventories to detect changes in terms of area and geographic location of these changes.
- Built Evolutional matrix for the periods providing all possible changes involved and the corresponding areas in terms of extension, regression and net evolution for all categories

2.3.3 Time Series Modeling

A time series is asset of observations taken at specific times, usually at equal intervals.

Mathematically, a time series is defined by
The values $Y_1\ Y_2\ \ldots$ *of a variable Y at times* $t_1, t_2 \ldots$
Thus Y is a function of t: this symbolized by $Y = F(t)$.

A time series involving a variable Y is represented pictorially by constructing a graph of Y versus t.
The computer software utilized is E-Views. E-Views provide sophisticated data analysis, regression, and forecasting tools on Windows-based computers.

The statistical modeling is preferable because it accommodates all the quantitative data related to land use change than simulation technique, applied to the analysis of land use changes. Markov analysis of land use change is an aggregate, macroscopic modeling approach as it does not account for any of the drivers of land use change; instead, it assumes that all forces that worked to produce the observed patterns and governed their transition probabilities will continue to do so into the future.

The census data of Kano was modeled with the spatial patterns of urban land use changes and infrastructure. This task was achieved through linking of Kano's land use history, population data, timelines of historical events, and related information to explain the mapped changes. Population data was correlated with temporal database so that human movement can be tracked and factored into these interpretations. Timelines of past events aid identifying the issues that affect the development of the city. The transportation networks were used to dictate patterns of urban growth. Historical land use pattern, together with current trends in Kano was used to model future land uses. The land use change model was based on simple parameters including present urban extend, population, major transportation routes and land use zones. Urban land use change was considered as dependent variables while land use data, on demographic and urban infrastructure in the corresponding interval of time was considered as independent variables.

The land use change and the corresponding changes in demographic and infrastructure data from 1962 to 2007 was incorporated, within a confidence level of 0.05.

3.0 Results

3.1 Spatial Patterns of Urban Land Use Changes in Kano Metropolis

Urban land use expansion in Kano is dominated along major roads into the city. Major activities areas like commercial, residential, and industrial areas had recorded major changes. Figure 2 shows 1962 urban land use in which development preoccupied the eastern part of old Kano city up to the Gwammala in the north. Developments out of the old Kano city were observed in Sabon Gari, CBD, and GRA, extending to Gwanwarwa in the north and west of Bompai industrial zone.

Figure 3 shows 1981 urban land use in which developments were observed more towards the Zaria road and Wudit roads. The new developments were observed adjoining old settlements in all directions. In the northern part, development extended to Amino Kano Airport and beyond to Kurna. Also the western part of the old city expanded leaving behind very small marginal land within the city wall. East ward new development occur further east of Bompai up to Dakata along Hadejia road. New developments were observed from GRA towards Tarauni and Hujora, Hausawa up to Sheka.

Figure 4 shows 2005 urban land use in which development pattern maintained the trend similar to that of 1981 except rapid development towards Bayero University Kano and the road to Gwarior. Figure 5 shows 2007 urban land use in which development pattern maintained the trend similar to that of 2005 with rapid development toward major gateways into the metropolis.

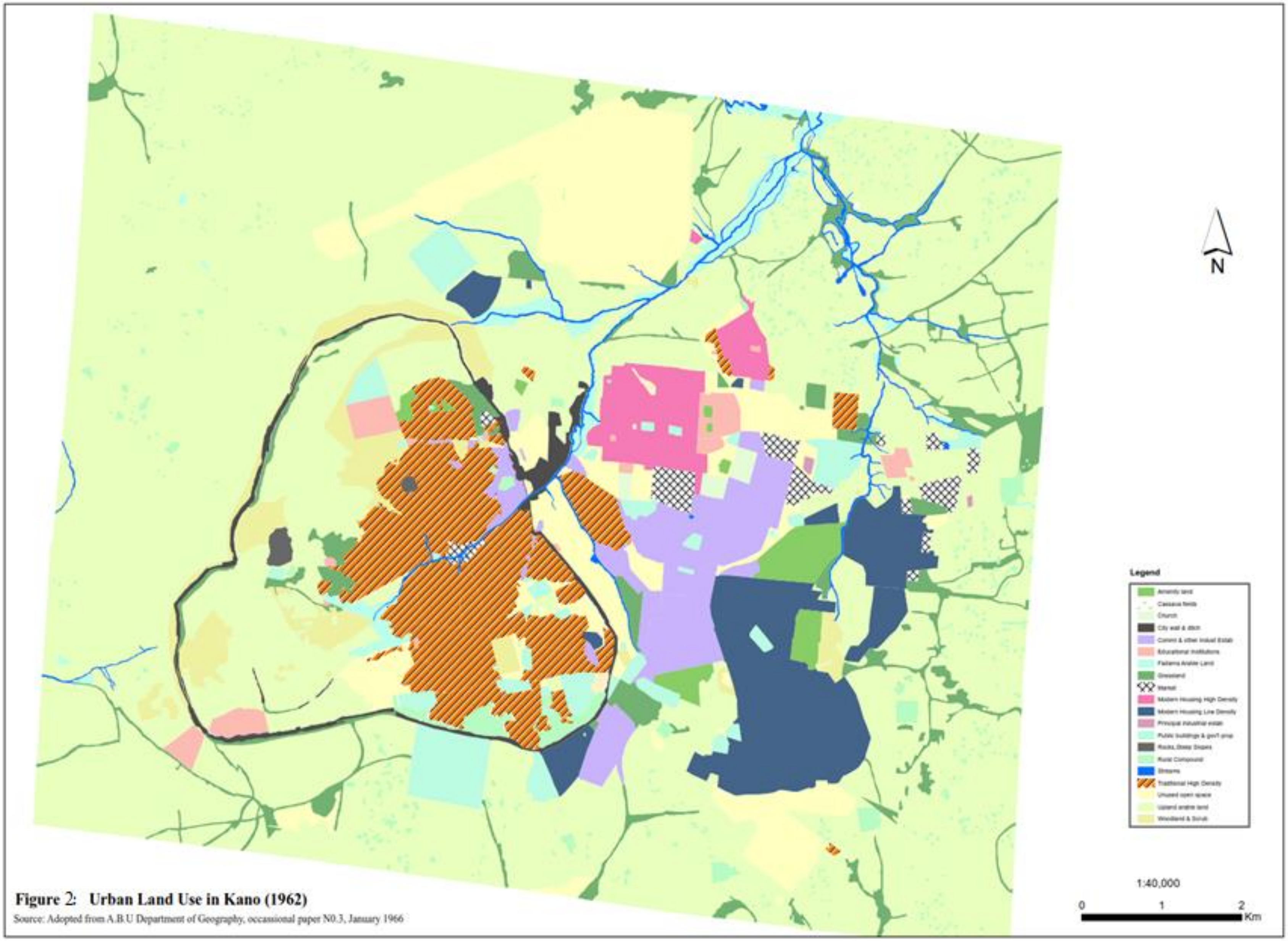

Figure 2: Urban Land Use in Kano (1962)

