THE EFFECT OF URBAN ENCROACHMENT ON GUGA FOREST RESERVE IN GIWA LOCAL GOVERNMENT AREA, KADUNA STATE, NIGERIA

BY

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A DISSERTATION SUBMITTED TO SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE DEGREE IN REMOTE SENSING AND GIS

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NIGERIA.

SEPTEMBER, 2015.

DECLARATION

I hereby declare that this dissertation entitled "The Effect of Urban Encroachment on Guga Forest Reserve in Giwa Local Government Area of Kaduna State, Nigeria' is record of my own research work under the supervisor of Dr. Benedine, Akpu and Dr. D. N. Jeb.

The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this thesis was previously submitted for the award of degree at this or any other university.

______________________ ____________________

Danburi Cecilia Nansok Date

CERTIFICATION

This dissertation entitled “The Effect of Urban Encroachment on Guga Forest Reserve in Giwa Local Government Area of Kaduna State, Nigeria” by Danburi, Cecilia Nansok, meets the regulations governing the award of the degree of Master of Science (Remote Sensing and GIS) of the Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This dissertation is dedicated to my beloved husband late Danburi Augustus Nansok and to my lovely children Ponchang, Chalbyen and Ponle.

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ABSTRACT

Urban expansion affects land cover at local, regional and global scales. Like other towns in Nigeria, Shika is growing at a very fast rate. The consequence of such urban growth if unplanned is the adverse effects on the environment. The aim of this research was to Assess the Effect of Urban Encroachment on Guga Forest Reserve in, Shika, Giwa Local Government Area of Kaduna State, Nigeria using Remote Sensing and Geographic Information (GIS) techniques. Landsat MSS imagery of 1986, Landsat TM imagery of 1990, Landsat ETM+ data of 1999 and Landsat 8 OLI image (2014) were used. The datasets were processed and classified into land use/land cover classes using the supervised classification technique in Erdas imagine 9.2 environment and ArGIS 10.1. The built-up area and forest land was extracted separately and the rates of growth between the periods (1986-2014) were ascertained. The built-up areas for the four time periods were overlaid in order to derive the urban growth map. The result revealed that built-up increased from 15.9 hectares in 1986 to 54.7 hectares in 2014 while forest land reduced from -7.8 hectares to -194.0 hectares within this same period. The built-up in the study area was increasing at the 0.9% yearly while the forest land was declined at the rate of -1.1% per annum within the period (1986-2014) studied The study recommend that Remote Sensing and Geographic Information System (GIS) technique which have proved to be efficient in the monitoring of forest/vegetation cover, This would help to control encroachment and reduce indiscriminate exploitation of the forest cover.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Urban concept varies from country to country and with periodic reclassification, can also vary within one country over time, making direct comparisons difficult. An urban area can be defined by an administrative criteria and political boundaries within the jurisdiction of a municipality or town committee. A threshold population size where the minimum for an urban settlement is 2,000 in habitat and this figure varies between 2000 and 50,000 people or where a significant majority of the population engaged in non agricultural activities (Brenna, 1990).

Urban growth refers to the relative or absolute increase in the number of people who live in towns and cities (Mathew, 2010). The pace of urban population growth depends on the natural increase of the urban population and the population gained by urban areas through both net rural-urban migration and the reclassification of rural settlements into cities and towns (Cohen, 2005). However, majority of the world's population today lives in urban areas thereby causing an unprecedented expansion of urban areas (Cohen, 2005; United Nations, 2009). Based on the United Nation's report in 2008, more than 50 percent of the world population presently lives in cities of varying sizes and this will continue to increase particularly in developing regions of the world (Adesina, 2005; Daramola and Ibem, 2010; United Nations, 2009).

Globally, the towns and cities of developing countries are growing rapidly in both population and areal coverage, due to great waves of distress migration from rural areas.

Thus the urban centre in developing countries are expected to double their total population from 2 billion in 2000 to 4 billion by the year 2030, and triple their total built-up areas from about 200,000 square kilometres to more than 600,000 square kilometres within this same period, given an annual average density decrease of 1.7% to constitute 54.5% of the total urban built-up areas in the world by 2030 (Adesina, 2005; Shlomo, Stephen and Daniel, 2005).

Expanding population has brought with them a range of problems for both the physical and built environment. As our big cities have grown away from the centre to accommodate people's settlement needs, suburbs have mushroomed outwards, producing what is referred to as 'urban sprawl' (Kumar, Mahesh and Deepak, 2008). This process means that the natural environment suffers as more space is required for the construction of houses, roads, the development of industry among other. As more ecosystems are disrupted and habitats are destroyed, urban growth leads to an even greater reduction and distortion of biodiversity of proximal area (Skwirk, 2014).

While continents like Europe, North America and Australia have stabilized their urban population to a large extent, most countries in Africa, Asia and Latin America are experiencing rapid urban population growth and have not been able to deliver on their promises of alleviating the precarious state of the living environment of their citizens (United Nations Habitat, 2003).

In order to assess the sustainability of a population, scholars have used the ecological footprint (eco-footprint) model to determine the effect of human pressure on its surrounding environment. This is done by providing an approximation of the total amount of land required by a city, with the resources it needs to sustain its population. In addition to accounting for the food, water and other natural resources people consume, the footprint also includes the space required to dispose of all the waste they generate. A studies has shown that Australia had ecological footprint of 7.4 hectares per person (ha/p), USA 9.7 ha/p and Africa with 2.1 ha/p; the global ecological footprint is about 2.3 ha/p (Skwirk, 2014).

Accordingly, for the past few decades, towns and cities in Nigeria have been growing at a rapid rate in terms of population and areas, as a result of rural-urban migration (Sada and Oguntoyinbo, 1981). Studies by Thematic Committee (2001) revealed that, in 1950, less than 15% of the total populations of Nigeria were residing in urban cities. Between 1975 and 2000, it has jump to 23.4% and 43.5% respectively, and was estimated to have jump above 50% by 2010. Adesina (2005) observed that 400,000 hectares of vegetation cover is lost annually and this vegetation is being removed to give way to road construction, expansion of settlements, and high level of household dependent on fuel woods for domestic energy among others. The increasing rate of urban growth in these parts of the world is expected to increase the ecological footprint ratio for these regions in general and Nigeria in particular, which translates to the need for more land areas to accommodate the ever increasing population.

Urbanization and city growth are caused by factors such as rural-urban migration, natural population increase and annexation (Cohen, 2004; Brockerhoff, 2000). However, while urbanization is taking place, natural resource land such as forest, wetland and agricultural land are being replaced by land uses with more impervious surfaces (Farooq and Ahmed, 2008). Human use of land has altered the structured functioning of the ecosystem.

Presently human settlement are becoming large active land use changes especially in developing region of the world, the pattern and the land use gives an in-depth into the factors that necessitated the land cover to change (Oluseyi, 2006).

The quality of the environment is constantly losing its status in most countries of the world which Nigeria is not exempted (Marsh, 1999; Otu, Joseph and Eja, 2011). Global increase in urban growth has led to a greater increase in the demand for forest resources and this has resulted in more cases of over exploitation of the forest resources (Sheyin, 2008). However, studies have revealed that, more than 50% of Nigerian population is expected to reside in urban cities by the year 2015 (Daramola and Ibem, 2010). While this population is increasing in Nigeria, the resources to manage the cities are dwindling. This mismatch between rapid urban growth and the decline in resources is at the root of the pervasive urban decay in Nigeria, characterized by urban poverty, inadequate infrastructure, ill-managed urban environment and severe urban insecurity (Abumere, 2003). And one of the consequences of the dramatic increase in urban growth is an exceptionally high demand for forest land for different purposes such as residential, commercial, transportation, industries as well as over exploitation due to high demand for food, energy, fodder and illegal logging and non replacement of the natural vegetation (FAO, 2010a).

Until 1980s, a large number of Forest Reserves in Nigeria that remained relatively undisturbed have disappeared in the last few decades as a result, an exceptionally greater demand thereby threatening the forest cover especially if there is no proper management and planning. Forest contains about 805 of the world's biodiversity (plants, animals, birds and insects), they are important resource in the development of new medicine, improved plant varieties and countless other product and as this natural forest ecosystem depletes, likewise most of this biodiversity which are useful to man also disappeared (FAO, 2010a; Otu, Joseph and Eja, 2011) . According to FAO's Global Forest Resource Assessment (FRA, 2010) cited in FAO, (2010b), estimated that the global forest area currently covers about 4.033 billion hectares and it also report that between 2000 and 2010, the world has lost about 130 million hectares of its forest. SOFO 2011 cited in FAO, (2011c) report that global forests area will continue to decline. However about one half of the forest that covers the earth is gone. A positive sign is that, the estimated loss of forests area at global level decline from 16 million hectares per year between 2000 and 2010 that is each year 16 million hectares disappear. The World Resource Institute estimates that only about 22 percent of the world original forest cover remain intact-most of this, is in three large areas: the Canadian and Alaska boreal forest, the boreal forest of Russia, and the tropical forest of the Northwestern Amazon Basin and the Guyana shield.

Forests in Africa are extremely diverse. Deforestation and urban population growth have gradually increased together, with heaviest forest losses coming in the area where wood is needed for fuel, construction purposes or where forest land is needed for growing crops. The forest in Africa currently covers about 23 percent of the land; it was reported that 75 million hectares of forest land (10 percent of the total forest area) was converted into other land uses between 1990 and 2010 (Aroins, 1998; FAO, 2011c).

According to Cunningham and Cunningham (2004), an estimated 12.5 million km^2 of tropical land were covered with closed canopy forest a century ago and 9.2 million hectares or about 0.6 percent of the remaining tropical forest is cleared each year. This situation occurs as a result of over exploitation due to high demand for food, energy and fodder and also through illegal logging and non replacement of the natural vegetation; people have decided to use firewood as an alternative means of energy for domestic purpose. Another dimension is added by felling and burning of wood to produce charcoal and this is causing serious depletion of the forest resources (Okonkwo, Umar, and Nwafor; 2002).

In the loss of biodiversity according to World Fact Book (2005), Nigeria was identified as one of the countries with the highest rate of forest loss (3.3 percent) in the world. Since 1990, the country has lost 6.1 million hectares or 35.7 percent of its forest covers. It also recorded that Nigerian most biodiversity ecosystem is fast depleting at an unbelievable rate. For example between 1990 and 2005, Nigeria lost an average of 409,700 hectares of forest every year equal to an average deforestation rate of 2.38 percent. As of 2005, Nigeria has the highest rate of deforestation in the world according to Food Agriculture Organization of the United Nations (FAO, 2010b). The significant effect of loss of forest/vegetation is the exposure of bare surfaces to disaster such as erosion, pollution and consequently climatic change with an adverse effect on both physical and human environment (Sheyin, 2004).

However, the situation in Guga Forest Reserve, like any other forest globally, is of both economic and environmental consequences. However, due to rapid urban growth, coupled with poor monitoring strategy, this forest reserve is now threatened greatly which could be devastating if it is not properly managed. Human activities are recognized worldwide as the major cause of deforestation, with the agricultural and urban-industrial activity complex which is considered as important factors (Geist and Lambin, 2003; Vince and Iovanna, 2006). Hence the need to assess the effect of urban growth within the area especially as it affects the forest land.

