International Scholars Journals

African Journal of Ecology and Ecosystems ISSN 2756-3367 Vol. 12 (3), pp. 001-008, March, 2025. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Spatial Assessment and Monitoring of Sustainable Land Management in Zaria using Remote Sensing and GIS

I. I. Abbas* and Y. A. Arigbede

Department of Geography, Ahmadu Bello University, Zaria, Kaduna State, Nigeria.

Accepted 4 January, 2025

The need for effective planning and disaster prevention is the main reason for real time data generation provided by Remote Sensing and GIS. Zaria is fast becoming more unplanned due to increase in population and the consequent human influence leading to high rate of land use-land cover change. This study therefore looks into changes in land use-land cover between 1985 and 2005 with a view to providing database for future planning. Landsat, spot and digital globe imageries for 1985, 1995 and 2005 respectively were used for the analysis. The result shows that built-up areas increased from 2.3% in 1985 to 36.4% in 2005, water body decreased from 22.5% in 1985 to 6.5% in 2005 while cultivation decreased from 44% in 1995 to 40% in 2005 sending a bad signal of imminent food crisis if not checked. The process has led to elimination of the crop, forest and scrub land mostly towards the eastern and southern outer limits of the city. The growth of built-up areas is mainly towards the east- west route in a linear pattern.

Key words: Land use-Land cover, sustainability, land management, Remote Sensing, Geographic Information System (GIS).

INTRODUCTION

Human induced conversions and modifications such as fertilizer use, deforestation and irrigation practices of land use has shown by research have significance for the functioning of the earth system through their impact on bio-geochemical cycles (Mengistu and Salami, 2007). This point is also emphasised by Warren (2002) that land use changes are closely driven by human activities.

Land use change apart from its implications for environmental sustainability also has important cones-quences for food security. Conversion of cultivated land to non-farm uses such as housing, factories and infra-structure in combination with a growing population are for some countries, regarded as serious threat to future food security (Millennium Ecosystem Assessment, 2005).

However, the biophysical conditions of land such as soil characteristics, climate, topography and vegetation determine to a large extent the spatial pattern of land use and land use change in relation to the driving factors that provide essential information for land use planning and sustainable management of resources.

Ripa et al. (2006) call sustainability a dynamic concept with five dimensions namely social, economic, ecological, geographical and cultural. The concept of sustainable development therefore embraces the basic concept of well being of all time, seen through its multiple dimensions (Reynolds et al., 2003).

For any meaningful development to take place in an area there is the need for adequate information on the past and present land use patterns. Sufficient records on land and its uses have not been adequate over time in this country. This may be due to the tedious nature and cost of conducting ground surveys and the bulky nature of data generated, which is impossible to be kept properly by manual or existing old methods of filing information on papers and in cupboards. The use of remote sensing and GIS to capture data and process for safe keeping, management and regular updating therefore serves as a reliable alternative.

Elsewhere, it has been found to be the most efficient and cost effective method of data gathering and storage. Studying the land use and its sustainable prospects in Zaria between 1985 and 2005 using remote sensing and GIS will thus generate the much needed information required for effective and efficient planning.

*Corresponding author. E-mail: innoabbas@yahoo.com.

Table 1. Data types and sources.

Data type	Date of production	Scale	Source
Digital globe	2005-11-03	30m ™	www.digitalglobe.com
Landsat image	1995-11-15	30m TM	GLCF
Landsat image	1985-11-07	30m TM	GLCF
Administrative and Local Government map of Kaduna State	2005	1:15,140,906 (view scale)	Ministry of Lands, Survey and Country Planning, Kaduna State

Table 2. Land use-Land cover distribution.

	2005		1995		1985	
	Area (Ha)	Area (%)	Area (Ha)	Area (%)	Area (Ha)	Area (%)
Built-up	17934.37	36.40313585	4043.162	10.19958	1016.153	2.398023
Waterbody	3217.036	6.529930995	5639.176	14.22581	9568.149	22.57991
Bare surface	8245.44	16.73657187	12357	31.17269	15037.49	35.48704
Cultivated	19869.157	40.33036128	17601.126	44.40192	16752.81	39.53503
Total	49266.003	100	39640.464	100	42374.61	100

Source: GIS analysis, 2010.