Source: Adopted from A.B.U Department of Geography, occassional paper N0.3, January 1966

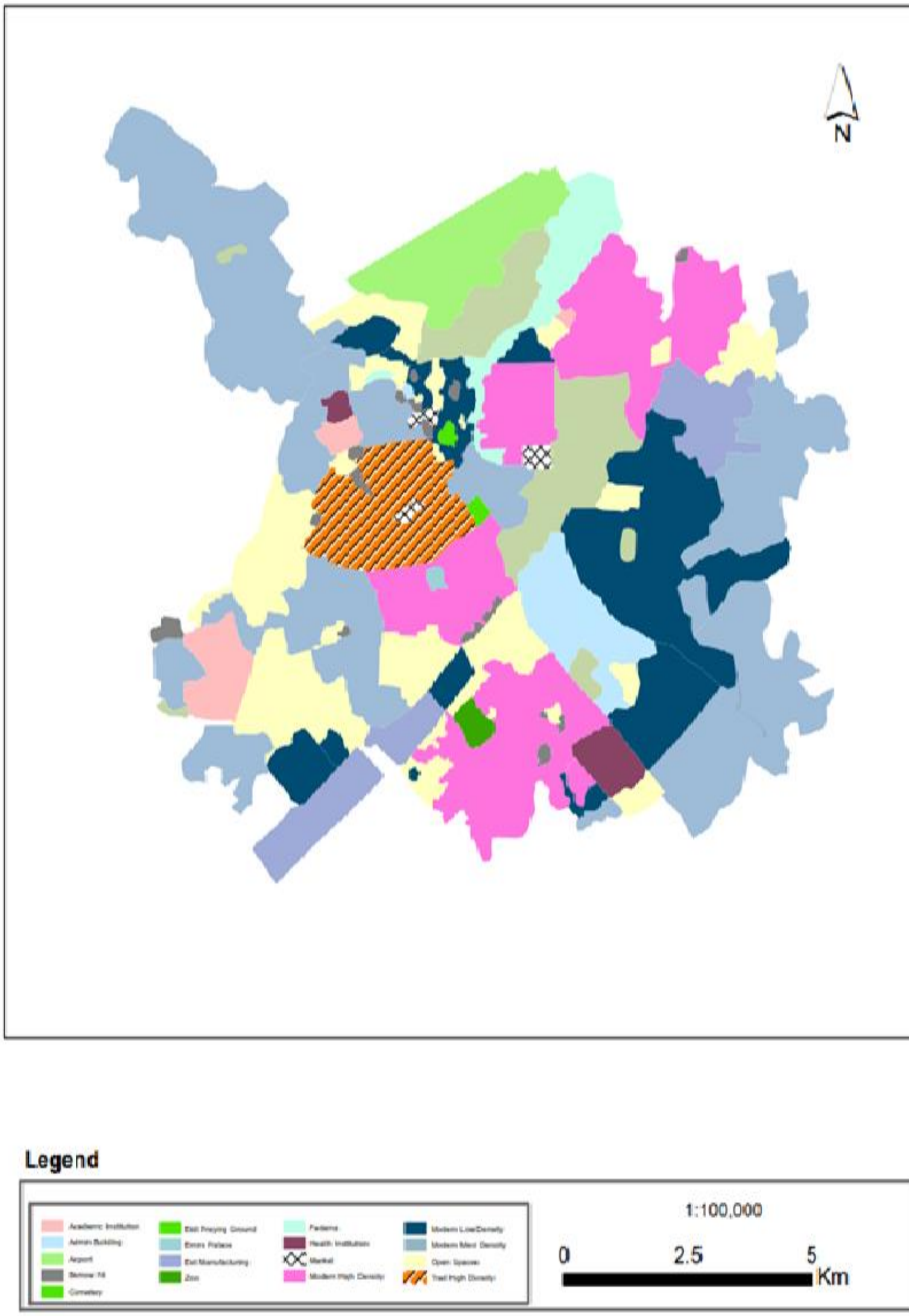

Figure 3: Urban Land Use in Kano (1981)
Source: Landsat TM

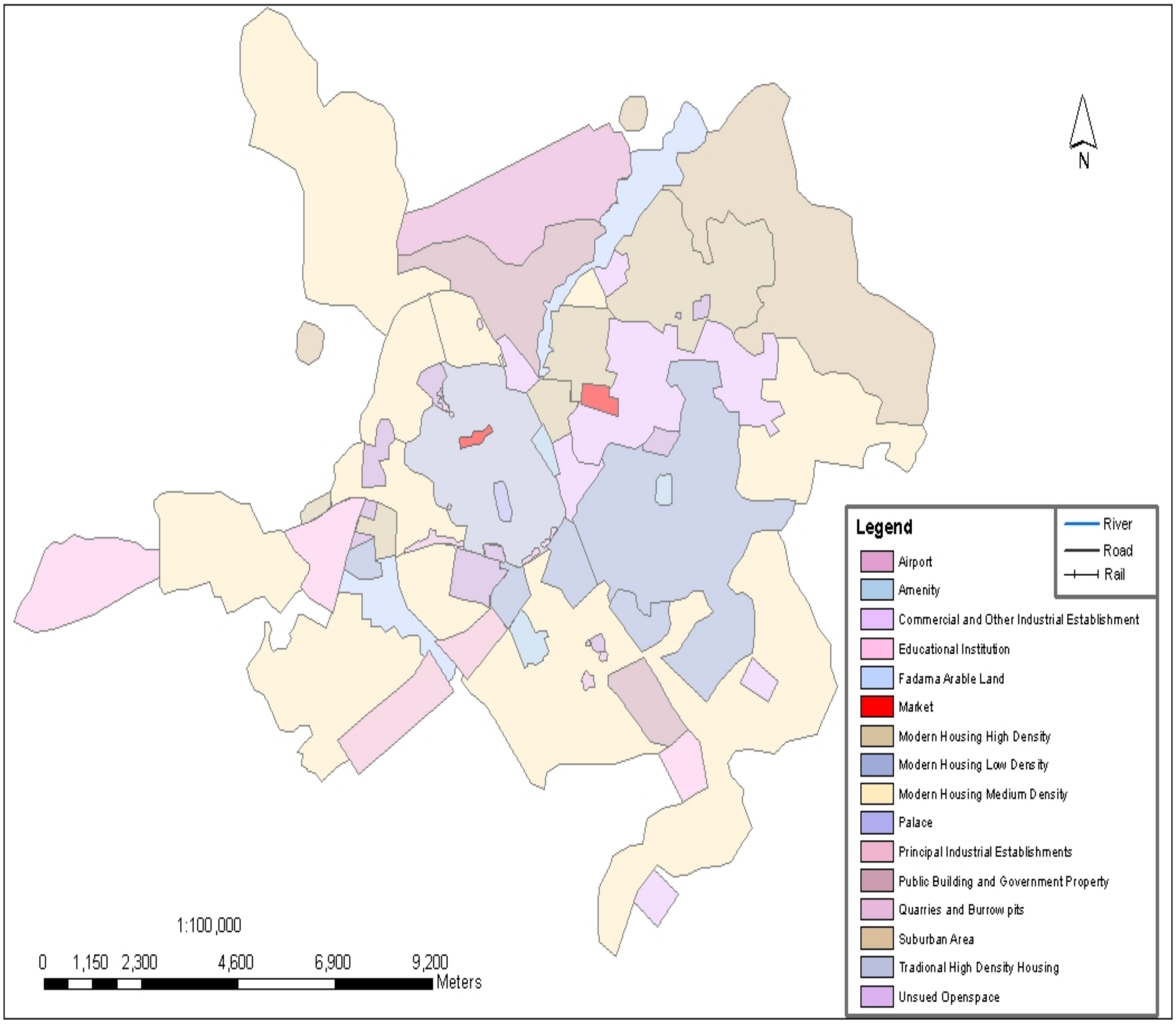

Figure 4 : Urban Land Use in Kano (2005)

