

A RETROSPECTIVE ANALYSIS OF URBAN EXPANSION PROCESS IN KADUNA METROPOLIS

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Abstract

Understanding the growth dynamics of urban centers has been one of the core ingredients for informed decision regarding spatial planning. This paper examined retrospectively, the urban expansion that translates into the development process of Kaduna metropolis, Nigeria. It discussed the physical development pattern and morphological changes in the area as a result of urbanization pressure. The study aimed at describing the form of the development process of the metropolis, which gives the city a changed character from its initial form: well-planned and aesthetic look. The spatial extent of the metropolis was defined by the extent of the planning space as stipulated by the Kaduna State Urban Planning and Development Authority (KASUPDA). A 35km radius was thus adopted as the limit of the research area. The 20km radius as proposed by Max lock 1967 was used as the inner limit. The built – up area of the metropolis expanded by 2,102 hectares between 1990 and 1995 an increase of 21.54%. The periods 1996 – 2000 and 2001 – 2005 experienced an annual growth rate of 5% and 4.8% respectively. The rate decreased to 3% between 2006 and 2013. The study highlights the time series development and expansion of the metropolis.

Keywords: Urban expansion, Metropolis, Spatial Development, KASUPDA, Max lock

Introduction

It is generally acknowledged that urbanization is an unavoidable phenomenon. With increase in population, urban areas grow and expand. One of the key problems that any nation undergoing modernization has to contend with is the management of urban expansion. Rapid spatial urban growth has been a global concern due to the attendant social, economic and environmental problems associated with such growth particularly in the developing world (Aiyejina, 2008). Most cities in developing countries their problems relating to rapid physical expansion are not due to land shortage but to lack of appropriate policies and strategies to guide new development, since overcrowding occurs in particular areas and yet at the same time large amounts of land are left vacant or only partially developed in other areas (Hardoy et al., 2001:175). Physical planning problems for most developing countries, the governance and management of their towns and cities appear to grow beyond management capacities and resources available (Agbola and Olurin, 1998). The means of rapid urban expansion in the developing countries are established on natural increase and rural-urban migration.

The growth in population and spatial expansion of built up area in Kaduna over the last two decades is unprecedented. Available records (National population Census: 1952, 1963, 1991 and 2006) indicate that the population increased from 39,000 in 1952 (FRN, 1952) to 250,000 in 1963 (FRN, 1963), 1,307,311 and 1,570,331 in 1991 and 2006 respectively (National Population Commission, 1991 and 2006). This shows an average increase of 40 per cent or 3.9 per cent annual growth rate. This growth rate is somewhat higher than the national average, which was put at 2.8% within the same period (National Bureau of Statistics 2005). At the same time, the city has experienced accelerated growth in spatial extent. The extent of the city as provided by the Kaduna Master Plan 1967 - 2017 is 20 Km², which has now extended to 35 Km², the difference of 15 km² radius now forms the expansion. These settlements were not anticipated soon and therefore not planned for in the development of the metropolis. This arose as a result of Kaduna being an administrative and military headquarters founded by Sir Frederick Lord Lugard in 1912. In addition, Kaduna was previously the headquarters of Northern Nigeria and at present the state capital; it is luckily accessible to all parts of Nigeria and draws commercial, industry, and government investments. This has truly generated urban growth and expansion of the town, which has developed into a large metropolis extending far beyond the expected plan and thereby assuming a more complex status. The rate of growth occurs in a faster rate than the rate at which utilities and services are being provided (Agbola and Olurin, 1998). This generally informed the spontaneous and unplanned growth of the metropolis. Policies for economic development of Kaduna, which have mainly been pursued from and around the city through industrialization, are also responsible for the urban expansion. In the urban suburbs where majority of the structures are without planning permission in uncoordinated layouts. Often times, these structures are products of squatters that choose to settle at the suburb as a result of their inability to afford residential accommodation in the city. (Olujimi and Gbadamosi, 2007)

Thirty years ago, Kaduna's future success as a modern city was largely pinpointed to depend on the political will to overcome the problems and restraints to its growth and development. It is unfortunate after this period; the suggestion remains significant and cannot be overstated (Bununu, Ludin and Hosni 2015; agboola 1986). Bununu, et al. 2015 stated "Perhaps what has changed if any is that the environment in which the city's managers operate today has become even more complex in spatial, economic and social terms." The improper coordination of the physical developments in Kaduna promotes high level of inaccessibility within the area. Such areas lack essential social and welfare infrastructure like water, electricity, access roads, health care, drainage and educational facilities among others. Planning authorities often realize these events when it is too late after so many developments have occurred. The provision of basic infrastructure and services usually proves costly because such layouts are not properly monitored to allow for coordination. More often, the areas are left unattended to and they degenerate into slums that usually have varying implications on the city and its management.

However, Kaduna metropolis has been experiencing rapid unplanned physical expansion, unstructured and unplanned development. Characterized by political problems, social distress, and environmental deterioration, physical and economic destruction. Yet, the unplanned expansion has not been controlled properly by appropriate planning intervention. Urban expansion is a highly debated topic throughout the world. Kaduna metropolis will have an increase of 606,000 people by 2025: with the present population growth rate and by 2050, the metropolis will account for nearly three million people (Federal Republic of Nigeria Official Gazette, 2007; UNDESA, 2009). This implies that the future will cause though a problem to local urban planners and managers is undoubtedly not unidentified. Nevertheless, the rationale behind

this study is to analyze the time series urban expansion of Kaduna metropolis and the potential causes of the emergence of the settlements amidst an existing development plan.