This study is therefore carried out at a time when awareness has been created for the need of proper documentation of land uses and patterns over time, so as to aid diligent predilections of future land uses for a more secured tomorrow.

The chosen area for this research is Zaria, which covers an area extent of 6100 hectares, located within latitudes 10° 15' to 11° 6' North of the Equator, and longitude 07° 04' to 08° 05' East of the Greenwich Meridian.

METHODOLOGY

To carry out this research, the use of satellite images for the period between 1985 and 2005 were employed. Ground surveys was carried out as means of verification and updating activities while GPS coordinates and photographs were taken to confirm the information on the satellite images and to make corrections appropriately.

Data acquired and sources

Landsat satellite images of Zaria were acquired for 1985 and 1995 while digital globe was acquired for 2005. It is also important to state that Zaria and its environs which were carved out using the local government boundary map and Nigerian Administrative map was also obtained from Ministry of Land Survey and Country Planning, Kaduna. The data acquired and the sources are summarized in Table 1.

The Landsat imageries of 1985 and 1995 were downloaded from the website of the Global Land Cover Facility (GLCF) of the University of Maryland, Maryland, USA (www.glcf.umiacs.umd.edu).

The digital globe imagery was downloaded from www.digitalglobe.com. The imageries were georectified to UTM-32 projection, WGS84 datum and corrected for geometric and radio-metric errors from the sources. From the imageries, were used to get the land use -land cover for 1985, 1995 and 2005 respectively.

The administrative map was converted into digital by scanning and imported into Arcview GIS 3x software. Control points (CP) for geo-referencing the scanned maps (images) were selected from the hardcopy maps. The transformation was done using the image analyst within Arcview software environment. The georeferenced map was displayed within the same view interface of Arcview and seamless vector data layers were extracted from the map.

The process of layers extraction from the map and imageries was done using the head-up (on-screen) digitizing method. This involves creating an empty theme of desired feature representation (point, line or polygon) within the view interface of Arcview GIS. Using the drawing and editing tools of the software, each entity of the feature of interest was traced out. The predefined code for each entity was attached as attribute. A look-up-table (LUT) was then prepared to assign all the entities into respective feature classes as appropriate. The vector layers generated from the administrative map were in geographic (Lat/Lon) coordinates. These were re-projected into UTM-32 coordinates, WGS84 datum. This was necessary to facilitate standardization of these data with data from the satellite imageries.

RESULTS

The static land use land cover distribution for each study year is presented in Table 2.

From Table 2, in 1985 the built-up area occupied 2.398023% of the total land mass with pockets of building around Samaru and Zaria city. The study further revealed that water body which was made up of rivers Galma and Kubani occupied 22.57991%, bare surface 35.48704% while cultivated land which is the largest of the four classes occupied 39.53503%. The pictorial representation is shown in Figure 1.