1.2 STATEMENT OF THE RESEARCH PROBLEM

As cities grow and expand, it is expected that economic growth coupled with development will progress and act as a driver for social transformation and improvement of urban areas and their greater rural hinterland. Unfortunately, an experience in developing nations in which Nigeria is not exempted shows a disjoint between urbanization and the envisaged socio-economic transformation (Antrop, 2000; Cohen, 2005; Michael, 2009; Mathew, 2010; Ayedun, Durodola and Akinjare, 2011).

However, this global increase in urban growth has resulted to greater increase in the demand for forest land and forest resources (Ezebilo, 2004; Sheyin, 2008). There has been a serious and growing concern regarding the status and the use of natural forest. The rate at which forest is being destroyed has emerged significantly over the years more especially around the tropics where more than 2.5 billion people rely on the forest resources for a variety of services (Park, 1992; Ezebilo, 2004; Jaiyeoba and Essoka, 2006). Consequently, the conversion of forest land into urban land uses and agricultural land to sustain the growing population is becoming a serious issue of concern in recent time. Unfortunately, a large amount of such land has been lost unnecessarily and the forms of existing urban growth cannot help to sustain its further development (Ellis, 2007). Due to rapid urban growth, there have been increasing rate of conversion of forest and woodland in the developing economies all over the world, mainly for the slash-and burn farming practice (Groten, Immerzeel and Leeuwen, 1999*)*. However, such diversification of forest resource exploitation is usually accompanied by an increase in environmental degradation and other related problems. Thus while urbanization is the driving force for modernization, economic growth and development, there is yet an increasing concern about the effect of expanding cities, principally on human health, livelihood and environment (United Nation Habitat, 2003).

The relevance of forests to the environment and mankind cannot be overemphasized, as it is often times referred to as an important component of the ecosystem at all levels which provides a wide range of services and functions such as; regulating water supplies, buffering floods and droughts, mitigating the adverse effects of Green House Gases (GHG) emission and harboring biodiversity . Forests are estimated to store about 289 gigatonnes of carbon in the biomass alone; they therefore play a central role in the earth's carbon balance and hold significant potential to mitigate climate change (Aroins, 1998; Ezebilo, 2004; FAO, 2010b).

Despite the importance of forest resource, a critical look at Nigeria reveals that the rate of deforestation has not been different from the ugly global scenario. As Moramkinyo (1994) reported that about 60 percent of the forest loss in Nigeria was between 1950 and 1960. Also, forest clearance in the country is put at an average rate of about 350,000 to 400,000 hectares per annum while afforestation has only 32,000 hectares annually (Oyebo, 2006). In the loss of biodiversity according to World Fact Book (2005), Nigeria was identified as one of the countries with the highest rate of forest loss (3.3 percent) in the world. Since 1990, the country has lost 6.1 million hectares (35.7 percent) of its forest cover. It also recorded that Nigerian most biodiversity ecosystem is fast depleting at an unbelievable rate. For example between 1990 and 2005, Nigeria lost an average of 409,700 hectares of forest every year equal to an average deforestation rate of 2.38 percent. As of 2005, Nigeria has the highest rate of deforestation in the world according to Food Agriculture Organization of the United Nations (FAO, 2010b).

It is however worthy of note that efforts have been made by scholars to study the effect of human activities on forest resources both in Nigeria and beyond. For instance, Frimpong (2011) used Remote Sensing and GIS in the study of forest cover change in Owabi catchment, area of Kumasi, Ghana. The results of the analysis revealed that between 1986 and 2007, the forest cover has declined by 3368.16 hectares representing 38.9 percent. The major causes were identified to be the population growth, agriculture and sand mining, it was also noted that a greater proportion of the forest cover is been converted to farmlands and settlements as a result of population pressure.

Moreso, Akpu, Tanko and Yahaya (2012), studied the implication of urban growth on vegetation cover in Afaka Forest Reserve and the study revealed that built-up increased from 7.54 percent in 1990 to 39.10 percent in 2009 while natural/ plantation forest decreased from about 20.94 percent to about 11.6 percent within the same period. The natural forest/ plantation dropped at the rate of 2.23 percent per annum.

Tanko (2011) integrated Remote Sensing and GIS technique, in assessing the spatio-temporal change of vegetation cover in Afaka Forest Reserve. The results of the analysis revealed that the growing urbanization around the study area has been a leading factor in the loss of its natural vegetation. The results show that the built-up area increased from 2.1 % in 1973 to about 39.2 % in 2009 while both the forest plantation and the vegetated area which were about 41.6 % and 54 % respectively in 1973 reduced to about 14.1% and 32.7% in 2009.

Akingbogun,Kosoko and Aborisade (2012), applied GIS and Remote Sensing technique in studying the effect of urban growth on the Eleyele Forest Reserve in Ibadan. The results revealed that there was a significant decreased in the forest cover between 1984 and 2000 from 12.5 percent to 0.13 percent.

Also, Olarewaju (2008), study the rate of urban expansion and the loss of vegetation cover in Kaduna integrating remote sensing and GIS technique. The study revealed that the built-up area was expanding at about 167.86 hectares annually while vegetation cover was declining at a faster rate of about 297.5 hectares annually.

In addition, Nwadialor (2001) used Remote Sensing and GIS technique in monitoring the trend of depletion of natural forest in Afaka Forest Reserve, Kaduna State Nigeria. The results of the analysis revealed that natural forest has declined from its original state of 95.98% in 1962 to 61.96% in 1994. The result shows a significant depletion of the forest as consequences of growing urbanization.

A cursory observation on Guga Forest reveals that a section of the forest has been degraded through activities like fuel wood harvesting, timber logging, agricultural activities, animal grazing, bush burning and rapid urban growth. These changes if unchecked, in the long run are capable of creating serious environmental problems like soil erosion, sedimentation of river channels, loss of soil productive capacity, loss of biodiversity etc.

A careful examination of the previous studies reviewed herein, reveals that no effort has been made to study the effect of urban encroachment on Guga forest and it is against this backdrop that this research which is concerned with integrating Remote Sensing and GIS techniques in assessing the effect of urban encroachment on Guga forest reserve is being carried out.

This study will attempt to answer the following questions:

i. What are the various land use/land cover changes for the period 1986-2014?

ii. How has the forest cover of the study area changed within this period?

iii. What is the extent of urban growth in the study area within this period?

iv. To what extent is urban growth responsible for the change in forest cover within the study area?

1.3 AIM AND OBJECTIVES

The aim of this research is to assess the effect of urban growth on Guga forest reserve. The aim will be achieved through the following objectives which are to:

i. determine the land use/land cover change of the area between1986-2014.

ii. determine the spatial changes of the forest cover in the area within these periods.

iii. examine the rate of the forest change in the area over these periods.

iv. determine the extent of urban growth in the study area.

v. determine the extent to which urban growth has affected the forest cover in the study area.

1.4 SCOPE OF THE STUDY

The spatial scope of this study is limited to Shika districts in Giwa Local Government Area. These suburbs were considered because they are the two major urban areas. In terms of content, the study will look at the effect of urban growth on the forest cover, especially how the forest land is been converted into urban use in the area, while the temporal scope will cover the time periods of 28 years, that is from 1986 to 2014.

1.5 JUSTIFICATION OF THE STUDY

A research of this nature is significant because it will provide a large volume of data which could be used for forest development, planning and management in Nigeria, Kaduna State and the study area in particular. This study will also add to the wealth of knowledge as regarding the use of remote sensing and GIS techniques in assessing the effect of several projects within and outside Kaduna State as the techniques is capable of assessing large area coverage within a short period of time with high level of accuracy and reliability of its result. This will also help policy makers in taking prompt decision as regarding such project within good time and to formulate and exercise efficient forest management policies and practices.

CHAPTER TWO

CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

2.1 INTRODUCTION

This chapter is divided into three sections, with the first part reviewing literature o the concept of urban, urban growth, forest reserve, importance of forest resource, forest loss. The second section of this chapter focuses on the theories of urban growth models, while the third section deals with the review of previous studies on the Application of Remote sensing and GIS in forest studies as well urban studies.

2.2 CONCEPTUAL FRAMEWORK

2.2.1 Urban Center

Urban places include areas within or near a city considered to share broad characteristics such as population concentration; shared and distinct employment pattern, lifestyle and land use; as well as the existence of different institutions that coordinate the use of public facilities (Hartshorn, 1991).

There is no standard approach for characterizing an area as either urban or rural, as this is closely bound up with historical, political, cultural, and administrative considerations. However four principal methods are employed to identify urban places, viz; base on population size, economic activities, function criteria and administrative criteria (David, 2003; Micheal, 2009).

The urban population threshold varies over time and space, population size presume that urban areas are generally larger than rural areas, as such it is possible to distinguish rural from urban areas based on their population size. Economic base emphasizes the importance of certain economic diagnostic criteria, particularly employment in the non agricultural sector in differentiating urban from rural settlement. Administrative criteria stresses the prerogative decision of legal and administrative entities in characterizing place urban while functional criteria look at the differences in functional characteristics of urban area from rural. For instance in Sweden and Iceland, places with as few as 200 inhabitants are considered urban; in USA the lowest limit is 2500 inhabitants while in Malaysia and Switzerland, is as high as 10,000 people. In other countries, population size is been combine with other diagnostic criteria in characterizing an urban center. For examples, Israel, Botswana, and Zambia, use population size and employment in non-agricultural occupation; Canada, France, use population size and density criteria; India considered size, density, legal and morphological characteristics (David, 2003; Micheal, 2009).

Thus, urban areas can be seen as rapidly growing and densely populated areas often identified on legal administrative or governmental basis (Pamela and Yongmei, 2010; David, 2003).

2.2.2 Concept of Urban Growth

The concept of urban growth could be absolute or relative increase in number of people who live in towns and cities which can result to functional or structural changes. The urban population growth can be as a result of natural increase and net migration or reclassification of rural settlement into town and cities (Skwirk, 2014). Cheng and Messer (2002) defined urban growth as a system resulting from complex dynamic interaction between the spatial, Interaction between these three system resulted in urban growth, the spatial/ conceptual system provides planning control requirement for urban growth while socio-economic and physical/ecological system contribute activities/ stimulant factors for development respectively.

Whenever there is physical growth in an area, it means that something has changed to give way to others. When a town expands, green areas and farmlands would have to give way for new buildings and other land use types. Urban growth also refers to increase in a town's population, which by implication, means there will be internal changes in the town, which their different affects the environment and the available social infrastructure (Kenk and Cotic, 1983).

Urban growth has become a common phenomenon around almost all Chinese big cities despite the government policies and effort to either control or maximize it (ADB, 2006). All of these expansion and growth have mainly come at the cost of agricultural lands. Millions of farm households have been either evicted or resettled and forest surrounding urban areas has been converted to urban uses such as residential, commercial, industrial, public open spaces and infrastructure.