Theoretical Framework

In their study on the urban spatial evolution of cities, Dietzel, Herold and Clarke (2005), observed that, the evolution of urban area in cities begins with a core or center that grows and diffuses to different individual development centers. This method of dispersal carries on along a path of organic growth and outward expansion. Adell (1999); Foeken and Mwangi (1998); Nuwagaba (1996); Carter (1995); and Oberai (1993): have pointed out that cities continuous growth could be attributed to its attractiveness as a place to live in and work, and as a trading centre, a place for the incubation of ideas, and birthplace of technological innovation. Despite this, there is no agreement concerning what the ultimate size and shape of a city should be. This sustained spatial development transitions to the merging of the different city blocks. This staged evolution originally comprises development in the open space in-between the central urban core and the outlying areas. As this abstract development pattern lasts, the system evolves toward a saturated state. This “concluding” mass can be seen as an early urban core for more expansion at a less exhaustive zoomed-out extent. (Dietzel et al. 2005).

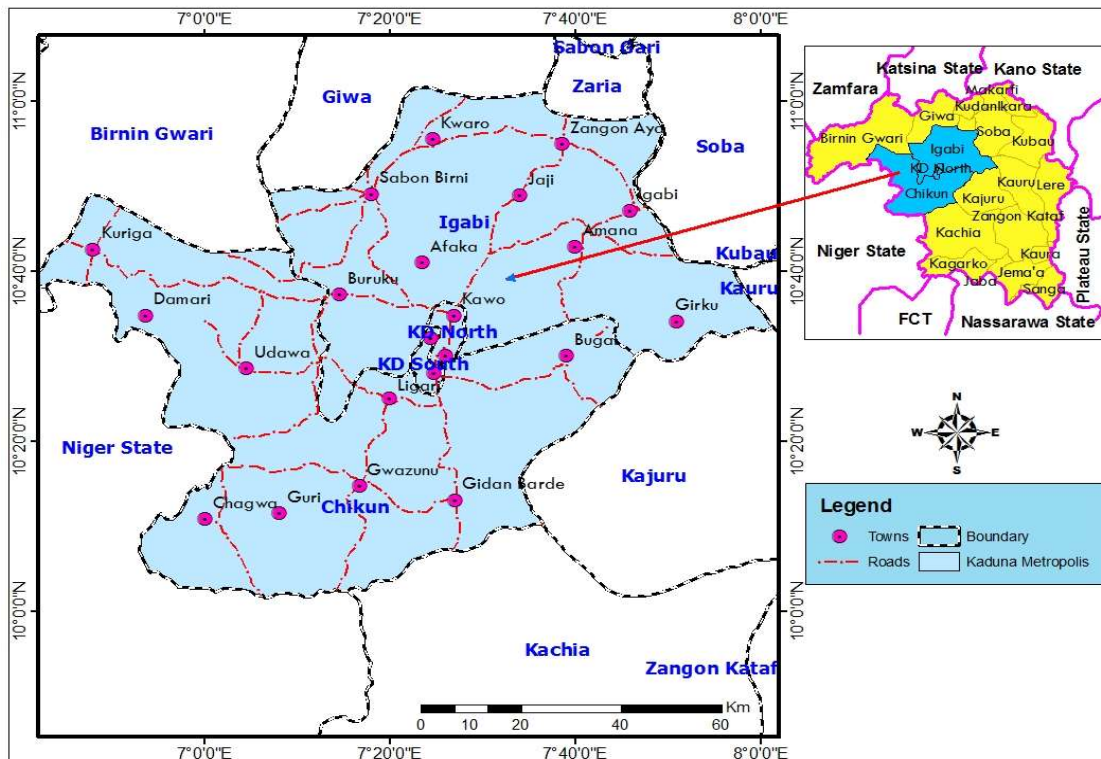
Balchin, Isaac and Chen. (2000) observed that, there is no specific theory to study the effect of urban expansion on rural farming community at the fringes. Scholars in the field of development have argued the issues of urban development and growth from different perspectives. The interaction of urban to rural was described in modernization theories of economic development. The main paradigm in this regard is the structural transformation model formulated by W. Arthur Lewis in the mid 1950s. The main focus of this model was the relocation of agricultural workforce and growing output and employment to the contemporary urban industrial sector through wages that is higher than subsistence agriculture. The theorist postulated that the city offers cost reducing advantages in economic, social and cultural amenities. However, this structural transformation has historically a great deal of upheaval, conflict, dislocation and human degradation in which the process involves winners and losers.

Carter (1995) indicates that, urban expansion has social consequence in dislocation, and separation that result in social fabrics chaos. People in urban areas “still live in somewhat rural areas where many of the residents live in the country but are invariably not socially and economically of it”. Social infrastructure is mostly concentrated in the centre. People in the extended area rely on proximity to facilities. This however includes long commuting to work, market, recreation and other basic social needs. Low-income households will continue to live in such severe social condition in the periphery. There is also a likelihood of separation from the city development and sandwiched between the rich creating class variance in the end (Mejia, 1999). Thengvel and Sachithanandan (1998), states that many of the urban expansion in developing countries happens at the expense of productive and fertile arable land at the periphery. This is most times not accompanied by environmental protection system. Urban waste relies on open canals, open drains and the roadside and holes in the ground as a regular means of disposing off waste especially in expansion areas. This exposes the residents to sanitation related disease and air pollution, environmental assets such as portable water and clean air has continually eluded those areas.

Materials and Methods

The Study Area

Kaduna metropolis is situated between Lat. N10°00' and N11°00' and Long. 7°00'E and 8°00'E. The research area was drawn around the proposed and the existing Kaduna metropolis. The area is about 12,347sq km comprises four Local Governments Areas i.e. Kaduna North, Kaduna South, Chikun and some part of Igabi Local Government (Figure 1); around 25 per cent of the state. Kaduna metropolis is a city with an equitable climate, a large perennial river, rich soils nurturing good farmland and mature tree cover. The population for this research work includes the whole population of Kaduna Metropolis comprising of Kaduna North, Kaduna South, parts of Chikun and Igabi local government areas with a total population of 1,914.281 people, (NPC 2006 amended 2020).