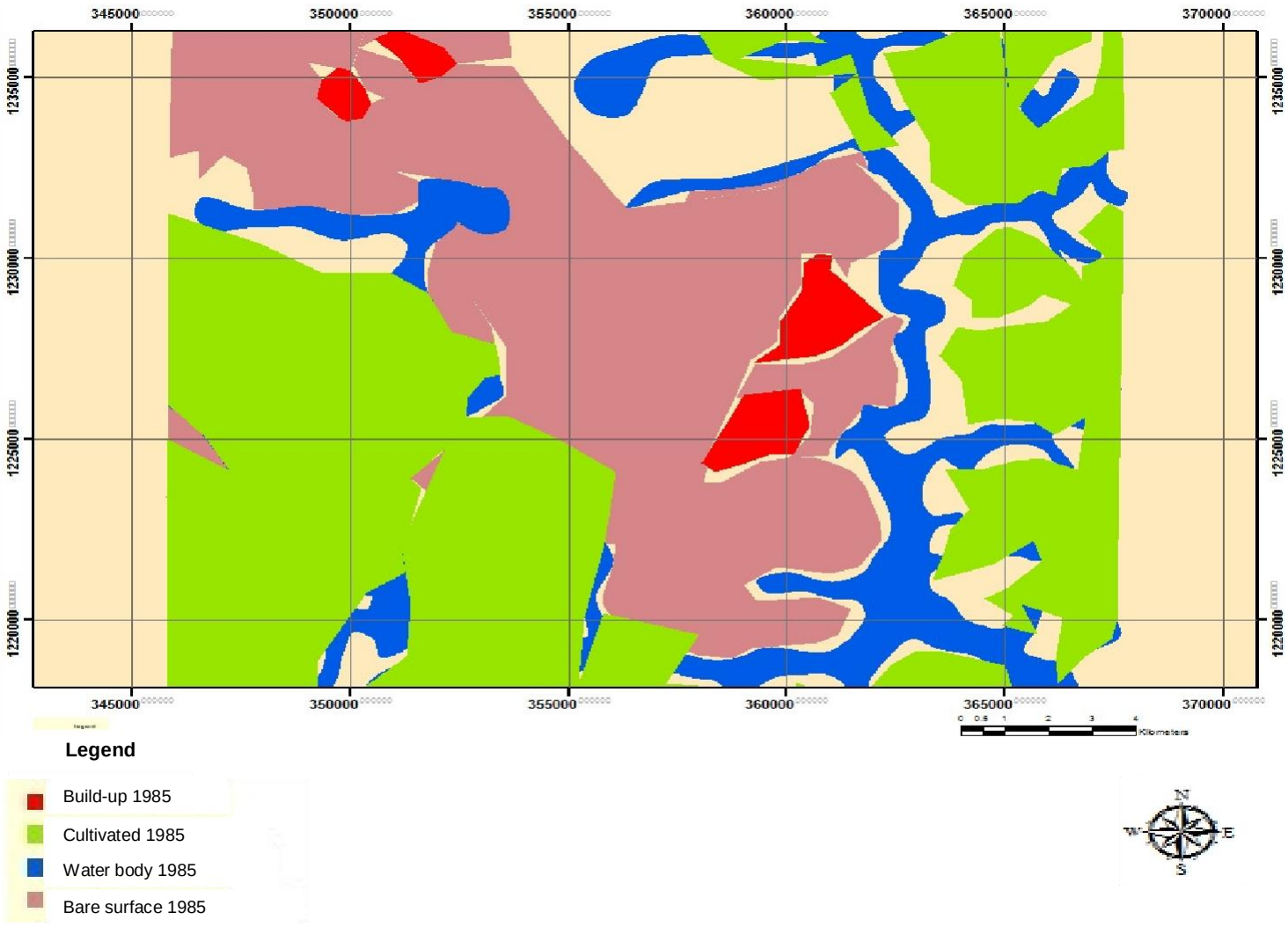

Figure 1. Land use- Land cover for 1985. Source: GIS analysis.

In 1995 from Table 2, the built-up area has extended towards Nigerian College of Aviation Technology with an increase percentage of 10.19958 due to the influx of students and the increase in staff strength of the various institu-tions in the study area, water body and bare surface have dropped to 14.22581 and 31.17269% respectively because of increase in the construction of buildings to accommodate the increase in the population and administrative structures, however, farming activities improved with cultivated land at 44.40192% increase due