Measurement of urban growth rests on the definition of 'urban', which is not standard throughout the world and differ even within the same country depending upon the nature of local jurisdiction and how they might have change over time (Charles, 1989; David, 2003; Emmanuel, Duncan and Owem, 2006). The study of urban growth has proceeded in a number of different strands. One strand has emphasized historical aspects of urbanization. Massive population movements from rural to urban areas have fuelled urban growth throughout the world (Emmanuel, Duncan, and Owem, 2006).

The concentration of population and economic activity in urban areas may increase either because agents migrate from rural to urban areas (urbanization) or because economies grows in terms of both population and output, which results in urban as well as rural growth. Urban centers may not be sustained unless agricultural productivity has increased sufficiently to allow people to move away from the land and devote themselves to non-food producing activities (Hartshorn, 1992; David, 2003). The process of rapid urban growth is closely related to the size distribution of cities (Daura, Ibrahim and Abba, 2006).

Several factors are responsible for urban growth. Increasing urban employment opportunities is one of the factors. Rural- urban migration coupled with natural increase in population caused by improved living standard, are major causes of rapid growth of cities and towns. Rural poverty, search for better living standards, environmental degradation (deforestation and desertification), inadequate and lack of basic amenities and services among other factors are pushing rural inhabitants out of the rural areas (Malanima, 2000).

Adindu and Ogbonna (1998) are of the view that urban growth is caused by rural unemployment, increased rural poverty, deteriorating living condition, declining soil fertility and unchecked rural migration. According to them, all these are responsible for people's movement out of rural land to urban center. Infrastructural development such as water, electricity, health, education, increases urban growth. Oyesiku (1995) remarked that growth depends on the natural increase on the part of the total population that is already in urban but it is affected more by the differences in the natural level between rural and urban areas. People respond to urban socio-economic opportunities by undertaking rural-urban and urban-urban migration. According to Adedibu, Opeloyeru and Ibrahim (1998), there are two major forces shaping the pattern of development of any city in the world. One is centrifugal in nature while the other is centripetal force. Factors that constitute the later force dominate the development of most of the cities in developing countries while centrifugal force is often associated with cities in developed countries. Salami (1997) also remarked that factors responsible for growth in Nigeria include urbanization, associated population increase, nature of urban uses, landscape configuration and location of development schemes, government policy and pattern of route development. Route development serve as a major force in reorganizing land use. Nkabwe (1984) opined that the pivot for economic growth and population expansion are the overall indicators of progress for any region.

Although urban growth has both positive and negative implications. The negative are more highlighted especially in the developing countries where rapid urban growth is often uncontrolled or uncoordinated. Higher economic production, better opportunities for unemployed or underemployed, opportunities for better basic and specialist services among others are some of the possible positive implications of urban growth. However, in many cases especially in the developing countries like Nigeria is not an exception, urban growth results in development of higher density settlement; highly polluted due to inadequate urban services such as electricity, paved roads, sewers, running water among others (Bhatta, 2010**)**

However the contemporary phenomenon of rapid growth of urban centers globally is responsible for many environmental and social changes in the urban environment today and its effects are strongly related to global change issues (Amjed *et al,* 2000; Bhatta, 2010)

2.2.3 Forest Reserves

Forest Reserves are areas designated by the government for the protection of timber and other forest resources. Harvesting of timber may be allowed under permit and under special concession to people in the surrounding community. Harvested timbers are mostly replaced with exotic trees species. Most of these Forest Reserves are also poorly managed by the various state ministries of Agriculture and natural resources (Usman and Adefalu, 2010).

The first Forest Reserve in Nigeria is the Olokemeji reserve established near Ibadan around 1900 (Onokerhoraye, 1985).This was followed by the establishments of other Forest Reserve in various parts of what forms the present day Nigeria. In these reserve, lumbering activities where made illegal. By 1908, a Forest Ordinance promulgated by the colonial government gave protection to all commercial timber outside the reserves.

In 1917, the first definitive government policy on forestry came into existence. In that year, the then governor, Lord Lugard, stated that each province of the country must reserve a minimum of 25% of its forests. This policy statement later faced lots of opposition in the eastern part of the country. This was because of the high population density and the resultant higher pressure on land (Egboh, 1979).

At the time of independence in 1960, many Forest Reserves were already in place in the country. Many of these Forest Reserves were to later become Game Reserves. For instance, the Yankari Game Reserve which was opened in 1962 was a forest reserve for some time (Onokerhoraye, 1985). From about 800 Forest Reserves and about 30 Game Reserves in the 1980s, the number of the forest reserves in the country has now increased to 966. There are also eight National Parks, twelve strict Nature Reserves and 28 Game Reserves in the country today (Areola, 1982; Federal Government of Nigeria, 2001).

The indiscriminate felling of trees has continued in virtually every part of the country. For instance, the Federal Department of Forestry (2001) estimated that Nigerian forests are being depleted at an annual rate of 3.5%. Nigeria used to have about 20% of its area covered by natural forests but these have been reduced to about 10%. It lost about 60% of its natural forests to agricultural encroachments, excessive logging and urbanization between the 1960s and the year 2000 (FAO, 2001). In some areas natural forest has been totally replaced with monocultures of exotic trees. Indiscriminate felling of trees has continued in both the high forest and savannah areas which have resulted to serious reduction in timber resources.

There is the fear that what is left of the forests and the wildlife may be completely lost within the next few years if care is not taken. The rate of afforestation continues to be far slower than the rate of exploitation.

2.2.3.1 Importance of Forest Resource

The relevance of forests to the environment and mankind cannot be emphasized, as it is often times referred to as an important component of the ecosystem at all levels which provide a wide range of services and functions such as; regulating water supplies, buffering floods and droughts, mitigating the adverse effects of Green House Gases (GHG) emission and harboring biodiversity. Forests are estimated to store about 289 gigatonnes of carbon in the biomass alone; they therefore play a central role in the earth's carbon balance and hold significant potentials to mitigate climate change (FAO, 2010). Because forests contain more than 80 percent of the world terrestrial biodiversity (plants, birds, animals and insects), they are important resources, with improved plant varieties and countless other product.

An increased emphasis on forest, forestry and forest product is therefore not just simply for meeting the world's increasing demand for timber and fiber, but also for providing ecosystem services and sustaining livelihoods. Forests are unique because they are potentially sustainable sources of resource development (World Bank, 2006).However, more than 2million people depend on wood energy as a critical source for cooking, heating and food preservation (FAO, 2010).

2.2.3.2 Deforestation (Forest Loss)

Forest is the gift of nature that helps in many ways, to improve and sustain a good environmental quality, however, many families of forest plants and animals are now threatened with extinction, principally through habitat destruction due to deforestation (Ayara, 2000). Deforestation is the removal of forest trees and other forms of vegetation cover without replacement. It is synonymous with destruction of wild life habitats and drastically reduces animal population, their productivity and species diversity while species are being threatened by extinction. It implies the lost of the protection which the plant cover gives to the environment which is largely responsible for accelerated desertification, biodiversity loses, soil erosion and the development of extensive gullies in various parts of Nigeria (NEST, 1991).

Forest loss therefore, causes significant ecological and economic loses with major adverse impact on environmental quality, human health and sustainable economic development in

Nigeria. However, there is a dearth of information on why people continue to destroy forest for instance the need for animal protein and income generation increase pressure on hunting on most extinct species of animals and the need for fuel wood for cooking, and income places high demand on indiscriminate cutting down of forest trees (Jaiyeoba and Essoka, 2006; NEST, 1991; FAO, 2011; Ayara, 2000). Forest loss in Nigeria is becoming an issue of great concern with loss occurring at the rate of 3.3 percent per year (FAO, 2011).

Major land use activities that are associated to forest loss (deforestation) include bush burning, agricultural/grazing, construction works among others. Onadeko and Mduna (1986) observed that important human activities that often leads to deforestation and accompanying impact include wide spread fire, clear felling, lopping and logging, agricultural activities, mining, grazing and development of communal facilities. Okonkwo, Umar and Nwafor (2002), asserted that serious anthropogenic activities has great impact on the environment. Their study reveal that, impact of some project on the vegetation of the ecosystems in Nigeria such as establishment of modern market, amusement parks, company site, house estates, television station etc, has led to the removal and destruction of many economic vegetation and the use of some of these trees are yet to be realized**.**

2.3 URBAN GROWTH MODELS

2.3.1 Concentric Zone Models

Based on the observation and interpretation of the land use structure of the industrial city of Chicago, Burgess in the 1930's proposed an ideal type of urban growth. According to him, cities constantly grow because of population pressures, which in turn trigger dual process of central agglomeration and commercial de-centralization; thus, as they grow spatially, patterns of land use would reflect the successive phases of invasion and occupation. The resulting pattern will be one of a centralized business core surrounded by four principal zones in an annular fashion as: a zone in transition where newly arrived migrants would seek lodging, a zone of working – class housing, a settled residential zone, and a ring of commuter suburbs (Phil, 2006; Gottdiener and Leslie, 2005; Micheal, 2009). However, the city of Chicago as at the time of Burgess's observation was a new city, and had grown rapidly due majorly to industrialization, which might not be the order in other cities, and thus would not have explained growth of other cities then, and the growth of some urban place like the Giwa Local Government Area of Kaduna State which thought result from population pressure, but develop majorly in a linear pattern along a major transportation route (Tim, 2006).

2.3.2 Sector Model

Like the concentric zone model, sector model was developed in America, by an economist Homer Hoyt, based on his study and analysis of the structure of more than 140 American cities, he suggested that cities grow outward from the central business district (CBD) in wedge – shape which can be characterized better by sectors, following prominent roadways as a result of intense competition for lands and real estate along transport corridors (Gerald, 2004; Phil, 2006; Michael, 2009).

Homer Hoyt however contradicted Burgess's idea that cities growth were carved up by concentric zones, and postulates that cities grow by unevenly shaped sectors within which different economic activities tend to congregate as a result of competition for locations within a capitalist market in real estate, that translated the functional needs of business into land prices; and that manufacturing and retailing had the tendency to spin off and away from the center and agglomerate in sectors that expanded outward, while leaving other economic activities behind in a more functionally specialized CBD (Gottdiener and Leslie, 2005).

The sector theory explains the role transportation plays in linking separate settlements together to form a functional urban area. Shika function road links several settlements together like Zaria, Funtua, Gusau, Katsina, Zamfara, Sokoto among others and urban growth is more intense along the major road

2.3.3 Multiple Nuclei Model

In 1945, Harris and Ullman suggested that large cities grow around a number of focal points especially in cities that were rapidly expanding in area. Based on the tenets that: nucleus may develop around specialized facilities such as transportation hubs or shopping centers, with little or no stimulus from the CBD, the nuclei are growth points in and of themselves; the clustering of industries for complimentarily could also produce nucleus that can attracts necessary supporting firms and services; some functions tend to repel one another in terms of location, like a concentration of heavy industry which might not likely locate next to high-cost residential housing or a municipal theme park; and some functions avoid areas with high rent costs, like used car lots, for instance, are not likely to be found near the nuclei centers, which land costs higher, nor will they be located next to a new shopping mall (Gerald, 2004), "Harris and Ullman augured that the spin offs of activities from the CBD would take the shape of separate centers rather than sectors radiating from central core" (Gottidiener and Leslie, 2005. 84).