Source: GIS and Remote Sensing Software Arc Map 10.1 Department of Geography ABU, Zaria.

Methods

Mixed research techniques (Descriptive and Developmental) were adopted for the survey of forms and series of development and changes over time interval for the research. Both primary and secondary data were employed: The primary data included the design and field visits while the secondary data comprises satellite images scenes of Kaduna for 1990, 1995, 2000, 2005, and 2010 at various resolutions.

Table 1: Maps Sources and their Characteristics

Data	Date	Resolution / Scale	Identification	Acquisition Source
Quick Bird	2010	1 meter	Kaduna	NASRDA, Abuja
Nigeria-Sat 1	2005	32 meters	Kaduna	NASRDA, Abuja
Landsat MSS (Multispectral)	2000	30 meters	Kaduna	National Centre for Remote Sensing (NCRS), Jos.
Landsat MSS (Multispectral)	1995	30 meters	Kaduna	National Centre for Remote Sensing (NCRS), Jos.
Landsat MSS (Multispectral)	1990	30 meters	Kaduna	National Centre for Remote Sensing (NCRS), Jos.

The spatial extent of the metropolis was defined by the extent of the planning space as stipulated by the KASUPDA is 35km radius was adopted as the limit of the research area, whereas 20km radius as proposed by Max lock 1967 was used as the inner limit.

Data Analysis and Presentation

Data collected was analyzed and presented using percentages and tables and the use of visual interpretation by use of maps, also using the available vector and raster analysis operations in Arc GIS 9.2. The built-up for the various years were computed and the extent of spatial growth, the pattern of growth and in the factors responsible for the urban expansion of Kaduna was ascertained. The percentage of the different land use/ land cover classes was calculated using attribute table command in ArcGIS. Analyzing the pattern of change involved comparing up the thematic maps extracted from the satellite images. The information generated after the analysis was summarized and taken to Microsoft office packages – MS Word 2010, MS Excel and MS PowerPoint for presentation and the details presented in form of graphs, charts, tables, maps and reports.

Results and Discussion

The areal extent of the built – up area in Kaduna Metropolis was presented in Figure 2, which shows an overlay of the built – up areas that was digitized from the satellite images of 1990 and that of 2010. The expansion of the built –up areas of Kaduna Metropolis within the 20 years period can easily be seen from this map. As represented on the legend, the redish - brown colour with stripes shows the extent of the expansion in 1990 (9,755 ha) while the light brown portion represents the extent of development in the year 2010 (20,839 ha). Comparison of the two years shows the expansion within the period of the research (11,084 ha). The variation on the extent of the settlement in the two different years shows not only the extent but also the direction, nature and form of expansion.