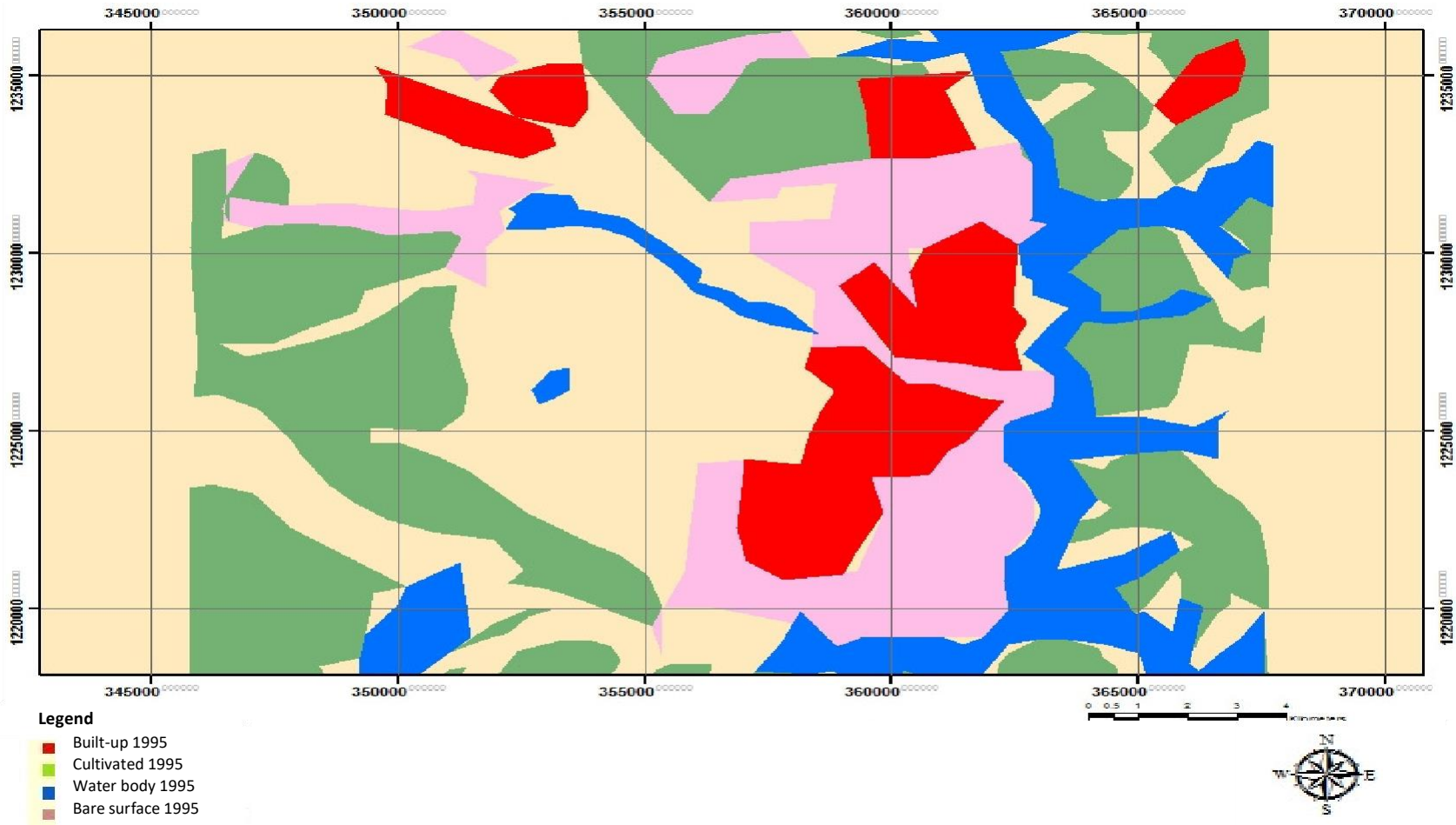

Figure 2. Land use-Land cover for 1995. Source: GIS analysis.

government policy such as fadama programme to encourage people should to farm. This is shown on the map represented as Figure 2.