Therefore multiple nuclei model is the one that best describes the urban growth process in Giwa because the area grows from different and independent rather than one CBD. Although areas of these suburbs grew up independently of each having its peculiar land patterns, they have become linked together by roads to form functional urban areas.

2.4 REVIEW OF LITERATURE

Deforestation has become a worldwide challenge of the 21stcentury because forests are considered as home or environment that houses important species of both plant and animal (Wayne, 1999; Oyebo, 2006).

Studies carried out by many researchers have stressed the significance of integrating Remote Sensing and GIS in urban studies (Jensen, 2005). However, for a great development to occur in a certain area, it is very important to have adequate information about the past and present land use pattern. Records on land and its uses are not sufficiently enough in Nigeria (Ndabula, 2006). Thus, justifiable attentions have been paid to urban growth assessment by researchers, though with relative changes in dimension, and more or less improvement in methodology and sources.

2.4.1 Application of Remote Sensing and GIS in Forest Studies

Ati, Abbas, Sheyin and Mohammed (2010) used Remote Sensing and GIS in assessing changes in Kagoro Forest in Southern part of Kaduna State. The results of the analysis revealed, that settlement and cultivated area increased between 1987 and 2005 by 72% and 17.77% respectively while undisturbed forest decreased by 24.06% within these same period. The results show a significant depletion of the forest as a consequence of human activities particularly cultivation for agricultural purposes.

Acharjee, Goswami, and Saikia, (2013) analyzed forest cover change in Jorhat Golaghat District of Assam using Remote sensing and GIS. They carried out a comparative study using toposheets of 1974 and IRS 1D LISS-3 bands 2, 3 and 4, imagery of 2005. The reserve forest areas were mapped from the satellite imagery using the visual interpretation techniques. The imagery was visually interpreted using six basic photo elements viz. tone, texture, shape, size, pattern and association together with numerous ground truth observations. With these assemblages of photo elements showed against each terrain unit, boundaries of distinct reserve forest were demarcated. The results showed substantial decrease in the Reserve Forest Area. Dayang Reserve forest is totally vanished by encroachment, same was the condition of Nambar, Holongapar and Disai Valley Reserve Forest where the crown coverage is less than 40 percent of the total Reserve Forest Area. The analysis reveals that the total reserves forest area decreased tremendously from 458.8sq km in 1974 to 176.68 sq km in 2005.

Daniel and Ayobami (2007) assessed changes in land use land cover in some part of south-western Nigeria over 16 years. Satellite imageries of 1986 and 2002 were used. The result showed that the disturbed/degraded forest constitute the most extensive type of land use land cover in the study area. The increasing population and economic activities were noted to be putting pressure on the available land resources. It was also discovered that 98.3% and 63.7% of the area covered with high forest in Ikeji forest reserve and Akure forest reserve respectively were converted to shrub lands / farm lands over the period of 16 years.

Jibril (2009) assessed changes in vegetation cover in Kpashimi forest reserve in Niger state Nigeria. Landsat TM, ETM plus, SPOT and Nigeria- Sat 1 of 1987, 1994, 2004 and 2007 were used. The images were classified using Maximum Likelihood classification algorithm by the extraction of Normalized Differential Vegetation Index based on supervised classification. Post classification method was applied. Arc GIS 9.2 and Erdas Imagine 8.3 image processing software were used in calculation the landscape indices and the quantification of landscape transformation processes. The spatial pattern change revealed that the landscape structure of the forest reserve has change tremendously due to shrinking in the proportion of the savannah woodland and Riparian forest.

Forkuo and Frimpong (2012) mapped and analyzed the structural changes of Owabi forest reserve in Ghana. Landsat and ASTER imageries of the study area were used. A supervised classification was performed on the three multi-temporal satellite imageries and a total of eight major land use and land cover (LULC) classes were identified and mapped. The 1986, 2000 and 2007 satellite images were reclassified based on the NDVI threshold values and the results were presented. It was observed that vegetation experienced a remarkable decreased of 3368.16 ha representing 38.9% from the period 1986-2007.

Sanchez-Azofeifa (1998) focused on fragmentation and deforestation inside and outside protected areas in Serapiqui region of Costa Rica using Remote Sensing and GIS techniques. Landsat of 1976, 1986, 1991 and1996 were used. The satellite imageries were overlaid with land status information on National parks and private conservation areas. The results revealed that, the deforestation and fragmentation rate within the national parks remained below 0.56% over the 20 years of study period. The result also revealed that deforestation decreased from 1.7% to 1.4% over the study periods in private conservation land while outside protected areas, deforestation rate was 3.6% and 3.2% and the number of fragments increased from 537 hectares to1, 231hectares in 1996.

2.4.2 Application of Remote Sensing and GIS in Urban Studies

Ade and Afolabi (2012) researched on Monitoring urban sprawl in the Federal Capital Territory. The research was to set out to measure the changes in land use land cover and population increase in the area. Multi-date satellite imageries of 1987, 1999, and 2007(Land sat, TM, ETM and Nigeriasat-1) were acquired for the study. Using supervised classification algorithm, the image were classified into four classes and used to carry out series of analysis. Coordinates of the area were obtained using GPS and figures from National population Commission were also used. Change analysis was carried out on the imageries to obtain the physical expansion of the area and the result revealed that built-up area increased from 8% in 1987 to 22% in 2007 while vegetation decreased from 40% to 17% within these same periods. Imageries were also categories using modular maximum likelihood classification techniques (MLC). The Markov Chain and Cellular Automata Analysis were used for predicting the change. The projection was done for the Population in the next 19 years and1, 925,464.089 figures which is about 37% was expected. A growth rate of 3.2% per annum was obtained from the 2006 census.

Adediji and Ajibade (2008) researched on change detection work of major dams in Osun state using remote sensing and GIS techniques. The Authors focused on the change dynamics of the major dams which are; Ede Erinle and Eko- Eden dam. Landsat TM (1986) and landsat ETM plus (2002). The processed classified and interpreted the images using ILWIS 3.3 software, The result shows that there was a sharp decline in the surface area of the dams from 45.42%, in 1986 to 37.49% in 2002.The result also revealed that despite the wide application of geo-informatics techniques in the study of urbanization in many part of the world; its use for urban studies in Nigeria is still very low in Nigeria.

Albert, Edmund and Yaw (2006) focused on the implication of rapid expansion in metropolitan Lagos for Land Administration using GIS and Remote Sensing Techniques. Satellite imageries for 1984 and 2000 were used. The Landsat imageries were classified into four categorized .The results of analysis revealed that the land under water declined from its initial estimate of 29,040 Hectares in 1984 to 24,708 Hectares in 2000, this represent an overall decreased of 14.91% while the size of the area covered by vegetation (coastal mangrove, forest and grassland area) also experienced the sign of decline from 180,384 Hectares in 1984 to 140, 568 Hectares in 2000.Agricultural land increased from 9,806 Hectares to 112.48% while settlement showed a change of 159.02% in that same periods. The result also revealed that built-up land was increasing at the rate of 5.8% annually

Balogun, Debo, Ahmed & Tobi (2011) analyzed urban expansion and land use changes in Akure, Nigeria using Remote Sensing and Geographic Information System techniques. Landsat for 1986, 2002 and 2007 (21-year time span) were used .The satellite imageries were classified using the Maximum likelihood classification approach. The results showed substantial change in land use and land cover of Akure. The results indicated a rapid increase in built up and arable land but terrible depletion of the dense forest. It was also observed that future changes by the year 2020 may likely follow the trend observed between 1986 and 2007 as the projection results indicated that built-up and arable land will increase rapidly and the dense forest would have been drastically reduced by the year 2020.

Odeh (2014) studied the impact of urban growth on agricultural lands in Zaria and its environs, using Remote Sensing and GIS techniques. Landsat MSS, TM, ETM plus and Nigeria- sat 1 of 1973, 1990, 1999, 2009 and field survey were used. The land use/land cover maps were classified into eight categories of classes using supervised classification techniques. The results of the study revealed that the land use land cover of the area has changed significantly over the study periods (1973-2009). The analysis revealed that built-up land increased from 11.52 km^2 to 37.13km^2 while natural forest/ plantation decreased from14.06km^2 to 8.64 km^2 within these same periods.

Olorunfemi (1983) use panchromatic aerial photograph to monitored expansion of housing land-use in Ilorin. Photographic element such as texture, pattern, color tone and association, supported with extensive field survey for field verification were the basis for photo interpretation to obtained a standard manual interpretation of the remotely sensed data (panchromatic aerial photographs) with the aids of pocket mirror stereoscope to produce stereo pairs from which interpreted pattern were delineated on acetate overlays on the photo mosaic to produce maps. According to the author, the research was tedious, slow and with large inherent errors, as it lack synoptic and temporal advantages of satellite data, and the flexibility of manipulating various themes as in GIS techniques. According to this same author, Olorunfemi (1987) focused on Identifying and measuring the aerial extents of settlements in Oyo-Ogbomosho–Ilorin Area. The author in this case appreciated the advantages of satellite images over aerial photographs. Landsat MSS of 1972 and topographic map on 1:50,000 and 1:100,000 were used. Thus a total of 95 pixels were selected as training areas. The spectral signatures of these areas were store to make it possible for the whole scene to be classified based on spectral responses observed in the training areas. Relative to previous aerial photographic approach, the use of satellite imagery and GIS techniques of image interpretation, reduced the extensive field survey sampled to pixels; image visualization and interpretation was simplified by image enhancement and the use of spectral signatures determine by statistical values inherent in the image, as against the use of mirror stereoscope and photographic element; and the extraction of information themes was rationalized by on-screen digitizing as against analogue tracing transparencies.

Oluleye (2010) studied urban growth dynamic using Geoinformation techniques in Zaria. Satellite images of four epochs such as Land Multispectral Spectrometer (MSS), Landsat Thematic Mapper (TM) image of 1990, Landsat Enhanced Thematic Mapper (ETM) of 1999 and Nigeria Sat-1 image of 2007 were used. The researcher also involved the use of reconnaissance survey and field work using GPS to complement the data extracted from these images. The results revealed that the spatial growth truly occur in Zaria between this periods.

Zubair (2006) researched on change detection in land use /land cover of Ilorin, Kwara state using Remote Sensing and GIS. Land sat images of Kwara state for three epochs such as 1972, 1986 and 2001, Land use/land cover vegetation maps as well as administrative maps of State was used. The result revealed that between the period of 1986 and 2001, there was a reduction in the expansion of Ilorin compared to the period between 1972 and 1986.The researched revealed that Ilorin the capital witnessed a remarkable expansion or growth and developmental activities; which has resulted increased in land consumption, modification and alteration in the statutes of the land use/land cover over time without a detailed and comprehensive attempt to detect the land consumption rate. The results also revealed that between1972-2001 the city has expanded at the rate of 27.62% per annum. The researched concluded that there is likely going to be crowdness brought by compactness in Ilorin comes 2015.