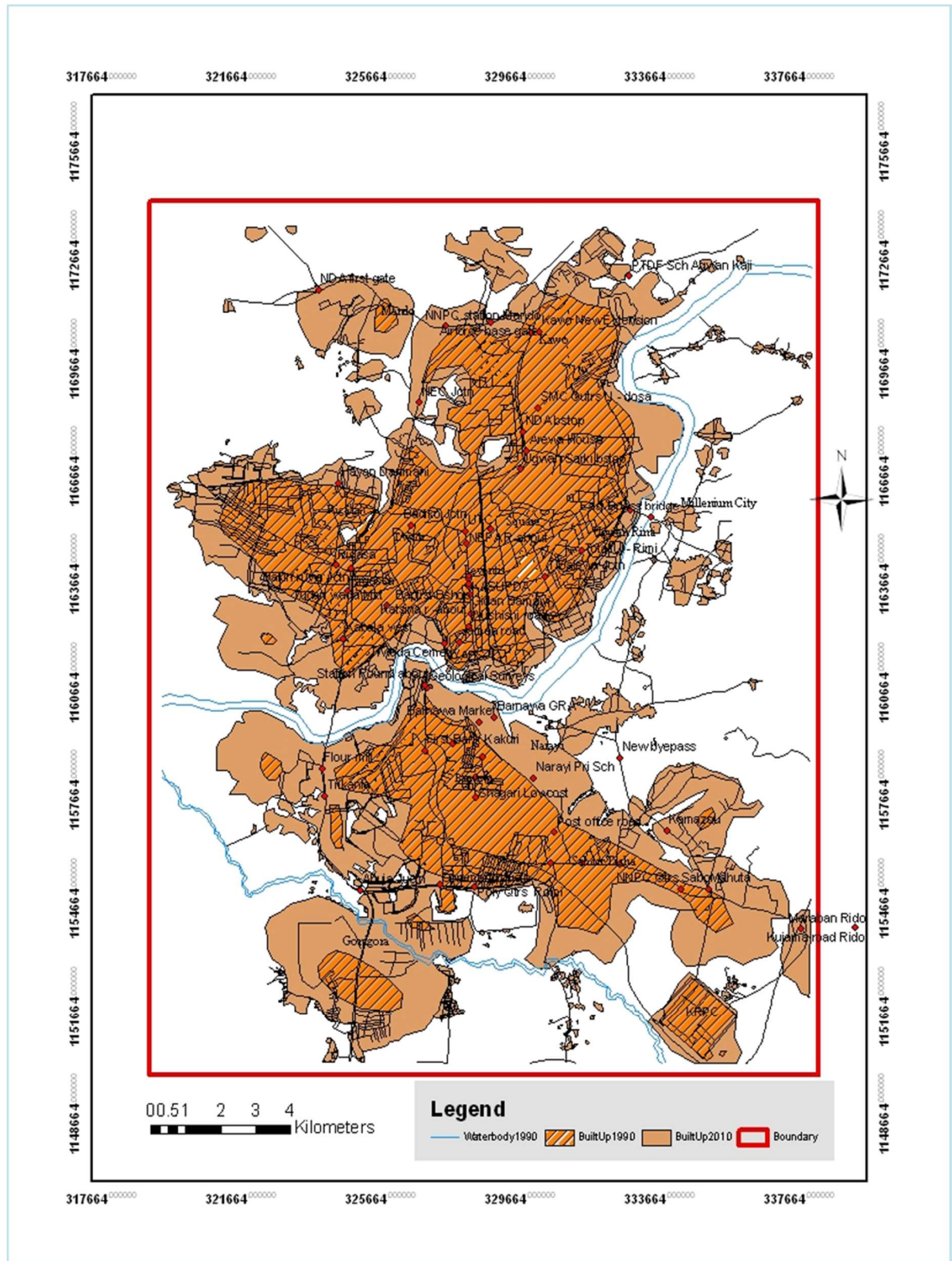


Figure 2: Built up of Kaduna Metropolis 1990 - 2010

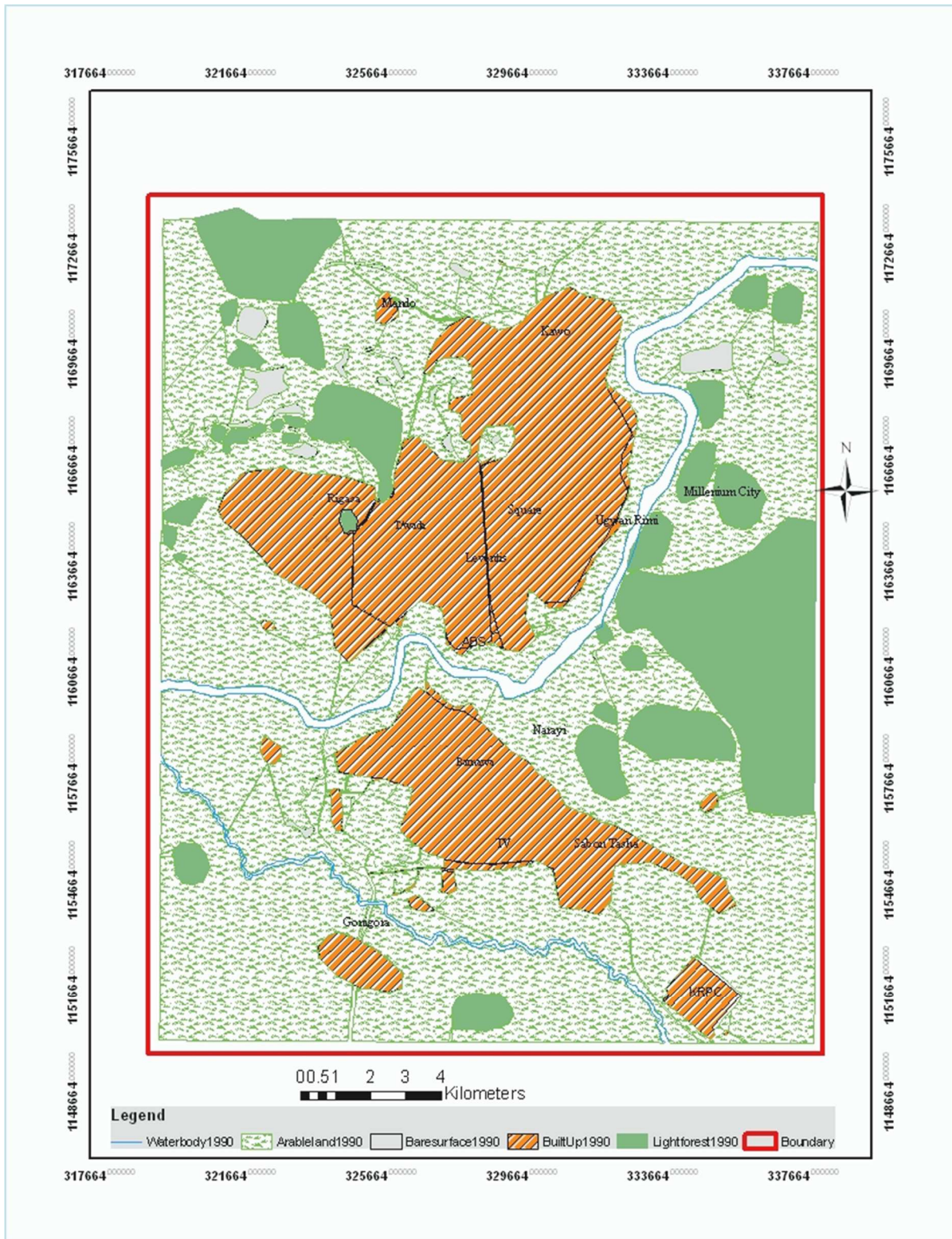