Source: Quickbird Satellite Imagery 2005 Resampled to 5m Spatial Resolution

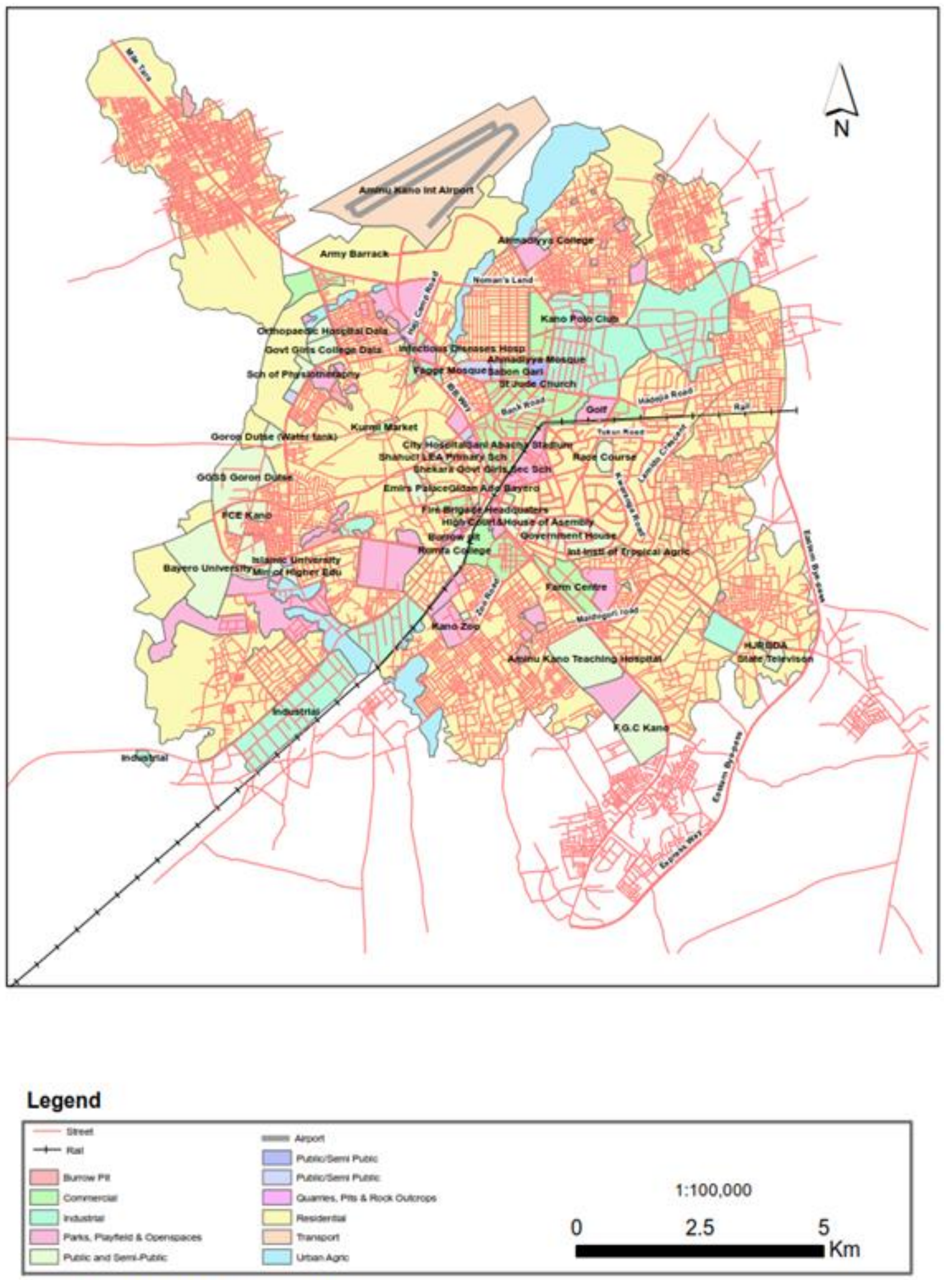

Figure 5: Urban Land Use in Kano (2007)
Source: QuickBird Satellite Image

Table 1 Rate of Land Use Changes in Kano Metropolis from 1962- 2007

Serial number	Type of Land Use	Standards for Multi-Functional city (%)	Area Coverage in 1962 (ha)	Cumulative Area coverage in 1981(ha)	Cumulative Area Coverage in 2005 ha	Cumulative Area Coverage in 2007(ha)	1962-1981 Percentage of Change	1981-2005 Percentage of Change	2005-2007 Percentage of Change	1962-2007 Percentage of change
1	**Residential**	51 - 57	1937.9	6644.6	9031.4	12845.4	242.9	35.9	42.2	**562.9**
	- High Density Area	*50*	*843.6*	1912.7	*3145.1*	*3698.3*	*126.7*	*64.4*	*17.6*	**338.4**
	- Medium Density Area	*30*	*597.3*	*2399.8*	*3346.2*	*6407*	*7250.0*	*-8.5*	*2.8*	**112**
	- Low Density Area	*20*	*497*	*2332.1*	*2540.1*	*2740.1*	*2960.0*	*18.1*	*8.4*	**451.3**
2	**Commercial**	2 – 3	374.6	556.2	995.8	1503.5	48.5	79.0	50.9	**301.4**
	-Business areas		*360.1*	*500.4*	*906*	*1195.3*	*4750.0*	*-44.5*	*18*	**231**
	- Markets		*14.5*	*55.8*	*89.8*	*308.2*	*86.0*	*484.0*	*00*	**1953.3**
3	**Industrial**	3 – 3.5	56.7	590.4	897.4	966	11589.1	65.6	-89.6	1594.7
4	**Public and Semi-Public**	10 – 11	1582.5	2078.2	2803.5	3671	31.3	34.9	30.9	**131.9**
	- *Emir's palace*		*12*	*14.0*	*22*	*22*	*7.6*	53.2	*1.9*	**83.33**
	- Services of welfare nature		*107*	*271.7*	*307.4*	*310*	*100.0*	43.5	*30.7*	**56**
	- Academic Institutions		*106*	*246.1*	*652*	*1192.3*	*2221.7*	119.5	*0.3*	**1014**
	- Health Institution		*1059.0*	*145.9*	*159.3*	*305.1*	*37.8*	5.8	*6.9*	**120**
	- Administrative Building		*283*	*383*	*639*	*816.6*	*1211.6*	24.7	*8.5*	**188.7**
	- Churches		*15.5*	*17.5*	*23.8*	*25*	*129.2*	95.5	*3.3*	**56.25**
5	**Parks, Playfield and Open spaces**	6.0 - 6.0	566.2	1605.1	496.6	972.3	183.5	-69.1	-95.8	**71.7**
									-0.6	**355**
	- Zoo		*00*	*46.1*	*45.4*	*44.58*	*00*	-3.3	*00*	**0**
	-mosque /Eldi-praying ground -		*20*	*40*	*88.2*	*90.7*	*46.7*	-3.7	*00*	**64**
	Open Spaces		*438.3*	*1505.6*	*264*	*718*	*1508.5*	-37.0	*-4.5*	**10.2**
	-parks, playfield		*107.9*	*13.4*	*99*	*119*	*00*	3.6		
6	**Transportation Networks**	10 – 12	1010.1	1223.5	1606.2	1662.7	21	31.3	3.5	**64.6**
	-Roads and Streets		*457.1*	*605*	*830.6*	*1036.1*	*69.7*	*25.2*	*11.3*	**132.6**
	- Railway		*87.6*	*87.6*	*87.62*	*87.6*	*00*	*00*	*00*	**0**
	- Airport		*465.4*	*530.68*	*688*	*538.95*	*518.1*	*1.6*	*-7.8*	**15.9**
7	**Other Uses**	12 – 13.5	8428.1	3818.4	708	698.1	-54.6	-81.5	-1.4	**-91.7**
	- Arable Irigation Land		*157.4*	*3480*	*462*	*429.4*	*00*	*-5.3*	*-0.3*	**173.2**
	- Wood Lands, Scrubs & Grass Land		*748.1*	*00*	*00*	*00*	*-100*	*00*	*00*	**0**
	-Quarries, Burrow Pits & Rock		*58.2*	*112.4*	*46*	*70.2*	*-100*	*00*	*00*	**20.7**
	Outcrop - City Wall		*123*	*113*	*87*	*85.5*	*00*	*-31.5*	*-8.0*	**-30**
	- Isolated dwellings		*137.9*	*00*	*00*	*00*	*8.1*	*-23.0*	*-1.7*	**0**
	- Streams		*113*	*113*	*113*	*113*				
	- Upland arable		*7090.5*	*00*	*00*	*00*				

Source: 1962-1983 Master Plan, 1981 LandsatTM, SPOT 5m Resolution 2005 and Quick Bird 2.44m Resolution of 2007; Kulshrestha (1970)