CHAPTER THREE

THE STUDY AREA AND METHODOLOGY

3.1 INTRODUCTION

This chapter describes the geographic variables of the study area and the methodology adopted for the study. The procedure adopted in this research work forms the basis for deriving statistics of the land use dynamics and subsequently in the attainment of the objectives.

3.2.1 Location

Historical Development: The history of Shika can be traced to the historic development of makayo village. The emergence of shika no dout, came in as a result of the expansion and growth of makayo village which was as far back as 1907. This expansion was mainly due to the establishment of some Institutions and Industries such as, the National Animal Research Institute (NAPRI),Ahmadu Bello University Teaching Hospital (ABUTH), Champion Soap Factory, Shika Ranch, Shika Grains Processing Center among others. The relocation of ABUTH to its present permanent site in the year 2005 saw a rapid development of Shika and its environs. Shika no doubt, came into being due to the influx of workers from various areas to the institution (ABUTH). Thus, most of the workers coming from afar settled at Shika town. Hence, the need for accommodation was inevitable. Therefore, this experience brought about rapid increase in human population (Agam, 2014).

Guga Forest Reserve is situated 12.9 kilometer (8 miles) west of Samaru along Zaria Funtua road in Giwa Local Government Area of Kaduna State, with an aerial extent of 4634 hectares. It is located on the plain of the northern part of Kaduna State. The forest reserve lies between Latitudes 11^{o} 10’00” N and 11^{o}16’14” N of the equator and Longitudes 7^{o} 30’ 34” E and 7^{o}37’ 06” E of the Greenwich meridian. It has a total land area of about 2,066 square kilometers. It is bounded to the north by Funtua, east by Sabon gari, Zaria and Kudan, in the south; it is bounded by Igabi local government area as shown in Fig. 3.1 and 3.2.

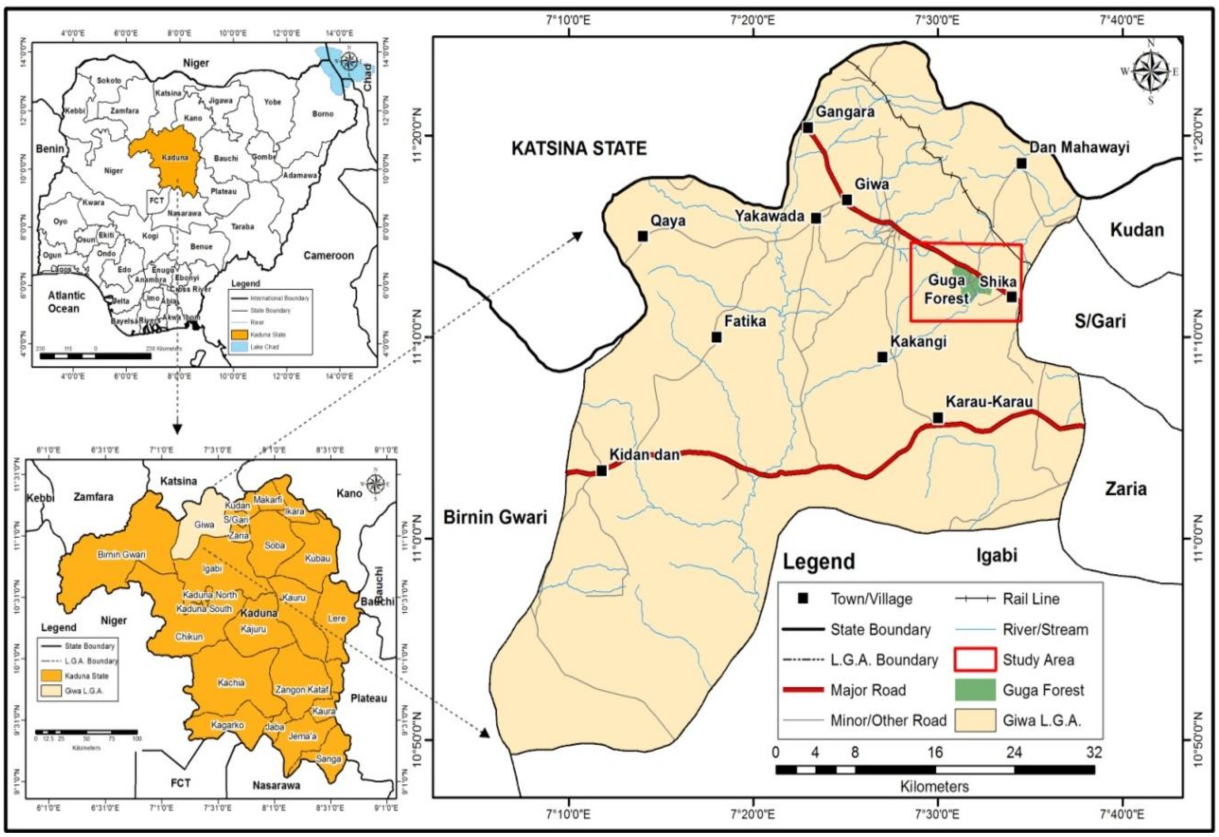

Figure 3.1: Giwa Local Government Area.

Source: Modified from the Administrative map of Kaduna State

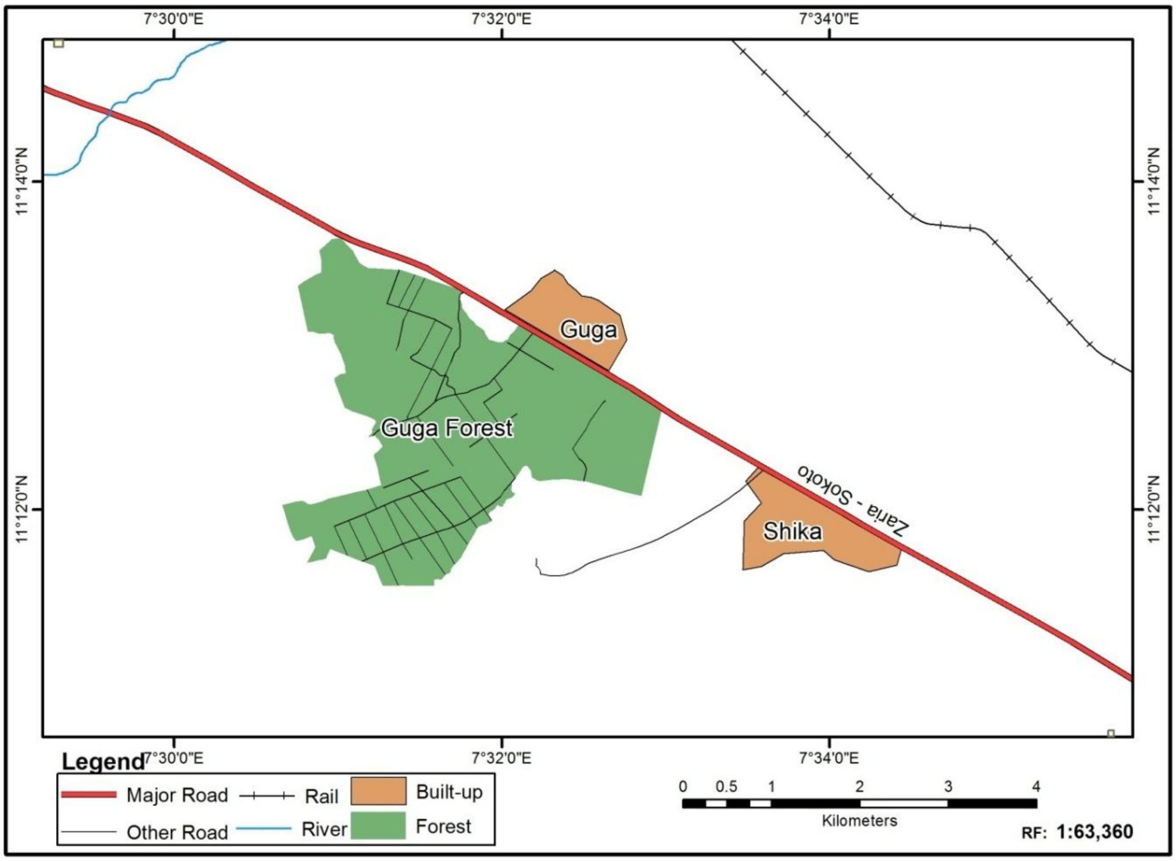

Figure 3.2: Study Area

Source: Modified from Administrative Map of Giwa LGA.

3.2.2 Climate

The Forest Reserve lies within the tropical continental climate (AN) based on Thornthwaits climatic classification. It is characterized by a clearly marked dry season and hot season (Nov. - April) and wet double maxima rainfall in May to October. The mean annual rainfall is about 1000mm.The dry season is particularly rainless. This low and seasonal character of rainfall makes vegetation of the area to assume various shades of green in the wet season and turns brown, pale or yellow in the dry season (Bello, 1993).

According to thornthwaits moisture index, the climate of the study area is dry sub-humid and is invaded by the two different air masses- one from the north is dry and continental in origin (the Sahara air mass) and the other from the Atlantic in the south which is moist cool and equatorial moist in nature. The weather depends to a large extent on the air masses from a discontinuity zone between the Moist Equatorial air (ME) of mostly southern atmospheric origin and dry Tropical Continental air (CTS) of the northern hemisphere origin (Mortimore, 1970).

3.2.3 Vegetation

The Guga Forest Reserve lies within the northern Guinea Savanna ecological zone, a designation which implies a woodland vegetation type characterized by the presence of *Isoberlinia doka*, *Isoberlinia tomentosa* with also a well-developed grass layer of tufted *Androgeneae* (Keay, 1957). *Isoberlina* is a tree which if left undisturbed forms moderately tall (20m) close woodland on the interfluves with a grass cover which does not impedes the observer from seeing through the woodland. Many other species and shrubs exist, some of which are limited to specialized habitants and others which becomes conspicuous under environmental conditions (Clayton, 1957; Bello, 1993). Also typical of this savanna woodland are the group of plants which generally flower before the onset of the rain and whose tops die back annually and are burned off during fire. These are cryptophytes, which include the buttons and rhizonation plants are the very typical sub-shrubs (Keay, 1957)

Many savanna trees can exist for years and will develop into trees when condition is suitable.The grass are tufted and of low ground cover and include many *Andropogeneas* such as *hyprrheria,schizchyrium*-semi herb and *monocymbiums cevesiforme*. Under a large part of Zaria plains is a layer of indurated laterite, this layer appears at the surface following erosion of the top soil, in the profile of the gullies as capping to small hills and a miniature escarpments. Several plants are associated where occurs. The *Anogerssus leiocarpus* is locally very frequent as marginal woodland to fringing forest.

3.2.4 Soil

The Shika soil reflects the geology, climate and vegetation of the area. It is part of the Zaria soil group with covering material consisting of several meters of decomposed rocks. The soil of this groups are normally heavily work; drainage being very poor on the account of high percentage of fine materials in upper layers. It becomes waterlogged with rain and also cracks during the dry season. Alluvial soils occur especially along the rivers and streams. The forest reserve lies on plain land ranging in height from 550m -750m above sea level. This plain is being drained by river kubani with its numerous tributaries. This river becomes heavily flooded during the wet season and dries up during the dry season. Alluvial soils which occur along this river are used for dry season farming (Keay, 1957).