From Table 2, the year 2005 shows a signify-cant growth in built up area at 36.40313585% due to the continue increase in population as explained earlier while there were reduction in water body, bare surface and cultivated land at 6.529930995, 16.73657187 and40.33036128% respectively. This change depicts that increase in built-up area is inversely proportional to the other three classes suggesting that urban expansion fundamentally depends on consumption of other land use classes. The situation in 2005 is represented in Figure 3.

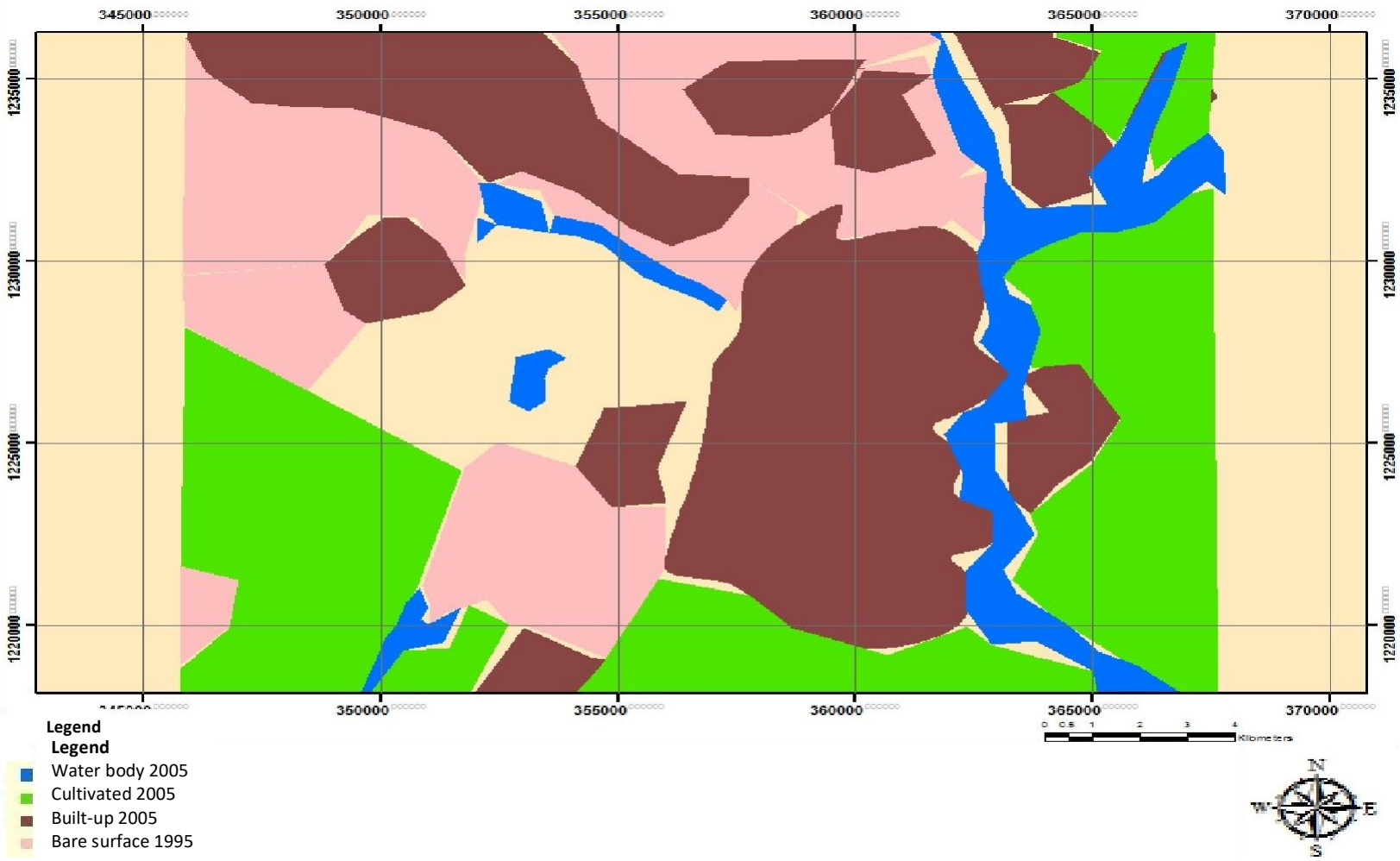

Figure 3. Land use- Land cover for 2005. Source: GIS analysis.