1962 serves as the base year of this study, the year the first master plan was produce. Data generated from 1981 landsat TM, indicates the total area of change between the two dates and rate of changes that existed between the various categories of land uses as shown in Table 1. Change from 1981 to 2005 was unprecedented as shown in Table 1. 2005 to 2007 was the shortest interval period of analysis. This was deeming necessary to gauge short term activity responses to urban expansion.

Table 2 Estimate Rates of Land Use Changes from 1962- 2007

Serial number	Type of Land Use	Standards for Multi-Functional city (%)	Area Coverage in 1962 (ha)	Cumulative Area Coverage in 2007(ha)	1962-2007 Percentage of change
1	Residential	51 - 57	1937.9	12845.4	562.9
	- *High Density Area*	*50*	*843.6*	*3698.3*	338.4
	- *Medium Density Area*	*30*	*597.3*	*6407*	112
	- *Low Density Area*	*20*	*497*	*2740.1*	451.3
2	Commercial	2 – 3	374.6	1503.5	301.4
	- *Business areas*		*360.1*	*1195.3*	231
	- *Markets*		*14.5*	*308.2*	1953.3
3	Industrial	3 – 3.5	56.7	966	1594.7
4	Public and Semi-Public	10 – 11	1582.5	3671	131.9
	-*Emir's palace*		*12*	*22*	83.33
	- *Services of welfare nature*		*107*	*310*	56
	- *Academic Institutions*		*106*	*1192.3*	1014
	- *Health Institution*		*1059.0*	*305.1*	120
	- *Administrative Building*		*283*	*816.6*	188.7
	- *Churches*		*15.5*	*25*	56.25
5	Parks, Playfield and Open spaces	6.0 - 6.0	566.2	972.3	71.7
	- *Zoo*		*00*	*44.58*	355
	- *mosque / praying Grounds*		*20*	*90.7*	
	- *Open Spaces*		*438.3*	*718*	64
	-*parks, playfield*		*107.9*	*119*	10.2
6	Transportation Networks	10 – 12	1010.1	1662.7	64.6
	-*Roads and Streets*		*457.1*	*1036.1*	132.6
	- *Railway*		*87.6*	*87.6*	0
	- *Airport*		*465.4*	*538.95*	15.9
7	Other Uses	12 – 13.5	8428.1	698.1	-91.7
	- *Arable Irigation Land*		*157.4*	*429.4*	173.2
	- *Wood Lands and Scrubs & Grass Land*		*748.1*	*00*	0
	- *Quarries, Burrow Pits & Rock Outcrop* -		*58.2*	*70.2*	20.7
	-*City Wall*		*123*	*85.5*	-30
	- *Isolated dwellings*		*137.9*	*00*	0
	- *Streams*		*113*	*113*	
	- *Upland arable*		*7090.5*	*00*	

Source: 1962-1983 Master Plan, Quick Bird 2.44m Resolution of 2007 and Kulshrestha (1970)

As indicated in Table 2, from 1962 to 2007, residential land use percentage of change was 562.9%, indicating over whelm positive growth. This is because of population pressure as more people are demanding for shelter. Nevertheless, Residential falls within the range of planning standard for multifunctional city. Planners often allocate more than 50% of urban space for residential purposes in most planning document.

From 1962 to 2007, commercial land use percentage of change was 301.4%, implying that commercial activity has more than double its required space standard in a multifunctional city. Commerce is therefore the most functional activity in Kano. This is because Kano is traditionally known for its commercial potentials in southern Sudan areas.

From 1962 to 2007, industrial activities percentage of change was over 1594.7%, far above the required space standard for industrial activity in a multifunctional city. This vast growth is associated with attempt by Federal and State governments over years to stimulate industrial activities.