3.2.5 Relief

Relief of Guga Forest Reserve lies within the north central highlands which are composed of granite rocks. This area is dissected portion of the Zaria-Kano plains; extensive peneplains developed on crystalline metamorphic rocks of the Nigerian Basement Complex. The plains vary in height thus reflecting both regional scope to the south and a local relief of 100-150m.The angle, whilst attaining comparatively steep values over restricted areas are generally low between 0.5 to 4 .0 degrees. The plains are a vast gentle undulating land with scenery which extends almost unbroken from Sokoto to Lake Chad and beyond, and also from Kaduna to the tigneddi scap (Foin, 2002).

3.2.6 Geology

The geology of the Guga Forest Reserve is an extensive older laterites cover of possible Pliocene age now preserved as low plateau remnant mainly on interfluves in the western half of the area. Dissection of these older part peneplain laterites and formation of the younger laterites and older alluvium are result of the pleistocene erosion cycle. Present day erosion is cutting through deposit of the earlier cycles and steep sided gullies are wide spread (Keay, 1957). Generally metamorphic rocks of the Nigeria basement complex are end product of at least two orogenic cycles (Mortimore, 1970). The later is massive of very old rock, belonging to the Precambrian. The surface of this underlying block of the older rocks is covered by the later formations of materials, including sediments deposited by wind, Aeolian deposits. Harmattan winds blowing over the Sahara may have carried these material enroute the later deposited them in this part of Nigeria (Mortimore, 1970).

3.2.7 Population Structure and Distribution

The result of 2006 census put the population of Giwa of Local Government Area at 286,427 in which the population size of male is 144,218 and that of female is 142,209 (NPC, 2009). Although the local government area is more of a rural setting, there are two major urban area i.e Giwa and Shika which together account for more than 30 percent of the total population. The important feature of the population is the 1:1 ratio of male to female, which is a positive trend in terms of socio- economic development plans (Foin, 2002). The 2006 census put the population of Shika at 40377 with a growth rate of 3.2% per annum. The ethnic composition of the area includes the Hausas and Fulani's who are predominantly Muslims.

3.2.8 Economic Activities

The major source of livelihood in this area is agriculture; about 50 percent of the populations are farmers while about 40 percent regard farming as a secondary activity for supplementing income (Abubakar, 2012). Their major crop is maize, rice, soya beans and groundnut which also serves as their main food crops. The bulk of the agricultural production in the area is carried out by the peasant farmers of which women participation is minimal. Because farming is an activity closely related to rainfall, farmers usually shift to other occupation particularly during dry season. These include trading and services which are mostly important in the area. However, during the dry season, some people in the area involve in dry season farming because there are floodplains in the area popularly known as fadama lands. These floodplains are characterized by availability and accessibility to both open surface and underground water which are favorable for irrigation farming (Foin, 2002).

3.2.9 Infrastructural Facilities

These facilities have a remarkable impact on the pattern of life and development of the area. Apart from the vital role they play in the economic life of the rural population, the also play a significant role in the maximization of social wellbeing of the people (Abubakar, 2012). For instance, transport facilities not only enhance the process of economic growth but making product and market function more effective, they also increase social wellbeing of the people by facilitating movement to places where other essential social services such as health, education etc. are available.

Furthermore, there are few tarred roads in other part of the area with a concentration in Shika and Giwa which are the major urban centers. The provision of basic services like telecommunication masts, electricity, pipe-born water, markets, health care facilities etc are found in these major urban areas (Abubakar, 2012).The two major urban centers which are the largest in terms of population has the largest number of both primary and secondary schools, police stations, it also has research institute known as NAPRI(National Animal Production Research Institute), Ahmadu Bello University Teaching Hospital (ABUTH), Zabawa General Hospital and primary health care's centers among other.

3.3 METHODOLOGY

3.3.1 Reconnaissance Survey

A reconnaissance survey was carried out in the area so as to enable the researcher get familiar with the state and nature of the forest/vegetation cover in the study area.

3.3.2 Types of Data

In order to achieve the aim and objectives of this study, the types of data used for the study were satellite imageries, Administrative map, and topographic map of the study area at a scale of 1:50,000.

3.3.3 Sources of Data

The primary data used for the research are mainly satellite images acquired from National Centre for Remote Sensing in Jos and these include the following:

i. Landsat Multispectral Scanner (MSS) of 7th December, 1986 with a spatial resolution of 79meters.

ii. Landsat Thematic Mapper (TM) of 27th November, 1990 with a spatial resolution of 30meters.

iii. Landsat Enhanced Thematic Mapper Plus (ETM+) of 19th October, 1999 with a spatial resolution of 30meters.

iv. Landsat 8 (OLI) of 20th October, 2014 with a spatial resolution of 30meters.

Literature materials were sourced from journals papers, thesis, seminar paper, conference paper, textbooks and other related sources.

3.3.4 Data Processing

3.3.4.1 Image Sub-setting

The Satellite imageries were imported into Erdas imagine 9.2 environment. A subset covering the area of interest was extracted from the larger scene of Landsat MSS, Landsat TM, Landsat ETM+ and Landsat 8 (OLI). The image bands were layer stacked to produce a color composite. Since the remotely sensed data used for this study is ortho-rectified, there was no need for geometric and radiometric corrections to be performed on them. However, the data sets were geo-coded (geo-referencing) and GIS software (Arc GIS 10.1) was used for analyzing images as well as other geographic data acquired for this research.

3.3.4.2 Image Geo-referencing

The Landsat MSS with a spatial resolution of 79meter, Landsat TM with a spatial resolution 30m, Landsat ETM+ with a spatial resolution of 30m and Landsat 8 (OLI) with spatial resolution of 30meter. The Landsat were imported into Erdas Imagine 9.2 environment where rectified to a common projection (Universal Transverse Mercator).This was done to translate the images to real world coordinate. Geo-referencing has to do with registering data to a geographic coordinate system by assigning geographic information such as location and position to the data sets (image). This enables the researcher to define the existence of these data sets in the physical space as well as establish their location in the real world.

3.3.4.3 Image Resampling

The images used for this research has different resolutions and as a result, cannot be compactable for overlay analysis, it is necessary to resample the images to a common spatial resolution. The resampling was done using geo-editing tools in Erdas Imagine to rectify the images for the purpose of this research at 30m resolution. However, since Landsat MSS has 79m resolution, the nearest neighbor resampling method was used to resampled the 1986, 1990, 1999 and 2014 imageries to 30m resolution in order to bring all the data set to a common resolution and projection. This is necessary in order to make it possible for overlay and other operations to be carried out. The image resampling techniques will be used due to its ability and simplicity to keep the original values in the altered scene of the image (Drury, 1990).

After the resampling was carried out, a false color composite (FCC) for each of these images was produced by bringing together the near infrared, red and green bands (i.e 4 3 2) for those images. This was done to enhance vegetation recognition, because the chlorophyll in plant reflects better in the near infrared than the visible band (Curran, 1992).

3.3.4.4 Image Classification

Supervised classification technique was performed using maximum likelihood algorithm in classifying the images into various classes (themes).This method is preferable due to its high level of accuracy and reliability in handling spatial data. This technique gives room to the researcher to generate training classes based on the land use/land cover themes present in the area. This according to Liu, Skidmore and Oosten (2002) helps in curtailing ambiguity that is associated with the unsupervised techniques in image classification. With these techniques, sample sites (training pixels) were selected based on spectral signatures of the features on the images. The known land cover types (training sites) were coded with names of the corresponding thematic features. Based on Jensen (2005), land use/cover classification scheme, the various land use land cover types within the area will be classified into five (5) viz: built-up areas, forest/shrubs, bare land, agricultural/farm land, water bodies as shown in Table 3.1.

Table 3.1: Land use/Land cover Classification Scheme

	LANDUSE/LANDCOVER CATEGORIES	DESCRIPTION
1	Built-up land	Residential, commercials, transportation and communication.
2	Forest land	Natural forest, natural vegetation like grasses, shrubs, grass- like plant.
3	Agricultural land	Farmlands, deforested area and clear forest land.
4	Water bodies	Rivers, streams, lakes.
5	Bare land	Exposed soil

Source: Modified from Jensen (2005)

3.3.4.5 Ground-truthing and Accuracy Assessment

Ground control points obtained using the Global Positioning System (GPS) from locations in relation to the classes of the study was plotted on the images to verify the training sites (defined classes) as regard to spectral signature. Error matrix and Kappa coefficient used in accuracy assessment of the defined classes. According to Congalton, (1991) Kappa coefficient expresses the proportional reduction in error generated by a classification processes compared with the error of a completely random classification.

3.3.5 Data Analysis

3.3.5.1 Land use/land cover change of the area for the period 1986-2014

The Land use/land cover change of the area was determined through broadly classifying the images into five different categories/ polygons viz: built-up, forest land, water bodies, agricultural land and bare land. After the image classification, the histogram (image statistics) of the area coverage (extent) of each land use land cover theme for each period of study were used to determine the land use land cover change by comparing the statistics of the recent image with that of the previous date. The change in square kilometers of a particular land use/ land cover type was derived by subtracting the previous area coverage (km^2) from the recent.

Change in square kilometers = the previous area coverage of land use/land cover type of interest minus the recent (for instance, the area coverage of built- up in 1986 minus the area coverage of built-up in 1990).

To get the percentage change of each land use/land cover type, this formula was used

Percentage change of class = $\dfrac{Observed\,change\,(km^2) \times 100}{Base\,year}$

3.3.5.2 The extent of the change of the forest covers within the study periods

To determine the extent of forest change in the study area, the forest cover layer for the periods of study were extracted from the land use/ land cover classified images and the statistics were generated, showing the extent of the changes that have occurred

3.3.5.3 The trend and pattern of the forest change in the study area over these periods

To achieve this objective, the percentage and rate of forest change in the area in kilometers as derived from the classified image statistics were used. The area change of forest was ascertained by subtracting the former area coverage of the forest from the latter.

The change in square kilometers (observed change) = the area coverage of forest of the recent image minus the area coverage of forest of the previous image.

Percentage change was however determined by dividing the observed change by the changes in latter years (base year) multiplied by 100.

Percentage change (rate) = $\dfrac{Observed\ change \times 100}{Base\ year}$

To obtain the annual rate of change in the forest, the percentage of the change of the forest was divided by the study period.

$$\text{Annual Rate of change} = \frac{\%\,Change}{No\,of\ Study\,year}$$

3.3.5.4 The extent of urban growth within the study period

To determine the extent of the urban growth within these periods, the built-up layer for each year were extracted from the pull of the image classification (land use/ land cover classified images) and the statistics was generated. A built-up map was generated to show the extent to which built-ups have expanded in the area over these periods.