DISCUSSION

The spatial variation in land use-land cover for the period 1985 to 2005 is as represented in Table 3. The period 1995 to 2005 reveals a drastic change in the normal course of urbanization. During the period, the built-up areas increased to 26.20% from around 7.80%. The year 2005 has shown a remarkable growth of built up areas in large-sized settlements away from the city limits.

The process has led to elimination of the crop, forest and scrub lands mostly towards the eastern and southern outer limits of the city. The growth of built-up areas is mainly towards the east- west route in a linear fashion. The

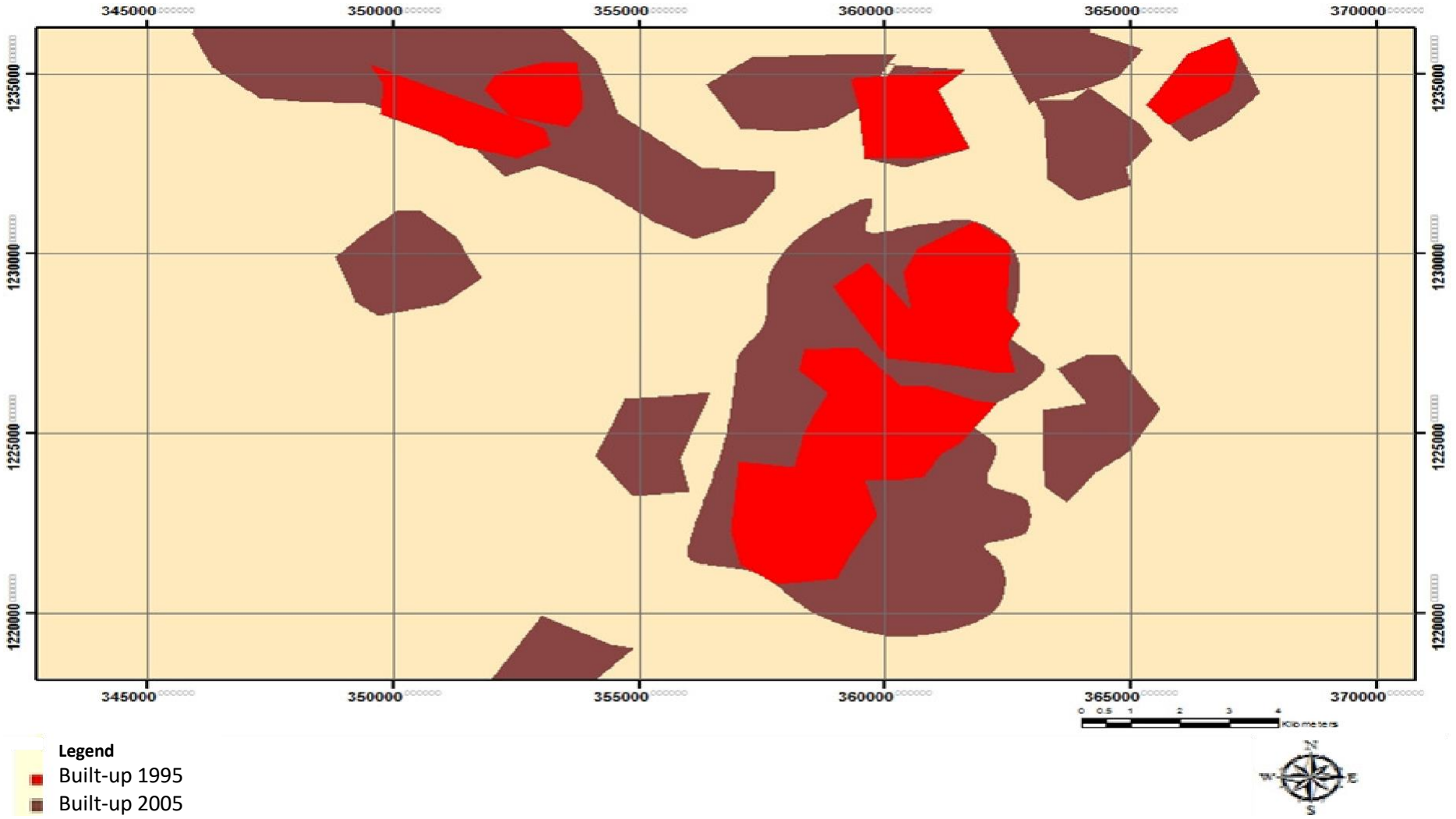

Figure 4. Overlay map of 1995 and 2005 Land use- Land cover. Source: GIS analysis.

eastern sections have also reported growth in the population. Rest of the region still depicts dispersed built-up land patterns. The period witnessed the setting up of the Ahmadu Bello University, Teaching hospital, College of Aviation, Federal College of Education and many other infrastructural developments that boosted the process of urbanization.

The bare surface and cul t i v at e d lands declined to 14.43 and 4.07% respectively in the period 1995 to 2005 which is about 10% higher than the decline during the 1985 to 1995 period.