Percentage of change for public and semi-public land uses in Kano from 1962 to 2007 was about 131.9%. This can be associated with increasing need of such activities as the city expanded. However, the total area occupied by public and semi-public land use in 2007 in Kano is estimated to be 16.48% much greater than the provided planning standard. It obvious that with such a huge population concentration in Kano metropolis, the need for welfare services, education, health , cultural and administrative facilities and services are over whelm needed to carter for the population.

Percentage of change for park, playfield and open spaces uses from 1962 to 2007 was 71.7%. This activity has witness major land lost in Kano metropolis than any other urban land use. In 2007, the total urban land area devoted to park, playfield and open spaces in Kano metropolis was 4.36% far less than expected space standard required for such an activity in a multifunctional city. This can be attributed to wanton and reckless conversion of open spaces to commercial, residential, and administrative buildings by constituted authorities in Kano which has been observed by many scholars see page 3.

Transport networks from 1962 to 2007 recorded percentage of change of about 64.6%. The total urban space occupied by transport networks was about 7.46% far less than required space standard in a multifunctional city. This short fall can be attributed to the fact that the total land area demarcated for Kano metropolis in 1962 is partially developed and the city is yet to grow to the full capacity that would required complex network connectivity.

Other land uses such as arable irrigation land, vegetation land , quarries, burrow pits ,rock outcrop , city wall and upland arable that existed in 1962 have witness a negative percentage of change of about -91.7%. This is as a result of urban expansion and urban pressure, collaborating to the argument that agricultural land suffers major land use changes as urbanization approaches. This reveals poor level of land management in Kano metropolis and complete neglect and non-compliance with required space standards and functions of these activities in a multifunctional city.

The study revealed overwhelm land use changes where residential, commercial, industrial, public and semi-public land uses gained more urban space than required space standard in a multifunctional city while parks, playfield and open space as well as agriculture land uses concealed to other land uses. This, however depict poor level of land management in Kano metropolis.

3.3 Urban Land Use and Urban Land Use Change Modeling

The decisions of allocations and locations of various land uses are formally and officially translated, to physical planning documents approved by the state and adopted by urban authorities as a policy guide for decisions about the physical development. This physical planning document creates land use changes in urban fabric. Data layers generated on urban land use and urban land use changes were based on decisions about the physical development in Kano metropolis development area. This is different from land uses changes derived directly from aerial photographs and satellite images' density types, weighting in reflected and infrared images generally used by scholars for land use changes. In this urban land use modeling process urban land uses have been digitized and classified as shown in Table 1. In this data model, thematic coverage was recorded and accessed separately by map name and title. This is accomplished by recording each variable, or mapping unit of the coverage theme as a separate number code or label, which can be accessed individually when the coverage is retrieved. The label corresponds to a portion of the legend and has its own symbol assigned to it. In this way, it is easy to perform operations on individual grid cells and groups of similar grid cells and the resulting change in value require rewriting only a simple number per mapping unit, thus simplifying the computations. Map method allows ready manipulation of the data in a many-to-one relationship of the attribute values and the set of grid cells. Map data model is flexible and easy to use and is linked with statistical packages.

Data layers of each class of urban land use digitized with respective attributes were tessellated to form a grid of cells. The respective code and attributes are maintained throughout in identifying the nature of the urban land use changes of the cell.

In a raster GIS modeling environment, the data layers were tessellated to form a grid of cells. The nature of the land use change of a cell is design as shown in Table 1.

Land use changes data of 1962, 1981, 2005, and 2007 modeling in the time-series environment produced future land use changes in Kano.

The data series shown in Table 3 was model as an author regressive time series using Eviews software. Estimated model for forecast was established in equation (1).

$$Y_t = C + \beta Y_{t-1} + \mu_t \quad (1)$$

Where:

- Y_t is current value of the time series
- C is constant (mean of Y_t)
- Y_{t-1} is previous value of the time series
- μ_t is random error term
- β is coefficient of Y value

The forecast value for the future was estimated in the equation (2) below:

$$\hat{Y}t = C + \beta Y_{t-1} \quad (2)$$

Where:

$\hat{Y}_t$ is the adjusted Y or predicted Y

β is estimated coefficient Y_{t-1}

Using this model (equation 2) each land use was predicted. Over 27 categories of land uses were predicted.

Equation 3 attempt to establish the influence of population growth and growth in transportation networks on land uses changes in Kano metropolis. The essence of this modeling is to provide an insight of how the city has developed under varying social, economic, and environmental conditions.

$$X_i = \alpha + \beta Y_i + E_i \quad (3)$$

Where:

- X_i is dependent variable (explained variable)
- α is constant term (intercept)
- β estimated value (gradient)

- Y_i is independent variable
- E_i is error term

Table 3 Nature of the Land Use Change of a Cell in a Raster GIS Modeling Environment

Variable Representation	Urban Land Use	2007 area in (ha)
X_1	Modern High Density Area	2387.4
X_2	Traditional High Density Area	1310.9
X_3	Medium Density Area	6407.0
X_4	Low Density Area	2740.1
X_5	Business areas	1195.3
X_6	Markets	308.2
X_7	Industrial Areas	966
X_8	Emir's Palace	22
X_9	Services of Welfare Nature	310.9
X_{10}	Academic Institutions	1192.3
X_{11}	Health Institutions	305.1
X_{12}	Administrative Buildings	816.7
X_{13}	Churches	25
X_{14}	Mosque/Eldi-praying ground	90.7
X_{15}	Zoo	44.6
X_{16}	Open spaces	718.6
X_{17}	Parks, play fields	119
X_{18}	Roads and streets	1036.1
X_{19}	Railway	78.6
X_{20}	Airport	538.9
X_{21}	Arable Irigation land	429.4
X_{22}	Wood lands, Scrubs and Grass land	00
X_{23}	Quarries, Burrow pits and Rock outcrop	70.2
X_{24}	City wall	85.5
X_{25}	Isolated dwellings	00
X_{26}	Streams	113
X_{27}	Upland arable	00

Source: Field Design, 2018

The demands for land use were calculated vis-à-vis population growth of various time periods. Land use changes were related to urban road infrastructural development and significant relationship were revealed at various levels of probability.

3.4 Urban Land Use Growth and Projections

Using least square method and sample adjusted to 24 including observations after adjusting to endpoints. 27 categories of land uses were estimated and projected as shown in Table 4. Levels of significance adopted are 0.05, 0.1 and 0.2 levels of probability. Amongst the 27 categories of land uses, X_7, X_9, X_{10} and X_{18} are significant at 0.05 level of probability. X_5, X_6, X_{12} are significant at 0.1 level of probability. X_1, X_3 and X_4 are significant at 0.2 level of probability while X_2, X_8, X_{11}, X_{13},X_{14},X_{15}, X_{16},X_{17}, X_{20}, X_{21}, X_{23}, X_{24} are insignificant at all levels of probability. X_{22}, X_{23}, X_{25} and X_{27} have limited data for estimation.