Figure 3: Kaduna Built-up 1990

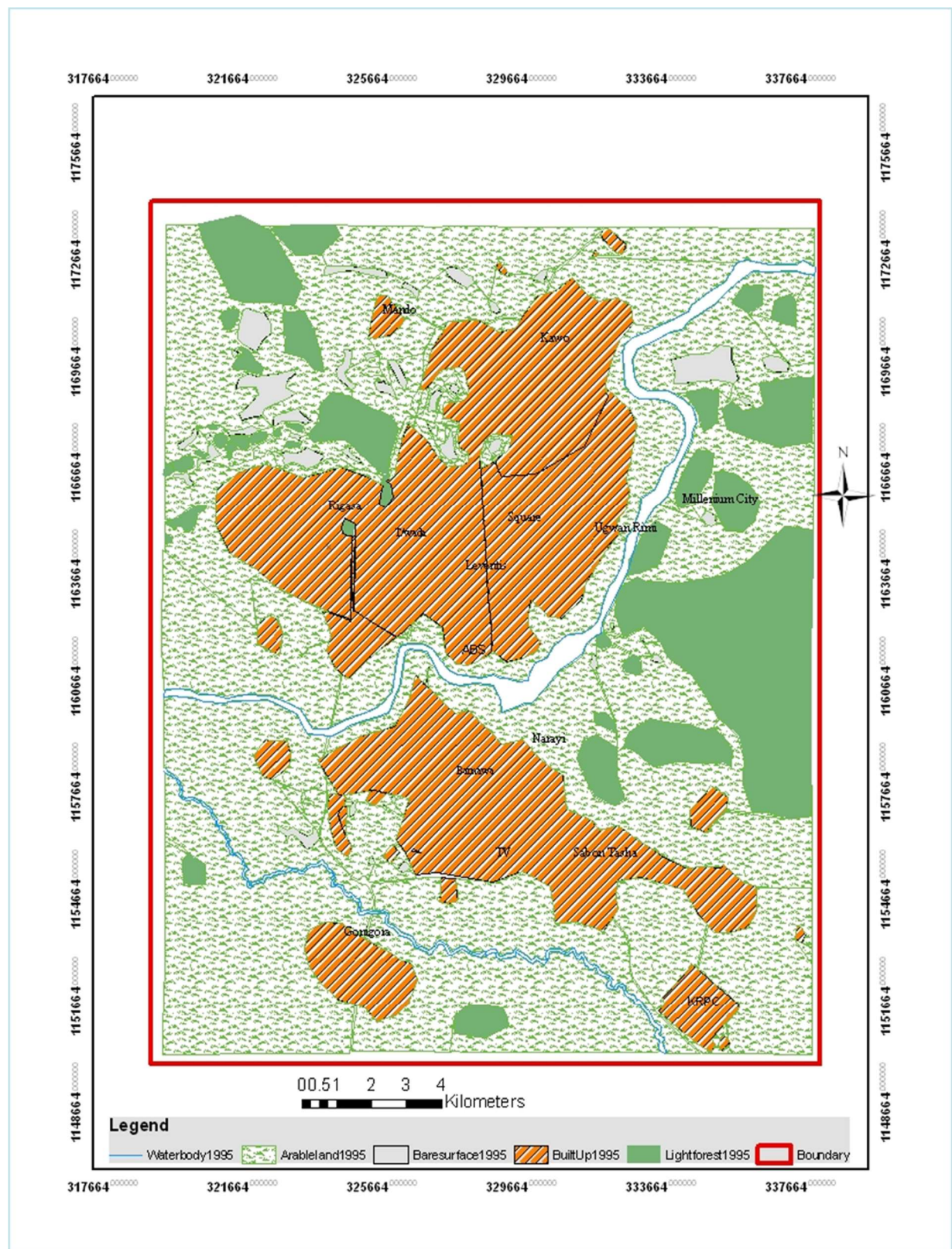
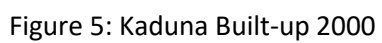


