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RESEARCH ARTICLE

AN ANALYSIS OF LAND USE AND LAND COVER CHANGE IN SOUTHERN PART OF KADUNA METROPOLIS, KADUNA STATE, NIGERIA

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ABSTRACT

Land use and land cover change is driven by human actions and also drives changes that limit availability of products and services for human and livestock, and it can undermine environmental health as well. Therefore, the aim of this paper was to analyse land use and land cover change (LULCC) in the southern part of Kaduna metropolis. The following data were used; Landsat (4) Thematic Mapper (TM) with 30m spatial resolution of 1990, Landsat (7) Enhanced Thematic Mapper Plus (ETM +) with 30m spatial resolution of 2001 and Landsat (8) Enhanced Thematic Mapper Plus (ETM +) with 30m spatial resolution of 2014 which covered the time frame between 1990 to 2014. Erdas Imagine Software version 9.2 and ArcGIS version 10.1 were used for the analysis. The landuse and land cover distribution was determined by classifying the landuse and land cover maps into built-up land, agricultural land, vegetation land, bare surfaces and water body using supervised classification technique. An overlay analysis was carried out in order to determine the magnitude and rate of change of the classified landuses. The analysis of the results revealed an overall landscape change in landuse and land cover status of the area. Urban landuse witnessed an overall net change or increase of (186.29%) with an annual growth rate of 7.76% from 1990 to 2014. While agricultural landuse being the most dominant landuse in 1990; witnessed an overall change or decrease of (25.64%) between 1990 and 2014. Similarly, Vegetation landuse also witnessed an overall change or decrease of (48.13%) between 1990 and 2014 and bare surfaces dropped by 18.81% between 1990 and 2014. Water body also changed or decreased by 29.23% between 1990 and 2014. In view of the findings of the research, the study recommends periodic monitoring, control and evaluation of the LULCC of the area in order to checkmate harp-hazard developments or modifications that may be detrimental to the inhabitants of the area.

INTRODUCTION

Land use and land cover dynamics are widespread and accelerating. It is a significant process driven by human actions but also producing changes that impact humans (Agarwal, Green, Grove, Evans, and Schweik, 2002). These dynamics alter the availability of different biophysical resources including soil, vegetation, water, animal feed and others. Consequently, land use and cover changes could lead to a decreased availability of different products and services for human, livestock, agricultural production and damage to the environment as well. Human beings have been modifying land to obtain food, shelter and other essentials of life for thousands of years. Current rates, extents and intensities of such modifications are far greater than ever in history and continue undocumented (Eastman 1999). At times, even the agencies or body that is charge with planning and enforcement of planning rules and regulations fail to do their jobs as a result of interference from different quarters. This negligence may lead to unprecedented changes in ecosystems and environmental processes at local and regional scales. Therefore, monitoring and mediating the negative consequences of land use and land cover changes while sustaining the production of essential resources has therefore become a major priority of researchers and policy makers around the world. Land cover (LC) according to Campbell (1996), refers to the physical cover of the earth including natural vegetation, crops, artificial constructions that cover the land surface. On the other hand, land use (LU) refers to the actual use of the land which is the purpose for which man exploits the land cover (Omojola, 1997); land use describes the use of the land by the people usually with emphasis on the functional role of land on economic activities (Campbell, 1996): and man's activities which are directly related to the land (Anderson, Hardy, Roach and Witmer, 1976). Therefore, Land use and land cover (LULC) are treated jointly. They represent both the physical cover and the human imprints on land. Therefore, Land use-land cover (LULC) is among the most important phenomenon of the earth's land surface (Lambin and Geist, 2001).