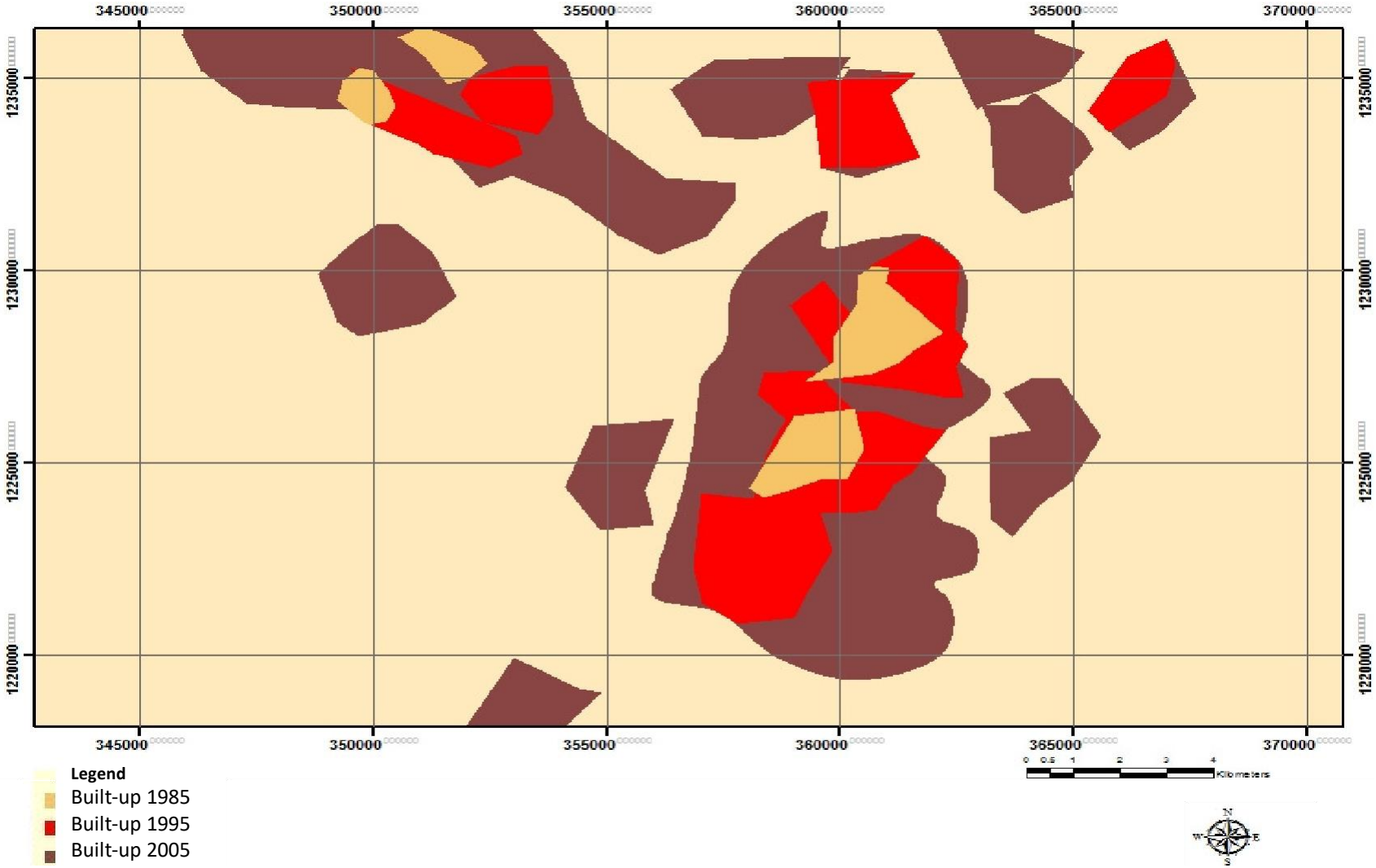

Figure 5. Overlay map of 1985, 1995 and 2005 Land use-Land cover. Source: GIS analysis.

The later period resulted in a rapid decline in the water bodies mainly because of the process of acquisition and occupancy of land by the dwellers.

Generally, land transformation has caused a hike in urban land prices. The study is therefore an important step towards realizing that land acquisitions were taking place at a very fast rate and if necessary sustainable management system is not put in place a major sprawl crisis will set in. The change scenarios explained previously are shown in Figures 4 and 5.

Table 3. Land use- Land cover change over Zaria (1985 to 2005)

Classes	1995 to 2005 (%) change	1985 to 1995 (%) change
Built-up	26.20355585	7.801557
Water body	7.695879005	8.3541
Bare Surface	14.43611813	4.31435

Source: GIS analysis.

Conclusions

Land evaluation helps to know how the different land use-land cover classes have performed (decrease or increase) over time. With this in mind, sustainable land planning and management can be done to cater for the causes of the changes especially population influx. Indeed, between the period of 1995 and 2005, there has been significant increase in the spatial expansion of Zaria compared to the period between 1985 and 1995. There is a possibility of continual increase in this region in the near future. This therefore suggests that the city has increased in producing functions that attracted migration into the area.