Land uses that are significant at 5% have high tendency of continues growth and thus urban expansion. This is because the demands for those land uses have been high from 1960s to 2007. On the other hand those land uses significant at 0.1 and 0.2 levels of probability are the next categories of land uses whose growth are of lesser grade or degree.

3.4.1 Test of Research Hypothesis 1

Using least square method and sample adjusted to 14 including 4 observations after adjusting to endpoints. 27 categories of land uses were estimated as shown in Table 5 and, levels of significant adopted are 0.05, 0.1 and 0.2 levels of probability.

Y_1 is significant with respect to X_5, X_{10}, X_{12}, X_{13}, X_{14}, X_{18}, X_{24}, at 5%; Y_1 is significant with respect to X_1, X_2, X_3, X_6, X_7, X_8, X_{11}, and X_{21} at 10%.

On the other hand, Y_1 with respect to X_4, X_9, X_{16}, X_{17}, X_{20}, X_{22}, X_{23}, X_{25} and X_{27} are insignificant at all levels of probability.

There is a very strong relationship between population growth and the rate of urban land use changes, specifically with respect to X_5, X_{10}, X_{12}, X_{13}, X_{14}, X_{18} and X_{24}categories of land uses in Kano. This has been revealed by t-statistics where the calculated values of those land uses are greater or equal to Table values of t-statistics of (n-2) degree of freedom. The Table value at 2 degree of freedom is 4.303 at 5% while the calculated values are indicated in Table 5.

There is strong relationship between population growth and the rate of urban land use changes, with respect to X_1, X_2, X_3, X_6, X_7, X_{11}, X_{21} at 10% categories of land uses in Kano.

This is because t-statistics values of those land use are greater or equal to Table values of t-statistics of (n-2) degree of freedom. The Table value at 2 degree of freedom is 2.920 at 10%, while the calculated values are indicated in Table 5.

3.4.2 Test of Research Hypothesis 2

Using least square method and sample adjusted to 14 including 4 observations after adjusting to endpoints. 27 categories of land uses were estimated as shown in Table 6. Levels of significance adopted are 0.05, 0.1 and 0.2 levels of probability.

Y_2 is significant with respect to X_1, X_5, X_7, X_8, X_{12}, X_{13}, X_{14} and X_{24} at 5%. Y_2 significant with respect X_3, X_{10} and X_{21} at 10%; Y_2 is significant with respect X_4, and X_{11} at 20%. On the other hand, Y_2 is insignificant with respect X_2, X_6, X_9, X_{14}, X_{22}, X_{23}, X_{25} and X_{27} at all levels of probability.

There is a very strong relationship between growth transportation and the rate of land uses in Kano. This has been revealed by t-statistics where the calculated values of those land uses are greater or equal to Table value of t-statistics of (n-2) degree of freedom. The Table value at 2 degree of freedom is 4.303 at 5%, while the calculated values are indicated in Table 6.

There is strong relationship between growth in transportation and the rate of urban land use changes, with respect to X_3, X_{10} and X_{21} at 10% categories of land uses in Kano. This is because t-statistics values of those land uses are grater or equal to Table values of t-statistics of (n-2) degree of freedom. The Table value at 2 degree of freedom is 2.920 at 10% while the calculated values are indicated in Table 6.

There is weak relationship between growth in transportation and the rate of urban land use changes, with respect to X_1, and X_{11} at 20% probability. Population growth and growth in road infrastructure revealed a leading role in urban growth and land use changes in all levels of probability.

The regression model sensitivity in identifying the rate of changes for each land use category as shown in Table 4, 5 and 6 respectively, efficiently and systematically evaluated relative contributions of each land use category in relation to population growth and growth in road infrastructural development.

Remotely sensed imagery used in GIS environment proves to be ideally a primary data source for urban modeling although pattern analysis needed more other socio-economic attributes. Population growth and growth infrastructural development proved to be major determinants of land use changes: thus master planning role diminishes in the specific periods.

The null hypotheses for the two research hypotheses of the study have been rejected. The study therefore reveals that population growth and growth in transportation are among other factors influencing land use growth and land use changes in Kano. They are therefore major driving forces/causes or urban land use changes in Kano.

Table 4 Kano Land Use Growth and Projections

Parameters/ variables	Constant	$X_{6(-1)}$	Constant	$X_{7(-1)}$	Constant	$X_{8(-1)}$	Constant	$X_{9(-1)}$	Constant	$X_{10(-1)}$
Coefficient	-22.7601	3.259834	580.5317	0.461121	11.56334	0.46733	307.2005	-0.9644	145.1555	1.645763
Std. Error	98.39207	1.59616	57.07183	0.091899	10.9113	0.656004	41.91353	0.264456	131.8283	0.323814
T-statistics	-0.23132	2.042298	10.17195	5.017676	1.059759	0.712389	7.329387	-3.64672	1.101095	5.082438
Probability	0.8553	0.2899	0.0624	0.1252	0.4815	0.6059	0.0863	0.1704	0.4694	0.1237
Forecasted value		981.9208		1025.979		21.37727		7.378806		2107.349

Parameters/ variables	Constant	$X_{11(-1)}$	Constant	$X_{12(-1)}$	Constant	$X_{13(-1)}$	Constant	$X_{14(-1)}$	Constant	$X_{15(-1)}$
coefficient	139.8913	0.624631	128.0629	1.114567	8.235986	0.732125	42.53921	0.61594	46.0936	-0.02405
Std. Error	97.26845	0.779835	188.217	0.409086	11.07546	0.574945	30.48361	0.533918	0.59175	0.015841
T-statistics	1.438198	0.800978	0.6804	2.724531	0.743625	1.273384	1.395478	1.153624	77.89367	-1.51837
Probability	0.3868	0.5701	0.6197	0.2239	0.5929	0.4238	0.3958	0.4547	0.0082	0.3708

Forecasted value		330.4662		1038.274		26.53911		98.40497		45.02136

Parameters/ variables	Constant	X 16(-1)	Constant	X 17(-1)	Constant	X 18(-1)	Constant	X 20(-1)
coefficient	1305.153	-0.64642	110.0586	-0.44825	108.3809	1.134124	666.8356	-0.14422
Std. Error	619.5632	0.674842	82.93796	0.976621	108.623	0.167287	432.5539	0.760102
T-statistics	2.10657	-0.95788	1.327	-0.45898	0.997768	6.779513	1.541624	-0.18974
Probability	0.2822	0.5137	0.4111	0.7261	0.5007	0.0932	0.3663	0.8806
Forecasted value		840.6162		56.71709		1283.447		589.1072