Figure 4: Kaduna Built-up 1995



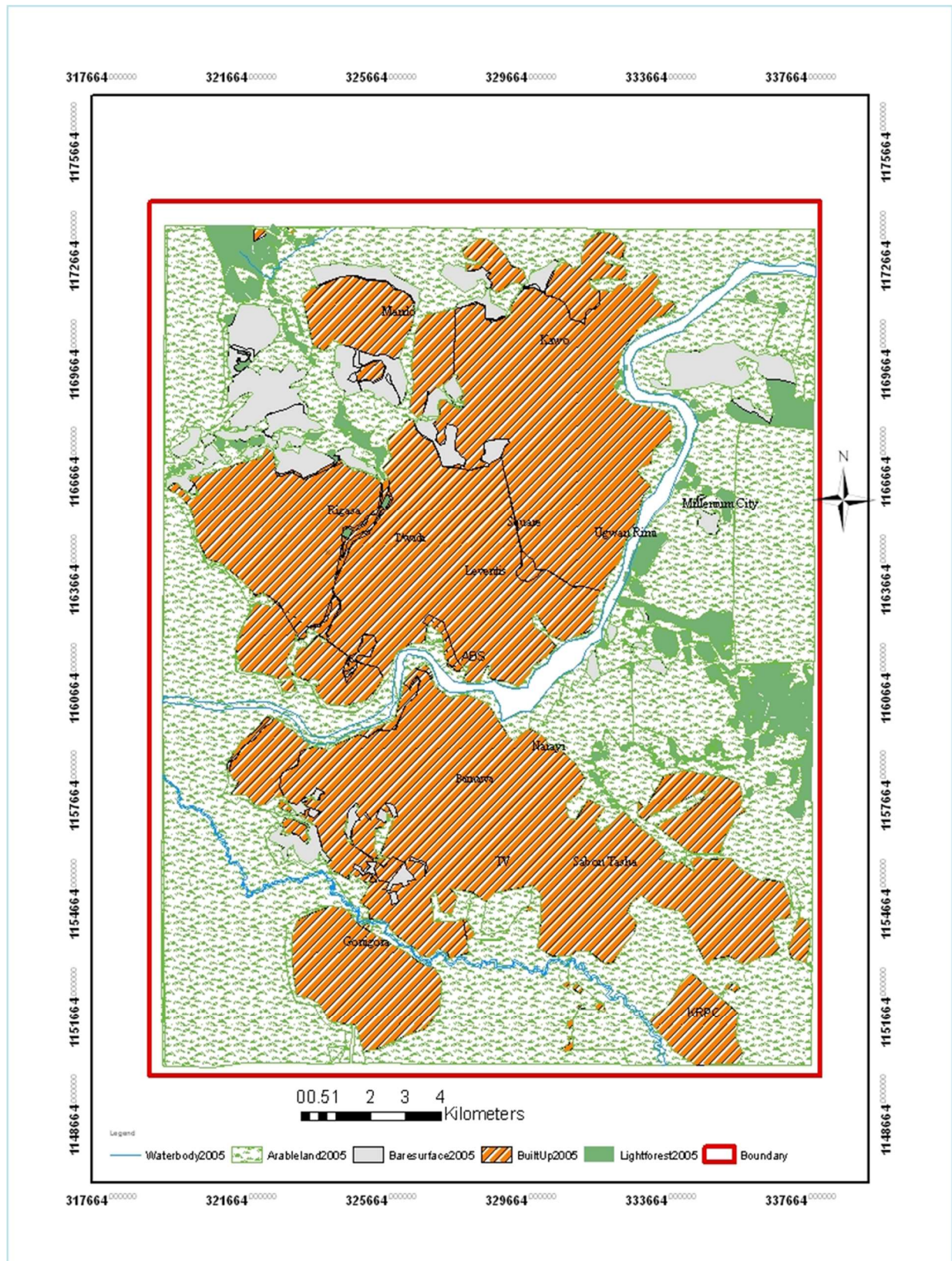


Figure 6: Kaduna Built-up 2005

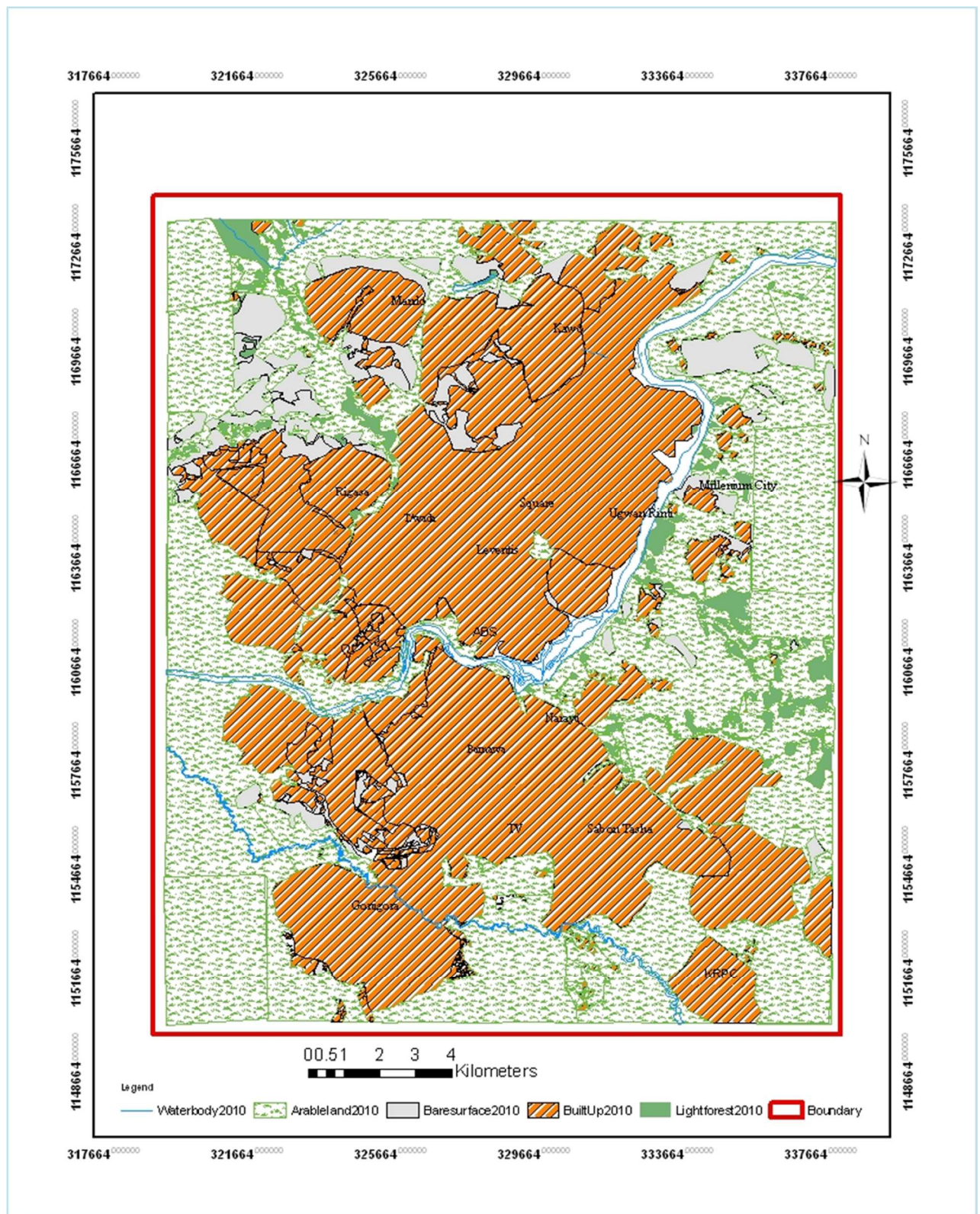


Figure 7: Kaduna Built-up 2010

Table 2: Urban Expansion in Hectares per Year and Percentage / Year in Kaduna Metropolis (1990 – 2013)

Period (Year)	Urban Area (Hectares)	Change (Hectare)	Change % Area	Time Span	Arithmetic Mean change (Hectare)	Arithmetic Mean change (%)
1990	9755					
1990 - 1995	11857	2102	21.54	5	420.4	4.3
1996 - 2000	14818	2961	24.97	5	592.2	5.0
2001 - 2005	18356	3538	23.87	5	707.6	4.8
2006 - 2010	20839	2483	13.52	5	496.6	3.0
1990 - 2010	20839	11084	113.6	20	554.2	5.7