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Population growth and rapid economic transformation has been identified as the leading cause of landuse change (Oyedele, 1977). According to the United Nations Press Release (2013), the current world population of 7.2 billion is projected to increase by almost 1billion people within the next twelve years, 8.1 billion in 2025 and 9.6 billion in 2050. Also, according to United Nations World Population Prospects (2012), it asserted that most of the population growth will occur in developing regions, which are projected to increase from 5.9 billion in 2013 to 8.2 billion in 2050. according to the same report, more than half of global population growth between now and 2050 is expected to occur in Africa. This means Africa could more than double its population by mid-century, increasing from 1.1 billion in 2013 to 2.4 billion in 2050, and will potentially reach 4.2 billion by 2100. Since it is established that population increase is the leading cause of landuse and land cover change (Oyedele, 1977), by implication, it means most of the landuse and land cover changes is occurring in developing countries of the world with Africa experiencing the fastest. In Nigeria, according to United Nations Press Release (2013), Nigeria population stood at 170 million and is expected to surpass that of the United States before the middle of the century, and could start to rival China at the end of the century as the second most populous country in the world. Back in 1960, when the country declared its independence from the United Kingdom, the country recorded an estimated 45.2 million people that constitutes a change of about 268% between the year 1960 and the year 2012. The entire population of Nigeria accounts for about 2.5% of the entire earth's population. This means that about 1 out of every 40 people in the world call Nigeria their home. This growth probably account for most of the landuse and land cover changes that is prominent in all Nigerian cities with Southern part of Kaduna metropolis no exception.

AIM OF THE RESEARCH

To analyse land use and land cover change in southern part of kaduna metropolis between 1990 and 2014.

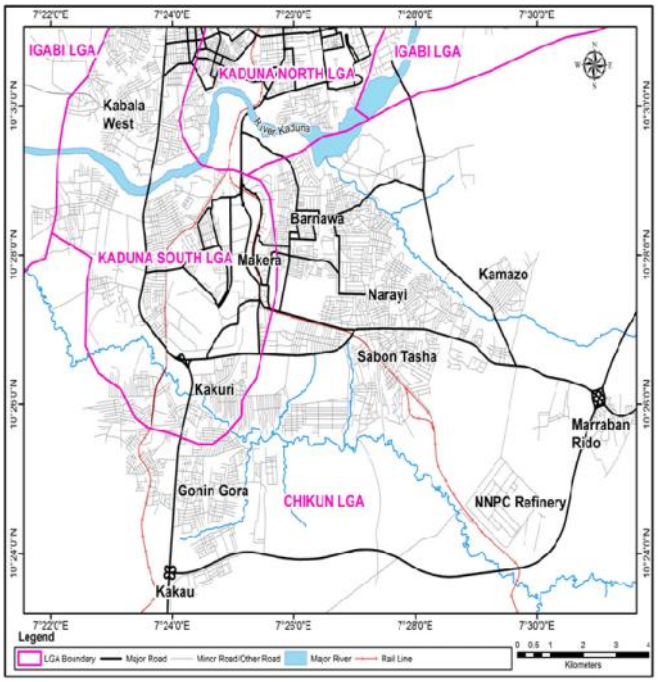
OBJECTIVES OF THE STUDY

identification and formation of a classification scheme for the LULC categories in Southern part of Kaduna metropolis.
identification of the distribution of landuse and land cover change in Southern part of Kaduna metropolis in 1990, 2001 and 2014. to determine the magnitude and rate of change in landuse and land cover in Southern part of Kaduna metropolis between 1990 and 2014.

THE STUDY AREA

The study area (Southern part of Kaduna Metropolis), Kaduna State, Nigeria is located between Latitudes 10˚ 23'30''N to10˚ 29' 30''N and Longitudes 7˚ 21'45''E to 7˚ 31'30''E (Fig 1.1). The area has a total land mass of 319.16km² and about 144 kilometres from Abuja, the new Federal Capital of Nigeria and some 846 kilometres from Lagos, the defunct Federal Capital of Nigeria. The area is located on an elevation of about ..... and is bounded by River Kaduna to the north and extends southwards to cover all the settlements south of River Kaduna (Oyedele, 1977). Southern part of Kaduna Metropolis lies on an enclosed gentle rolling within the undulating high plains of northern Nigeria (Musa, 1993).