After the initial increase in farm land between 1985 and 1995, the city witnessed a steady drop in this land use and in deed, may continue in this trend if not checked. In view of this, the study shows the importance of Remote Sensing and Geographic Information System techniques in change detection and land uses monitoring. If the land change pattern and trend of a place is known, then sustainable land planning can be embarked upon to have sustainable land management and development that is eco-friendly. It is suggested here that a deliberate attempt should be made by the local government to reverse this trend since this could lead to major food insecurity in the future.

REFERENCES

Millennium Ec os ys tem Ass ess ment (2005): Ec os ystem and Human well- Being, W etlands and W ater Synthes is Report . World Resources Institute, Washington, DC. p. 6.

Mengistu DA, Salami AT (2007): Application of RS and GIS in land use-land cover mapping and change detection in a part of south western Nigeria, Afr. J. Environ. Sci. Technol., 1(5): 099-109. December.

Reynolds JF, Stafford S, Lambin E (2003): ARIDnet- Seeking novel approaches to desertification and land degradation, Global Change Newslett., 54: 5-9.

Ripa MN, Leone A, Garnier M, LoPorto A (2006): M.N. Agricultural land use and best management practices to control non-point pollution, Environ., Manage., 38(2): 253–266.

Warren A (2002): Land degradation is Contextual. Land Degradation Dev., 13: 449-459, John W iley & Sons Ltd,

www.digitalglobe.com