3.3.5.5 The extent to which urban growth has affected the forest cover in the study area

The land use/ land cover maps prepared from the images were used to assess changes in land use land cover. The built-up and forest categories were overlaid to show the level of urban encroachment into the forest reserve for the periods under study. The calculated changes between these land use classes were used to determine the extent to which the urban growth has affected the forest land in the study area over the periods.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 INTRODUCTION

This chapter deals with presentation and analysis of result obtained from the research analysis. The analysis of data and presentation of result were carried out under the following sub-themes: characterization of land-use/land-cover, land-use land-cover change, rate and pattern of land-use/land-cover change, the extent of the forest change as well as the extent to which urban growth has affected forest cover within the study area. The results of the analysis were then discussed and appropriate inferences were made to assess the effect of urban growth on forest cover within the study area.

4.2 CHARACTERIZATION OF LAND-USE/LAND-COVER OF THE AREA

The land-use/land-cover classes of Guga Forest in 1986, 1990, 1999 and 2014 were characterized into five prominent classes which include: Built-up, Agricultural land, Forest land, Bare land and Water bodies as shown in Fig.4.1, 4.2, 4.3, 4.4 and Table 4.1 below.

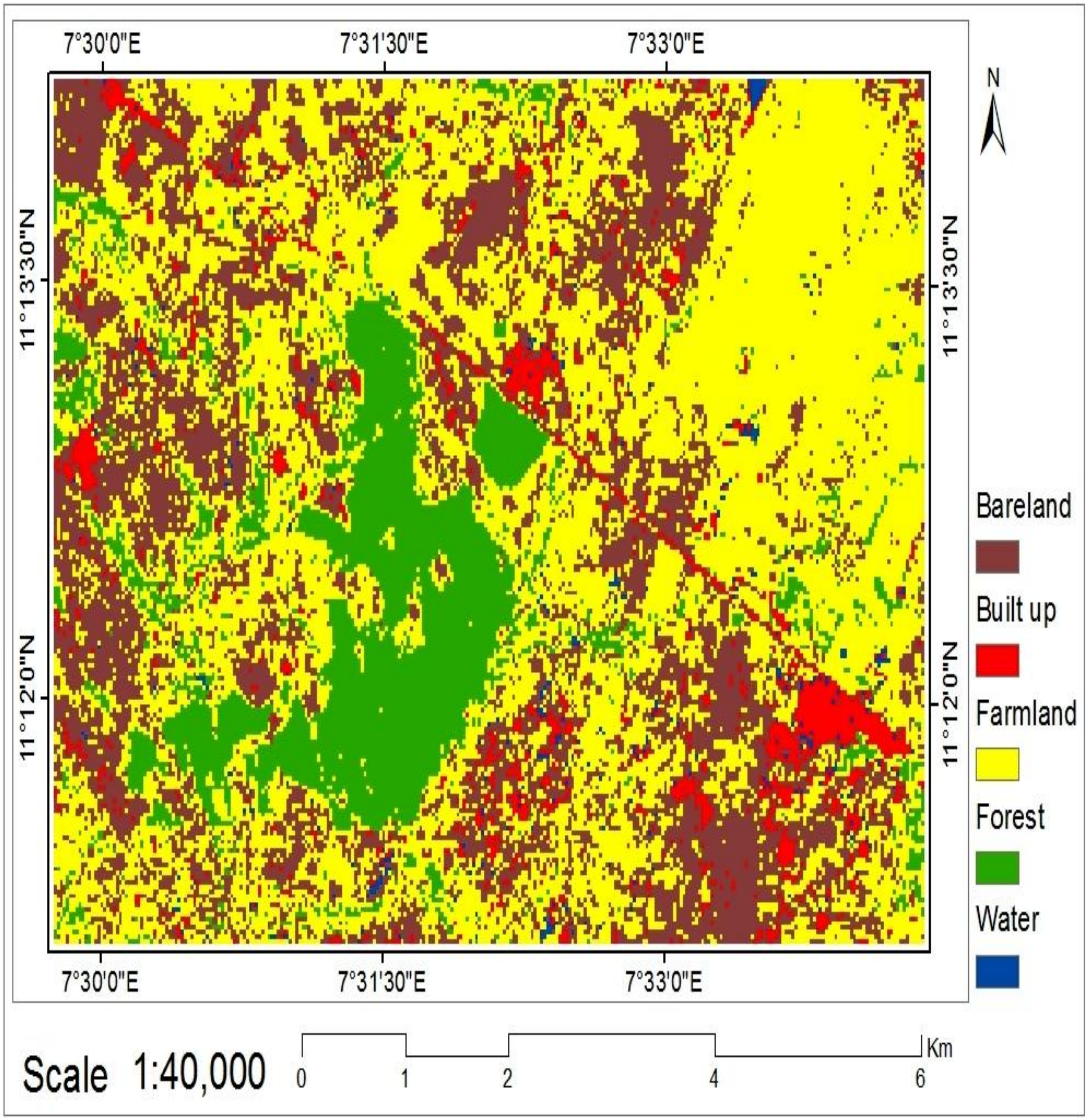

Fig 4.1: 1986 Land use/Land cover Map of the Study Area

Source: Authors Analysis, 2014

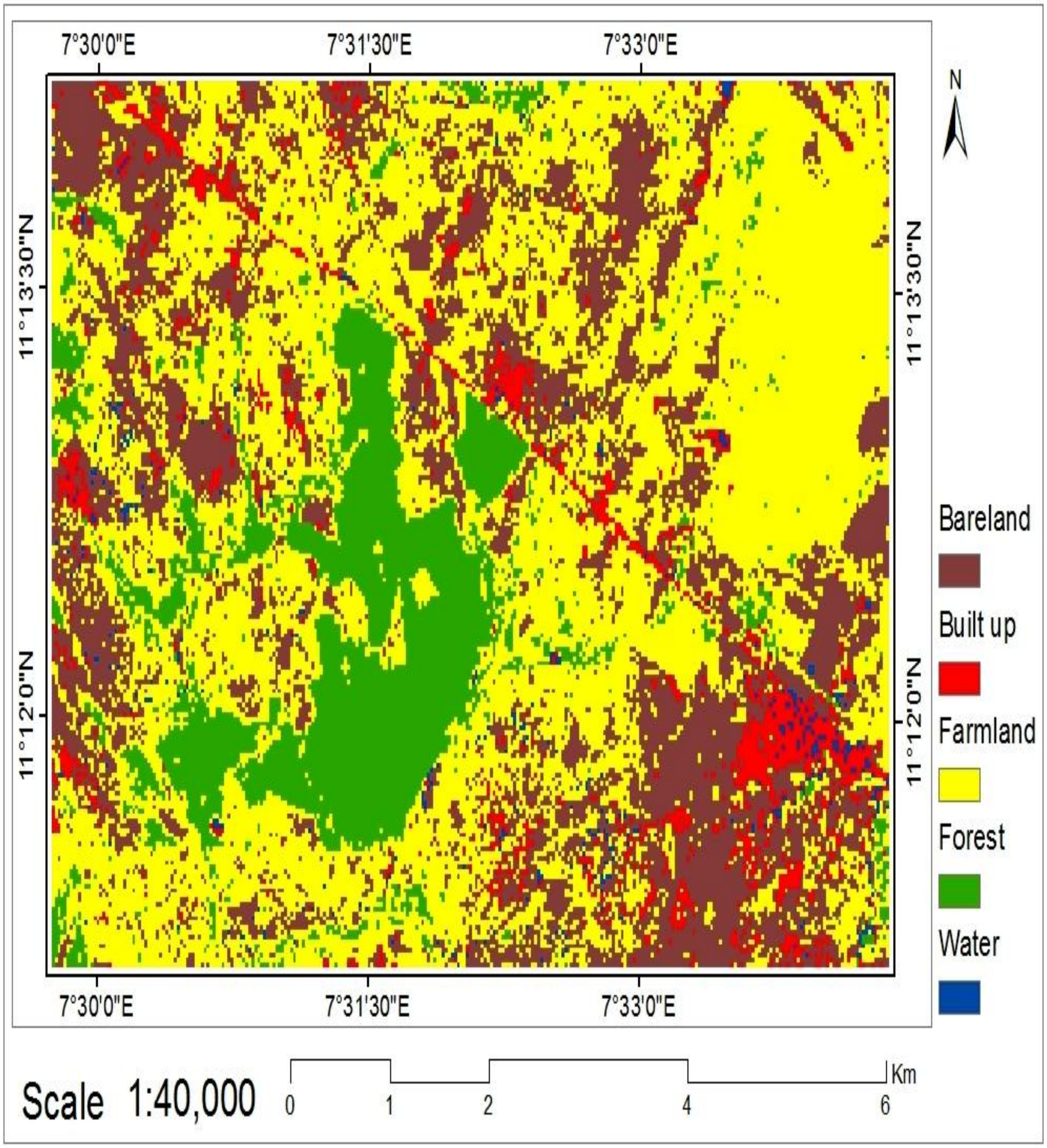

Fig 4.2: 1990 Land use/Land cover Map of the Study Area

Source: Authors Analysis, 2014

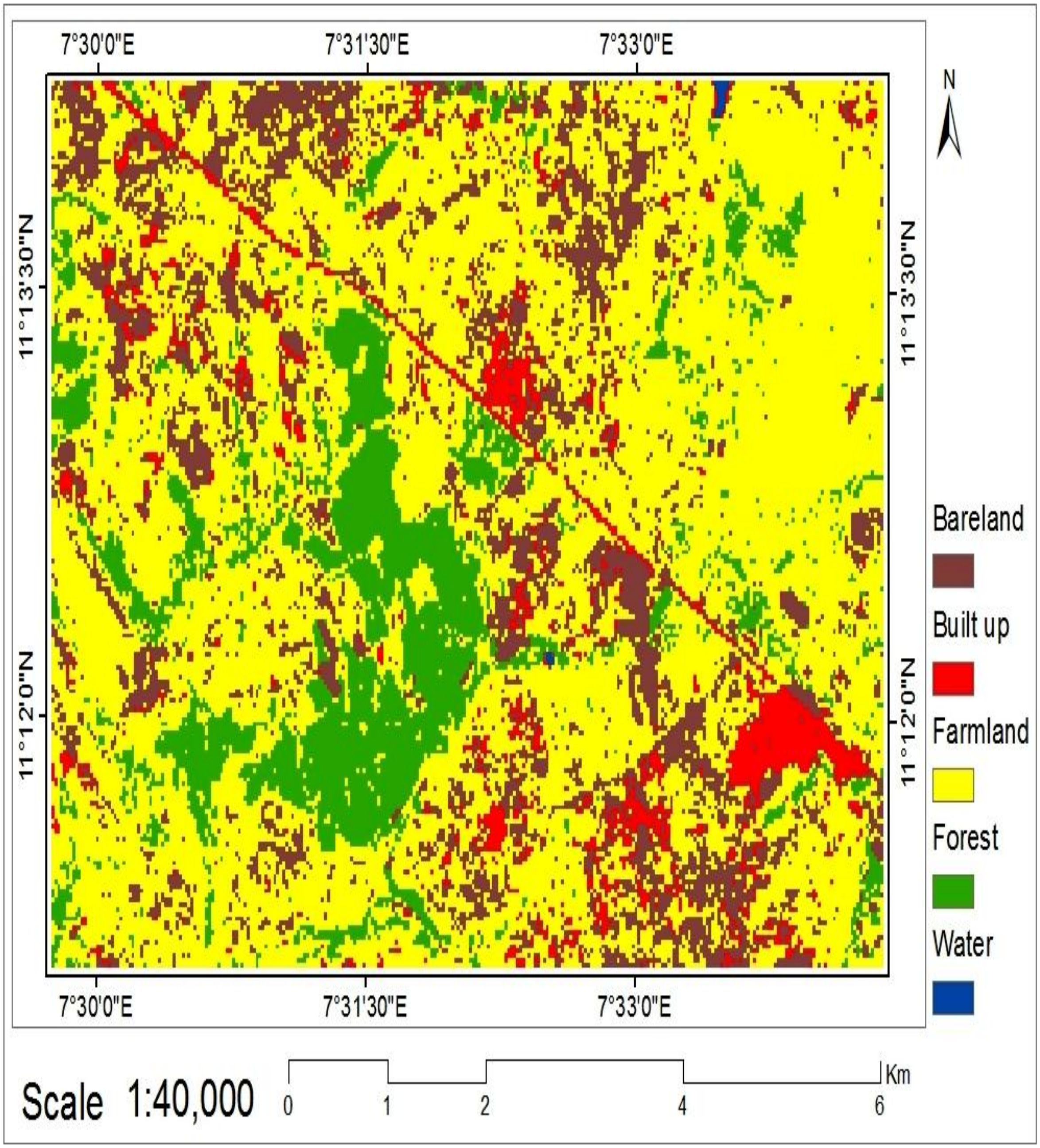

Fig 4.3: 1999 Land use/Land cover Map of the Study Area

Source: Authors Analysis, 2014

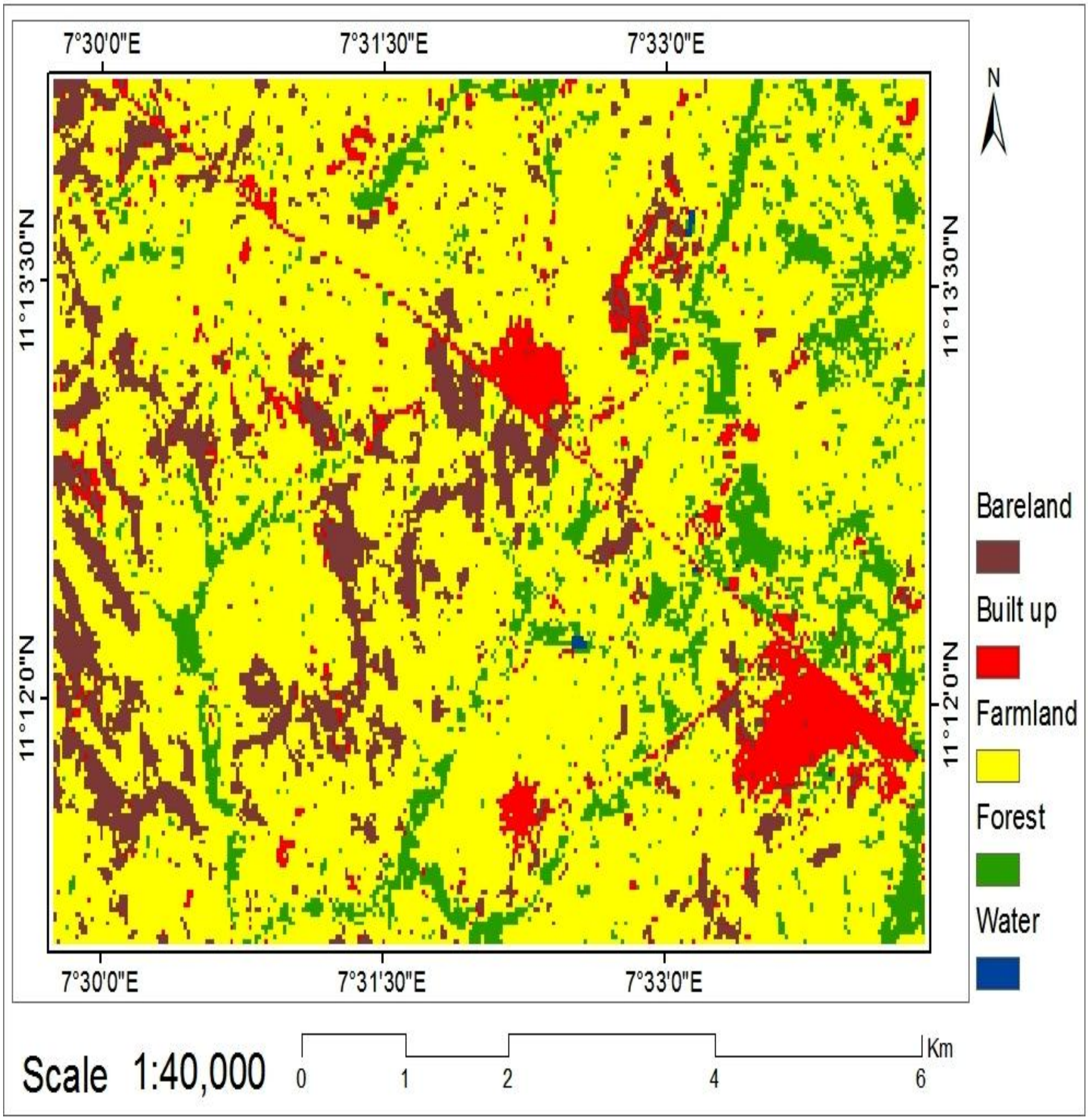

Fig 4.4: 2014 Land use/Land cover Map of the Study Area

Source: Authors Analysis, 2014.

Table 4.1: Extent and Proportion of Land-use/cover in 1986- 2014

	1986		1990		1999		2014	
Land use	Ha	%	Ha	%	Ha	%	Ha	%
Bare land	1409.0	29.2	1339.9	27.7	851.0	17.6	570.1	11.8
Built up	224.8	4.7	240.5	5.0	260.1	5.4	279.5	5.8
Agric/land	2483.0	51.4	2538.1	52.5	3062.9	63.4	3498.4	72.4
Forest	673.1	13.9	665.3	13.8	653.3	13.5	479.1	9.9
Water	40.4	0.8	46.6	1.0	3.2	0.1	3.2	0.1
Total	**4830.4**	**100.0**	**4830.4**	**100.0**	**4830.4**	**100.0**	**4830.4**	**100.0**

Source: Author's Analysis, 2014

The Land-use/Land-cover maps for the four years of the study depicting the five Land-use/land-cover classes were generated and presented in Fig. 4.1, 4.2, 4.3 and 4.4. The area and percentage coverage of each of the class is further depicted in Table 4.1.

From the analysis, Table 4.1 shows the various land cover types and the proportion of the total area occupied by each of them. The result generated from 1986 LandSat MSS (Fig 4.1) indicates that agricultural land occupied the highest proportion of the total land accounting for more than half of the entire area (51.4%), followed closely by bare land (29.2%) while forest, built-up and water body amounted to 13.9%, 4.7% and 0.8% respectively.

The image classification resulted from 1990 LandSat TM (Fig4.2), shows that agricultural land still remains the major land use land cover with an increase to 52.5%, Bare land and forest has decreased to 27.8% and 13.8% while built-up and water body increased slightly by 5.0% and 1.0%.

Results generated from LandSat ETM 1999 (Fig4.3) still recorded an increase in the proportion of agricultural land (63.4%) and built-up areas (5.4%) while forest, bare land and water body still experienced a tremendous decline by 13.5%, 17.1% and 13.5% within that same study period.