Source: Computed from Table 2

Table 2: shows the expansion of the built - up area within Kaduna Metropolis for the period under study. The built – up area expanded by 2,102 hectares between 1990 and 1995 an increase of 21.54%. This gave an average of 420.4 hectares (4.3%) for the five years period. The expansion of the metropolis showed significant increase within the next period of 1996 – 2000 in which the metropolis expanded by 2,961 hectares an increase of 24.97%. This gave an average growth rate of 592.2 hectares (5%) at the five years interval each. The highest change was recorded between the periods 2001 - 2005 when the built – up area expanded by 3,538 hectares (23.87%), which translated to 707.6 hectares (4.8%). The period 2006 – 2010 recorded a total increment of 2,483 hectares (13.52%) and this translates to an average of 496.6 hectares (3%) growth rate. The third column on table 2: shows that the built up area in Kaduna Metropolis expanded by 11,084 hectares for the period under study (20 years) which translates to an average growth rate of 5.7%.

Table 3: Percentage Change of Land cover in Kaduna Metropolis (1990-2010)

SN	Land cover	1990		1995		2000		2005		2010	
		Area (ha)	Area (%)	Area (ha)	Area (%)	Area (ha)	Area (%)	Area (ha)	Area (%)	Area (ha)	Area (%)
1	Built -up	9755	22.81	11857	27.73	14818	34.65	18356	42.9	20839	48.7
2	Road	34	0.08	38	0.09	51	0.12	65	0.15	77	0.24
3	Arable land	26384	61.7	24510	57.31	22027	51.5	20091	47	18064	42.2
4	Light forest	6019	14.1	5407	12.64	4267	10	1802	4.21	1017	2.4
5	Bare surface	465	1.09	842	1.97	1486	3.5	2330	5.5	2614	6.1
6	Water body	107	0.22	110	0.26	115	0.23	120	0.24	153	0.36
7	Total	42764	100	42764	100	42764	100	42764	100	42764	100

Sources: Derived from Landsat, NigeriaSat-1 and Quick bird Imageries for the years

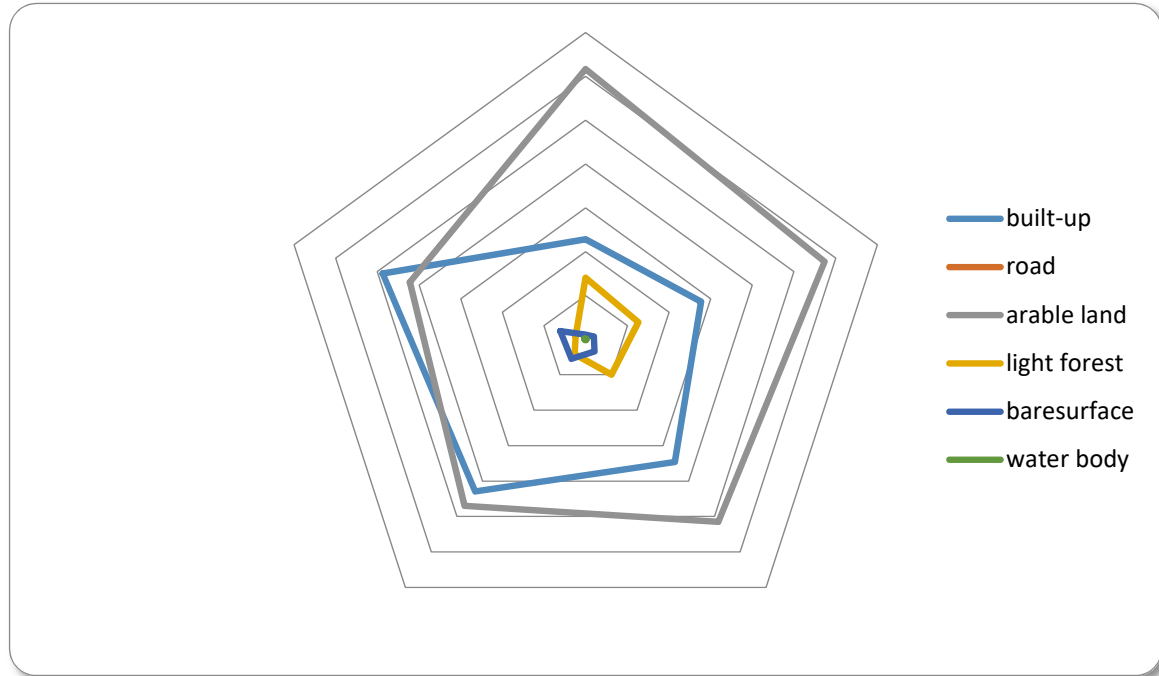


Figure 7: Percentage Change in Distribution of Land cover in Kaduna Metropolis

Figure 7 shows the distribution of the land-cover classes for the various years under study, which was generated from Table 2. The total land area that was demarcated for the study within Kaduna metropolis from the satellite imageries is estimated at 42,764 hectares. The built – up area for 1990 was estimated at 9,755 hectares, which is 22.81% of the total land area. The major roads covered 34 hectares (0.08%). The Arable land for 1990 is estimated at 26,384 hectares that constitute 61.7% of the total land area and the light forest is estimated at 6,019 hectares making a total of 14.1 %. The bare surface, which represents rock outcrops and land that is neither used as built-up, road, forest, nor for cultivation was 465 hectares (1.09%), while water body represented 107 hectares (0.22%). These changes can easily be appreciated on the composite maps generated for Kaduna metropolis above.