It has a general pattern of the West African interior/continental climate with marked dry and wet seasons. The dry season lasts from November to March. The mean annual rainfall is about 1525mm and the length of the rainy season period is about 200 days. The mean monthly temperature reaches 28ºC in March and drops to 23.3ºC in December (Abaje and Giwa, 2008). Humidity is constantly high (above 60%) at mid-day and close to 100% at night during the rainy season (Ndabula, 2006). The geological composition of Southern part of Kaduna Metropolis consist of biotite younger granites and older granite, undifferentiated gneiss with migmatite and granite of the basement complex. The population of southern part of Kaduna metropolis stood at 299,451 according to 1991 census figures of localities and is expected to reach 597,280 by the year 2014 as projected by the researcher.



Source: Modified from the Administrative Map of Kaduna State.

Figure 1.1. Southern part of Kaduna Metropolis.

MATERIAL AND METHODS

A reconnaissance survey was first carried out to identify landuse and land cover types. The use of a hand-held GARMIN PRO MAP 76 CSX receiver facilitates navigation and identifications of location of salient points. Remotely sensed satellites imageries (data) were used for this study and was underpinned with ground truth exercise to ascertained the accuracy assessment. Geographic Information System (GIS) and Remote Sensing method was used to analysed the data because of its effectiveness as a tool for handling spatial data and very efficient tool in urban studies (Donnay, Barnsley and Longley, 2001; Batty and Howes, 2001; Herold, Scepan and Clarke, 2002). It is also considered to be highly economical, easy to acquired and flexible to use in rapid updating of maps than aerial photographs. The time span of this study covers 24 years (1990-2014) and the choice of this span of time for the study was considered wide enough to analyse the changes that has taken place in area over the study period. The satellite data includes Landsat 4 Thematic Mapper (TM) with 30m spatial resolution of 27th November 1990, Landsat 7 Enhanced

Thematic Mapper Plus (ETM +) at 30m spatial resolution of 24th October, 2001 and Landsat 8 Enhanced Thematic Mapper Plus (ETM +) at 30m spatial resolution of 23rd February 2014 were used to generate the landuse and land cover maps of Southern part of Kaduna metropolis. The Sub-setting of the area of interest was achieved from the larger scenes using ERDAS IMAGINE 9.2 software. The datasets were auto-rectified and need no any geometric and radiometric correction. However, the datasets were geo-coded or geo-referenced in order to conform to a geographic coordinate system. Since the datasets are of the same spatial resolution, re-sampling to bring the datasets to a common projection system was not necessary since the data are already suitable for overlay analysis and other forms of GIS operations.

RESULTS AND DISCUSSION

Southern part of Kaduna metropolis has witnessed a tremendous change in the status of its landuse and land cover as a result of rapid population increased. The changes in LULC is attributed to the fact that because of the high concentration of industrial layouts, a vibrant economy and the administrative role it played due to the presence of government departments and establishment have together served as a population pull factor which resulted in the alterations and modifications of the LULC of the area.

Classification scheme: The development of a classification scheme was based on the prior knowledge of the study area, reconnaissance survey and additional information from previous researches. However, the Classification covered 5 LULC classes. The classification scheme rather formed a broad classification as shown in table 1.1

Table 1.2 shows that Built-up areas is the second dominant landuse in 1990 as it occupied 40.56km² (12.71%) of the total land area (319.16km²). In 2001, it occupied an area of 61.71km² (19.34%) while in 2014, it covers an area of 116.12km² (36.38%). However, Agricultural Landuse has the dominant coverage of 213.79 km² (66.99%) in 1990. In 2001, it occupies an area of 201.18 km² (63.03%) and in 2014, it occupies an area of 158.98 km² representing 49.81%. Vegetated landuse occupied a total land area of 28.07 km² (8.79%) in 1990, while in 2001, it covers an area of 22.46 km² (7.04%) and in 2014, it occupies an area of 14.56km² (4.56%). Bare Surfaces which resurfaces in Sabon-Tasha, Maraban-Rido and some other areas within the study areas, occupied an observable land area of 33.50 km² (10.50%) in 1990. In 2001, it covers a total land area of 31.17 km² (9.77%) and it occupied a total land area of 27.20 km² representing 8.52% in 2014. On the other hand, the study revealed that Water Body had the lowest proportion of land coverage (3.25 km²) representing 1.02% in 1990. In 2001, it occupies an area of 2.64 km² (0.83%) and covers an area of 2.30 km² (0.72%) in 2014 (figures 1.2)

MAGNITUDE AND RATE OF CHANGE IN LANDUSE AND LAND COVER: The magnitude and annual rate of change in landuse and land cover distribution between periods of 1990 and 2001 and between 2001 and 2014 is presented in table 1.3. While figure 1.3 shows the spatial growth of the urban land use in 1990, 2001 and 2014.