Parameters/ variables	Constant	$X_{21(-1)}$	$X_{22(-1)}$	Constant	$X_{23(-1)}$	Constant	$X_{24(-1)}$	Constant	$X_{25(-1)}$	Constant	$X_{27(-1)}$
coefficient	315.8631	0.301572	0	183.6572	-1.2246	28.18678	0.622104	0	0	0	0
Std. Error	81.11884	0.234414	0	NA	NA	60.07917	0.552551	0	0	0	0
T-statistics	3.893831	1.286491	NA	NA	NA	0.469161	1.125877	NA	NA	NA	NA
Probability	0.16	0.4206	1	NA	NA	0.7207	0.4623	1	1	1	1
Forecasted value		445.3611			183.6572		28.18678				

Table 5 the Relationship between Land Use Changes and Population Growth Mechanism (Dependent and independent variables)

Parameters/ variables	Constant	X_1Y_1	Constant	X_2Y_1	Constant	X_3Y_1	Constant	X_4Y_1	Constant	X_5Y_1
coefficient	448.4358	0.000758	498.6223	0.000238	88.34994	0.002022	1102.302	0.000634	293.052	0.000307
Std. Error	469.9989	0.000259	147.2557	8.12E-05	871.7515	0.000481	690.3088	0.000381	8.553009	4.72E-06
T-statistics	0.954121	2.923969	3.386099	2.927324	0.101348	4.204882	1.596824	1.665144	34.26302	65.02118
Probability	0.4407	0.0998	0.0772	0.0996	0.9285	0.0522	0.2514	0.2378	0.0009	0.0002

Parameters/ variables	Constant	X_6Y_1	Constant	X_7Y_1	Constant	X_8Y_1	Constant	X_9Y_1	Constant	$X_{10}Y_1$
Coefficient	-22.5084	9.57E-05	196.2582	0.000296	11.95317	3.67E-06	73.37617	5.63E-05	-15.2743	0.000387
Std. Error	56.88971	3.14E-05	197.2649	0.000109	1.991545	1.10E-06	146.7342	8.10E-05	77.60528	4.28E-05
T-statistics	-0.39565	3.049324	0.994897	2.717162	6.001961	3.337724	0.500062	0.695005	-0.19682	9.04258
Probability	0.7306	0.0928	0.4246	0.113	0.0267	0.0792	0.6666	0.5589	0.8622	0.012

Parameters/ variables	Constant	$X_{11}Y_1$	Constant	$X_{12}Y_1$	Constant	$X_{13}Y_1$	Constant	$X_{14}Y_1$	Constant	$X_{15}Y_1$
Coefficient	20.27533	9.07E-05	245.7161	0.000195	15.11044	3.66E-06	20.16163	2.71E-05	17.29989	1.15E-05
Std. Error	55.01559	3.04E-05	10.43151	5.75E-06	1.017549	5.61E-07	10.82977	5.97E-06	18.21993	1.01E-05
T-statistics	0.368538	2.988402	23.55519	33.9117	14.84984	6.52371	1.861686	4.539578	0.949504	1.140338
Probability	0.7478	0.0961	0.0018	0.0009	0.0045	0.0227	0.2037	0.0453	0.4426	0.3723

Parameters/ variables	Constant	$X_{16}Y_1$	Constant	$X_{17}Y_1$	Constant	$X_{18}Y_1$	Constant	$X_{19}Y_1$	Constant	$X_{20}Y_1$
Coefficient	905.4574	-0.00012	56.82097	1.92E-05	435.6922	0.000203	87.62	0	500.1527	3.81E-05
Std. Error	545.2844	0.000301	43.34693	2.39E-05	30.05293	1.66E-05	0	0	83.89488	4.63E-05
T-statistics	1.660523	-0.39614	1.310842	0.803223	14.49749	12.26001	NA	NA	5.961659	0.823493
Probability	0.2387	0.7303	0.3202	0.5061	0.0047	0.0066	0	1	0.027	0.4968

Parameters/ variables	Constant	$X_{21}Y_1$	Constant	$X_{22}Y_1$	Constant	$X_{23}Y_1$	Constant	$X_{24}Y_1$
Coefficient	219.0376	8.92E-05	471.834	-0.0002	89.4085	-1.79E-05	123.2369	-1.45E-05
Std. Error	82.26993	4.54E-05	293.7108	0.000162	41.6049	3.41E-05	5.621575	3.10E-06
T-statistics	2.662426	1.96567	1.606458	-1.20497	2.14899	-0.52437	21.92214	-4.66672
Probability	0.1169	0.1883	0.2494	0.3515	0.2773	0.6925	0.0021	0.043

Parameters/ variables	Constant	$X_{25}Y_1$	Constant	$X_{26}Y_1$	Constant	$X_{27}Y_1$
Coefficient	87.01904	-3.60E-05	113.01	0	4472.067	-0.00185
Std. Error	54.16826	2.99E-05	0	0	2783.806	0.001536
T-statistics	1.606458	-1.20497	NA	NA	1.606458	-1.20497
Probability	0.2494	0.3515	0	1	0.2494	0.3515

Table 6 the Relationship between Land Use Changes and Growth in Transportation Mechanism (Dependent and independent variables)

Parameters/ variables	Constant	X_1Y_2	Constant	X_2Y_2	Constant	X_3Y_2	Constant	X_4Y_2	Constant	X_5Y_2
coefficient	-2956.32	3.279139	-231.252	0.782782	-7527.53	7.681005	-1904.79	2.858537	-878.386	1.176951
Std. Error	687.916	0.490707	695.3888	0.496037	3588.5	2.559763	1656.593	1.181687	323.4231	0.230705
T-statistics	-4.2975	6.682479	-0.33255	1.578071	-2.09768	3.000671	-1.14982	2.41903	-2.7159	5.101531
Probability	0.0501	0.0217	0.7711	0.2553	0.1708	0.0954	0.3692	0.1367	0.113	0.0363

Parameters/ variables	Constant	X_6Y_2	Constant	X_7Y_2	Constant	X_8Y_2	Constant	X_9Y_2	Constant	$X_{10}Y_2$
Coefficient	-331.742	0.326292	-1130.59	1.278153	-4.13178	0.015582	-112.36	0.194687	-1407.37	1.422559
Std. Error	261.9188	0.186833	352.5795	0.251503	2.881248	0.002055	464.7698	0.331531	633.5058	0.451895
T-statistics	-1.26658	1.746435	-3.20662	5.082052	-1.43403	7.581566	-0.24175	0.587234	-2.22156	3.147987
Probability	0.3328	0.2228	0.085	0.0366	0.288	0.017	0.8315	0.6165	0.1564	0.0878

Parameters/ variables	Constant	$X_{11}Y_2$	Constant	$X_{12}Y_2$	Constant	$X_{13}Y_2$	Constant	$X_{14}Y_2$	Constant	$X_{15}Y_2$
Coefficient	-327.852	0.349262	-505.158	0.752817	0.064362	0.014822	-95.4467	0.112805	-42.4336	0.05558
Std. Error	191.9751	0.13694	192.1767	0.137084	1.639161	0.001169	7.509228	0.005357	46.41725	0.033111
T-statistics	-1.70778	2.550465	-2.62861	5.491643	0.039265	12.67613	-12.7106	21.05949	-0.91418	1.678608
Probability	0.2298	0.1254	0.1194	0.0316	0.9722	0.0062	0.0061	0.0022	0.4571	0.2352