Summary and Conclusion

In conclusion, we have seen that the built-up area in Rigasa Community expanded by 1,430.38 hectares within the 20 years period. This gave arithmetic mean change of 286.1 hectares for each of the five years interval and translates to a growth rate of 7.1%. The absolute change in areal coverage of arable land from 1990 to 2013 was 709.3Ha, which gives a mean change of 177.3Ha for each of the five years period. This implies that arable land in Rigasa is loss to other landuses at about an average of 3.4% for the period under review. The total absolute change for the light forest cover in Rigasa was 660.76Ha giving an average of 165.2Ha for each of the periods. The loss in light forest to other competing uses is about an average rate of 2% for the 20 years period. This brought the net change in bare surface in Rigasa to 60.32Ha and translated to an average of 15.08Ha for each of the periods. The mean rate of decline in bare-surface in Rigasa is 4% for the 20 years period.

The built up area in Unguwan Muazu Communities expanded by 192.1 hectares within the 20 years period. This gave arithmetic mean change of 38.42 hectares for the five years interval and translated to a growth rate of 7.5%. The absolute change in areal coverage of arable land from

1990 to 2013 is 105.94Ha, which gives a mean change of 21.2Ha for each of the five years period. Arable land in Unguwan Muazu is lost to other land uses at about an average of 2.5% for the period under review. The total absolute change for the light forest cover in Unguwan Muazu was 73.18Ha giving an average of 14.64Ha for each of the periods. The loss in light forest to other competing uses is about an average rate of 1.7% for each of the five and eight year's interval. The mean rate of decline in bare surface in U/Muazu is 3.1% for the 20 years period.

The built-up area in Gonin-gora settlement expanded by a total of 899.28 hectares within the 20 years period and translated to a growth rate of 13.6%. This corresponded to arithmetic mean change of 179.85 hectares for the five years interval. The absolute change in areal coverage of arable land for the 20 years period is 327.12Ha, which gives a mean change of 65.42Ha for each of the five-year period. This implies that arable land in Gonin-gora is loss to other land uses at about an average of 3.5% for the period under review. The total absolute change for the light forest cover in Gonin-gora was 441.35Ha giving an average of 88.28Ha for each of the periods. The loss in light forest to other competing uses is about an average rate of 2.8% for each of the five years interval. The absolute change in bare surface in Gonin-gora was 130.77Ha this corresponded to an average of 26.15Ha for each of the periods. The mean rate of decline in bare surface in the settlement is 2.9% for the 20-year period.

The built up area in Narayi peri settlement expanded by a total of 218.8 hectares within the 20 years period. This corresponded to a growth rate of 4.8% and arithmetic mean change of 43.76 hectares for the five years interval. The absolute change in areal coverage of arable land for the 20 years period is 147.67Ha and the mean change of 29.53Ha was recorded for each of the five-year period. This follows that arable land in Narayi is loss to other land uses at about an average of 1.2% for the period under review. The total absolute change for the light forest cover in Narayi was 50.63Ha giving an average of 10.13Ha for each of the periods. The lost in light forest to other competing uses is at an average rate of 0.6% for each of the five years interval.

Similarly, the built up area in Rafin Guza expanded by a total of 171.8 hectares within the 20 years period and translates to a growth rate of 10%. This corresponded to arithmetic mean change of 34.36 hectares for the five years interval. Arable land recorded a total change of 117.48Ha. This corresponded to a mean change of 23.50Ha for each of the five-year period. This implies that Arable land in Rafin Guza is loss to other landuses/landcovers at about an average of 2.2% for the period under review. The total absolute change for the light forest cover in Rafin Guza was 135.1Ha giving an average of 27.02Ha for each of the periods. The loss in light forest to other competing uses is about an average rate of 0.5% for each of the five years interval. In the same vein, Rafin Guza recorded an absolute change in bare surface to the tune of 80.78Ha. This translated to an average of 16.16Ha for each of the periods. The mean rate of increase in bare surface in the settlement is 8.7% for the 20 years period.

The built up area in Rigachikun settlement expanded by a total of 186.96 hectares within the 20 years period at a growth rate of 9.5%. This corresponded to arithmetic mean change of 37.39 hectares for the five years interval. The absolute change in areal coverage of arable land from in Rigachikun is 179.98Ha. This gave a mean change of 36.1Ha for each of the five-year period. This implies that arable land in Rigachikun is loss to other land uses at about an average of 1.4% for the period under review.

The total absolute change for the light forest cover in Gonin-gora was 441.35Ha giving an average of 88.28Ha for each of the periods. The loss in light forest to other competing uses is about an average rate of 2.8% for each of the five years interval. The absolute change in bare surface in

Rigachikun was 69.59Ha. This translated to an average of 13.92Ha for each of the periods. The mean rate of increase in bare surface in the settlement is 8.1% for the 20 years period.

The total absolute change in the built up areas in hectares was used as the basis for the comparison of the extent of deterioration within the settlements under study. Rigasa settlement was the most deteriorated settlement amongst the six settlements with a total change of 1,430.38 hectares in the built up area. This was followed by Gonin-gora settlement, which recorded a total change of 899.28 hectares for the 20 years period. However, a wide gap exists between Gonin-gora and Narayi settlement, which is ranked third with a total of 218.8 hectares. Kabala West and Unguwan Muazu settlements were ranked fourth with a total change of 192.1 hectares. This was closely followed by Rigachikun and Rafin guza settlements, which were ranked fifth and sixth with a total of 186.96 and 171.8 hectares respectively.

The extent of the spatial expansion of the built-up area of Kaduna metropolis has outdone the capacity of the stipulated metropolitan area: 20km radius as provided by Max lock 1967 and the area of 15km forms the extent of the city's expansion. The study identifies and maps the land use/land cover of Kaduna Metropolis over a period of 20years at an interval of 5 years. Several approaches have been advanced in trying to consider the behaviour of built up areas and population density over spatial and temporal changes taking place, and in most cases patterns of such expansions identified through visual interpretations. The areas under study were observed at different spatial and temporal scales, through the use of satellite imagery to facilitate a time series analysis of the spatial and morphological transformation of the city of Kaduna (1990 – 2010).

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