The result in table 1.3 and figure 1.3 shows that the growth or increase in urban landuse between 2001 and 2014 is more than double (54.41km²) compared with the urban land increase between 1990 and 2001 (21.15 km²). Consequently, the period between 2001 and 2014 shows an annual increase rate of 6.78%. This increase is almost double compared to 4.74% annual increase rate between 1990 and 2001. This increase, however, is substantial compared to the findings of Ishaya, Ifatimehin and Okafor (2008), whose result shows an overall increased of 1846.46ha from 1990 to 2000 for the entire Kaduna metropolis. This increase could be attributed to rapid urban expansion that is taking place in the area due to rapid socio-economic activities as a result of population increased. This increased in urban landuse mostly took place between 2001 and 2014, a period which coincided with a period Kaduna metropolis witnessed most of its civil and religious crisis. However, table 1.3 revealed that the period between 2001 and 2014 has the highest annual rate of loss in agricultural land(1.61%) compared to the annual loss of 0.54% between 1990 and 2014. This annual rate of loss between 2001 and 2014 is rather high and by implication, accounts for most of the decrease in agricultural land between the periods. The drop or decreased could be linked to an increased in urban landuse which increases simultaneously and displaces the agricultural land in the area. Most of the lost also occurred between 2001 and 2014. i.e during the period of civil and religious disturbances in Kaduna metropolis. Consequently, the result from table 1.3 also revealed that the period between 2001 and 2014 has the highest annual rate of loss of vegetation landuse (7.90 km²) representing 2.72% compared to the annual loss of 5.61 km² (1.82%) between 1990 and 2014. This annual rate of loss between 2001 and 2014 indicates that vegetation landuse lost twice of its coverage between 2001 and 2014 compared to 1990 and 2001 loss. Vegetation landuse is evenly scattered within the study area and most of it has been tempered with by the anthropogenic activities of man especially during the 2001 and 2014 period of civil and religious disturbances.

Bare land or surfaces are land that does not support agriculture but can be useful in the building of residential, infrastructure and can also be put into other landuses. However, table 1.3 shows that bare land or surfaces in the study area also diminished over the study periods. Most of the bare surfaces are seen between Unguwan Romi and Command Secondary School. A trace of bare surfaces can be spotted in Unguwan Musa and Mahauta with other traces scattered all over the study area However, table 1.3 reveals that the periods between 2001 and 2014 recorded the highest loss (3.97km²) in bare land surfaces amounting to 0.98% compared to 0.63% of the periods between 1990 and 2001. The loss could also be linked to an increased in urban landuse which also coincided with the crisis period of 2001 and 2014. This shows that bare surfaces could not have escaped the pressure exerted on them as most of it is also lost to urban landuse during the crisis period. The result of table 1.3 also shows that water surfaces has also witnessed decrease in its area coverage within the study periods. It covers the least area compared to other landuses. Water bodies or water surfaces can be seen in rivers, ponds and streams within the study area. The analysis in table 1.9 revealed that water bodies has witnessed decrease (0.34km²) and an annual rate of loss (1.13%) between 2001 and 2014. This result described the fact that water ways also suffered and formed part of the diminishing process as a result of an increased in urban

Table 1.1. Classification Scheme

CODE	LAND USE/LAND COVER CATEGORIES	DESCRIPTION
1	Build-up land	Land used for settlements and building of urban infrastructures such as roads, schools, railways etc.
2	Agricultural land	Land used as cropland, agricultural plantation such as farmlands and orchards etc.
3	Vegetated land	Lands covered natural vegetation that is predominantly grasses, shrubs and grass-like plants and natural forest
4	Water body	Streams, Rivers, dams and ponds
5	Bare land	Exposed soils, land devoid of vegetal cover