Parameters/ variables	Constant	$X_{16}Y_2$	Constant	$X_{17}Y_2$	Constant	$X_{18}Y_2$	Constant	$X_{19}Y_2$	Constant	$X_{20}Y_2$
coefficient	1306.632	-0.41801	11.91095	0.053017	-349.192	0.786141	87.62	1.99E-16	261.5722	0.213859
Std. Error	1693.031	1.207679	144.1602	0.102833	210.5977	0.150224	1.98E-13	1.41E-16	210.5977	0.150224
T-statistics	0.771771	-0.34613	0.082623	0.515568	-1.6581	5.233114	4.43E+14	1.410631	1.242047	1.423596
Probability	0.521	0.7623	0.9417	0.6575	0.2392	0.0346	0	0.2938	0.3401	0.2906

Parameters/ variables	Constant	$X_{21}Y_2$	Constant	$X_{22}Y_2$	Constant	$X_{23}Y_2$	Constant	$X_{24}Y_2$	Constant	$X_{25}Y_2$
coefficient	-212.273	0.408159	1473.339	-0.93511	121.5911	-0.03859	184.6766	-0.06001	271.7238	-0.17246
Std. Error	155.9089	0.111214	742.5532	0.529681	144.0226	0.110496	4.545864	0.003243	136.947	0.097688
T-statistics	-1.36152	3.670043	1.984153	-1.76543	0.84425	-0.34927	40.62518	-18.5072	1.984153	-1.76543
Probability	0.3064	0.0669	0.1857	0.2195	0.5536	0.7861	0.0006	0.0029	0.1857	0.2195

Parameters/ variables	Constant	$X_{26}Y_2$	Constant	$X_{27}Y_2$
Coefficient	113.01	0	13964.38	-8.86305
Std. Error	0	0	7037.958	5.020343
T-statistics	NA	NA	1.984153	-1.76543
Probability	0	1	0.1857	0.2195

4.0 Growth Divers

Three factors were identified as the major determinants of urban land use changes in Kano; these include:

4.1 Population Growth

Kano metropolis has experience a drastic population growth since the first census in 1932 still the last census of 2006, where the population was estimated to be 2,587,991 people. A number of reasons ranging from natural growth, public service, humanitarian, economic and diplomatic activities are responsible for this enormous population growth.

Population growth was associated with high population densities over the years. The population increase has stimulated economic and political opportunities and that has brought about land use competition and consequences changes in urban land uses. Land uses that have experienced most changes are business areas, administrative institution, academic institutions, places of worship, residential development, market, industrial and health institution. The consequences of high rate of urbanization has made the demand for urban and peri urban land to be very high and induce quite rapid and complex changes in urban land use.

Table 7 Population Growth and Land Occupation in Kano

Year	Population	Growth Rate	Total Area (Km^2)	Number of Persons Per Square Kilometer
1962	250,000	7.7	139	1799
1981	640,000	7.7	165.16	3879
1991	1,600,000	6.0	-	-
2005	2,000,871	6.0	188.42	10619
2006	2,587,991	6.36	-	-
2007	2,944,000	6.36	203.63	14431

Source: Census and Satellite Images

4.2 Growth in Transportation Network

In Urban Kano transportation improvement has contributed significantly in the internal functioning of the urban areas. Effort to cope with transportation demands, have resulted to urban land use changes, this is because of the accessibility advantage associated with transportation networks. For example more accessible sites tend to provide more benefits to property owners as well as users, thus changes in land use becomes high because of location advantage. This explains why residential buildings are given way to commercial activities in CBD and other more accessible areas of the metropolis. These accessible areas attracts volume of businesses conducted and revenue obtain is high, thus potential users are willing to pay for the sites. Such increase in demand will eventually induce the property owner to convert initial land uses to more profitable uses. The transportation system in Kano metropolis provides greatest accessibility within the urban area, thus inducing land use changes. This explains why land use changes are greater around urban core especially the CBD and at minor foci points in transportation system.

Transportation improvement in Kano has increased demand for certain urban land uses in specific areas. The degree to which any business or household uphold planning regulations dependent on what he can benefit from accessibility. This has led to pressure on urban authorities to permit alternative uses.

The transport network induced changes residential development, business activities, industrial activities, administrative buildings, places of worship, academic institution.

4.3 Land Use Zoning

Zoning is the legal regulation of use of land that segregates parcels of land into broad classifications of appropriate use such as residential, commercial, industrial, public and semi-public, transport networks and parks, play fields and open spaces. Building codes are legislative measures to ensure that use and development of land is according to the approved plans. Land use regulations and control measures are in practice administered in the city in sequence with the land development process. The application of these laws in effect shape land development and land use pattern.

Where zoning regulations are rigid, very little change is notice. High level of land use changes in Kano is associated with flexibility in the application of zoning regulations.

5.0 Physical Planning Implications of Urban Land Use Changes in Kano Metropolis

1. urban land use changes were characterized by disorder, haphazard and disjointed pattern of urban development and planning processes from 1960s to 2007 culminating to:

    - Poor living environment without safety, amenity, energy, conservation and environmental protection;
    - Unsafe, unhealthy, unpleasant environment for all commercial, industrial, civic and community land uses in addition encouraging disturbances to neighbouring environment (e.g. Commercial motor parks in GRA).
    - Conflicts in different land uses in particularly among mixed land users.

- Poor preservation of amenities on that land, and environmental controls.

2. The rate of Urban Land use changes in Kano implied that Land use regulations and control measures were impracticable in the metropolis in sequence with the land development process.
3. The trend in Land use changes implied difficulties in maintaining the classification system adopted in production of development plans in Kano metropolis over time.

6.0 Conclusion

Data layers of urban land use and land use changes were detected base on existing physical developments at selected time period. This is different from land uses changes derived directly from aerial photographs and satellite images' density types, weighting in reflected and infrared images generally used by scholars for land use changes.

Kano has over the years receives or subjected to coordinated and integrating planning and development by government agencies. In principle development activity in one part has effect on the whole planning area. The city growth has attracted different land use activities and the incidence and other factors have prompt changes in initial land uses. The changes are expected development facets but the rates and trends in changes are of great importance in order to ensure coordinated development has been the focus of the study.

Land use continually changes in response to population growth and desires for economic expansion. Urban development becomes inevitable in order to accommodate the growth at the cost of ecosystem integrity. Predictive modeling using GIS technology and advanced statistical analyses provides us with different pictures of possible land use changes and allows us to assess their potential ecological impacts under different scenarios were thoroughly addressed in the study.

In a nutshell Kano metropolis faces the growing problems of urban sprawl , loss of natural vegetation and open spaces, and the general decline in the extend and connectivity of wet lands and farm lands. These activities are gradually replaced by residential, commercial, public and semi –public and industrial activities.

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