Source: Modified from Anderson, Hardy, Roach, and Witmer (1967)

Table 1.2 Land use and Land cover distribution

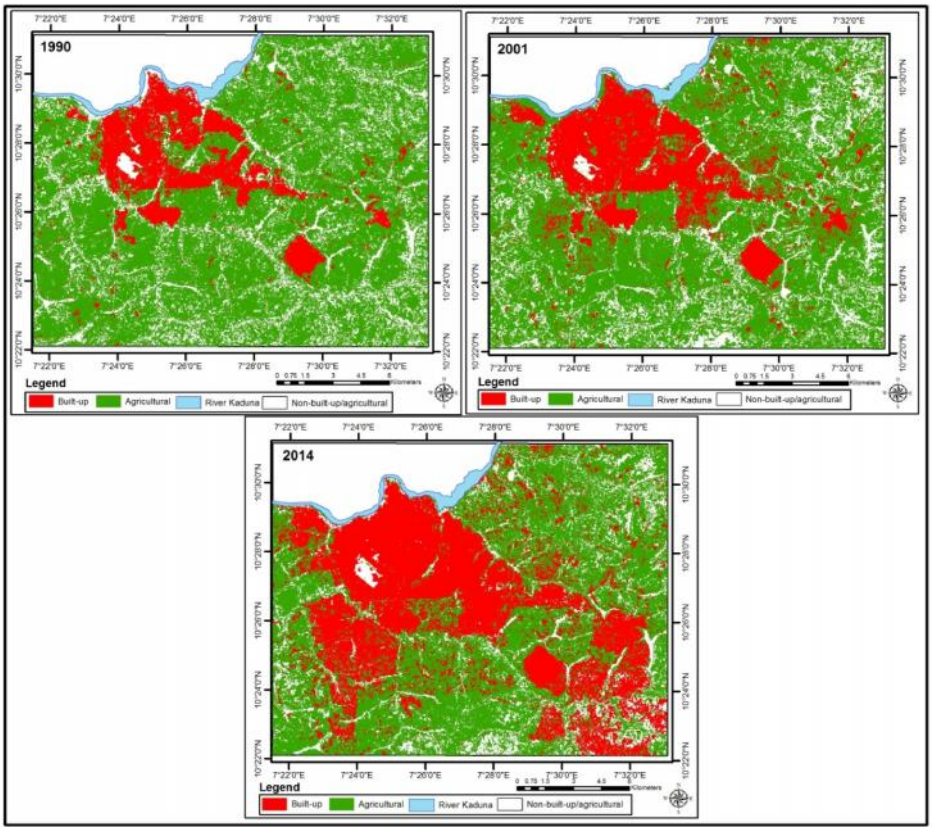
Year	1990		2001		2014	
Land use	km²	%	km²	%	km²	%
Built-up land	40.56	12.71	61.71	19.34	116.12	36.38
Agricultural Land	213.79	66.99	201.18	63.03	158.98	49.81
Vegetated land	28.07	8.79	22.46	7.04	14.56	4.56
Bare Surface	33.50	10.50	31.17	9.77	27.20	8.52
Water Body	3.25	1.02	2.64	0.83	2.30	0.72
Total	319.16	100.00	319.16	100.00	319.16	100.00

Source: Author's analysis 2014

Table 1.3. Magnitude and rate of change in landuse and land cover between 1990 and 2014

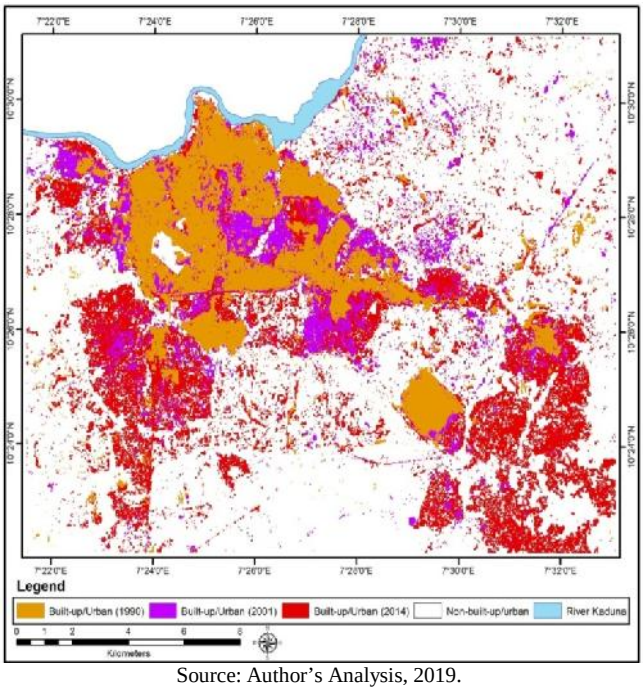
Land use	Magnitude of Change						Annual rate of change					
	2001-1990		2001-2014		1990-2014		1990-2001		2001-2014		1990-2014	
	km²	%	km²	%	km²	%	km²	%	km²	%	km²	%
Built-up	21.15	52.15	54.41	88.17	75.57	186.29	1.92	4.74	4.19	6.78	3.15	7.76
Agricultural	-12.61	5.90	-42.20	20.98	-54.81	25.64	-1.15	0.54	-3.25	1.61	-2.28	1.07
Vegetated	-5.61	19.99	-7.90	35.17	-13.51	48.13	-0.51	1.82	-0.61	2.72	-0.56	2.01
Bare surface	-2.33	6.96	-3.97	12.74	-6.30	18.81	-0.21	0.63	-0.31	0.98	-0.26	0.78
Water body	-0.61	18.77	-0.34	12.88	-0.95	29.23	-0.06	1.71	-0.03	1.13	-0.04	1.22

Source: Author's Analysis, 2019



Source: Author's Analysis, 2019

Figure 1.2. Land use Land cover distribution of Southern part of Kaduna Metropolis in 1990, 2001 and 2014



Source: Author's Analysis, 2019.

Figure 1.3. An overlay analysis showing spatial growth of urban landuse in 1990, 2001 and 2014

landuse. This explained why some parts of southern part of Kaduna metropolis experiences seasonal flooding which have been narrowed down to buildings of residential houses along the water ways, though there may be other factors responsible for its disappearance such as climate change etc. However, it is established that most of the disappearance of water bodies also occurred during the crisis period of 2001 and 2014.

CONCLUSION AND RECOMMENDATIONS

This research work demonstrates the ability of GIS and Remote Sensing technique in capturing spatial-temporal data for analysing landuse and land cover change. Land-use and land-cover change is evident in southern part of Kaduna metropolis as revealed by the analysis. All the landuses in the study area have changed dramatically within the second period (2001 and 2014) from their original coverage. The main changes observed is increase in urban landuse (186.29%) between 1990 and 2014; and decrease in other landuses with agricultural landuse having the highest decrease or loss (13.83%) between 1990 and 2014. It was also established that most of the landuse and land cover changes are driven by human actions which in-turn affects man.

The analysis of the results also revealed that most of the landuse and land cover change took place during the 2001 and 2014, a period which coincided with a period when Kaduna metropolis experienced frequent civil and religious disturbances. Having revealed by the study that landuse and land cover change is evident in the study area, in order to curb it, there should be periodic Modelling of landuse and land cover changes in the study area for formulating effective environmental policies and management strategies. Again, Monitoring, control and evaluation of the LULCC of the area should be done regularly so as to checkmate the harp-hazard developments or modifications that may have negative consequences on the inhabitants.

Finally, Kaduna State Urban Planning Development Authority (KASUPDA) being a body charge with planning and enforcement of planning rules and regulations should be given the mandate to do their job without interference from any quarters; so as to curb unnecessary modifications that will results in further changes in the landscape.

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