The analysis further generated from Landsat 8 OLI (Fig4.4) revealed that agricultural land and built-up increased dramatically by 72.4% and 5.8% respectively. Forest, bare land and water body decreased to 9.9%, 11.8% and 0.1%. This implies that agricultural land and built-up is fast encroaching into the forest land. The increase in built-up as well as agricultural land was as a result of increase in human population which is presumably due to both migration and natural increase which has given rise to higher demands for agricultural land as well as physical development like residential, commercial, infrastructural and other urban structure. In the quest to meet up with these demands, some of the forest/vegetation land in the area was replaced by these land use classes.

The pressure on the land as a result of increase in the demand of land together with inadequate planning led to the encroachment of built-up and agricultural land on the other area occupied by forest and other land cover types irrespective of the consequences. The dramatic increase in conversion of land for physical development and agricultural activities led to decrease in bare land and water bodies. However, bare surfaces could be seen in built-up area as paved or unpaved land during construction; in cultivated lands during cultivation or after harvesting; along river course as deposition; in forests due to clearing as well as along or on roads mostly when it is unpaved.

4.2.3 Land-use/Land-cover change

The result of land-use/land-cover change of the study area between 1986-1990, 1990-1999, 1999-2014, and 1986-2014 is presented in Table 4.2.

Table 4.2: Extent of Land-use/Land-cover change

	1986 - 1990		1990 -1999		1999 -2014		1986 - 2014	
Land use	Ha	%	Ha	%	Ha	%	Ha	%
Bare land	-69.1	-4.9	-489.0	-36.5	-280.8	-33.0	-838.9	-59.5
Built up	15.7	7.0	19.6	8.2	19.4	7.5	54.7	24.3
Agric/land	55.1	2.2	524.8	20.7	435.5	14.2	1015.4	40.9
Forest	-7.8	-1.2	-12.0	-1.8	-174.2	-26.7	-194.0	-28.8
Water	6.2	15.4	-43.5	-93.2	0.1	2.9	-37.2	-92.0

Source: Author's Analysis, 2014

Table 4.2, revealed the extent of change of change in the land use/ land cover in the study area. In 1986 to 1990 forest, bare land and water body decreased by -1.2%, - 4.9% and -43.5% respectively. Built-up and agricultural land which is an attribute of urban growth increased by 7.0% and 2.2%. Similarly, from 1990 to 1999, built-up increased by 8.2%, agricultural land by 20.7%, water body by 31.2% while forest and bare land experienced a negative change by -1.8% and - 36.5%. This may be due to the creation of a Giwa Local Government Area in 1991. More so, in 1999 to 2014, built-up, agricultural land and water body increased drastically by 7.5%, 14.2% and 2.9% while forest bare land decreased by -26.7% and – 33.0%.

Lastly, the extent of the change in land use/ land cover between 1986- 2014 revealed that, built-up and agricultural land increased drastically by 24.3%, 40.9% within the 28 years study period. On the other hand, forest reduced by -28.8%, bare land by -59.5% and water body -92.0 The result showed a clear indication that physical development has taken over. The increase in physical development coupled with inadequate monitoring of the forest reserve led to the encroachment. The sharp increased was attributed to the development in transport network, presence of some basic amenities, primary health care as well as the movement of Ahmadu Bello University Teaching Hospital (ABUTH) from Kaduna, Tudun-wada and Malumfashi to its present permanent site in 2005. These act as a pull factor by creating employment and commercial activities in the area. These trigger the increased in population as well as physical development. The increasing urbanization resulted in the removal of forest cover in the area mostly for the purpose of construction, cultivation, cooking energy and electric poles. The increasing urbanization has also led to a higher demand for available land in the area as seen in Figs. 4.3 below which shows the chart of the classified land use/cover change.

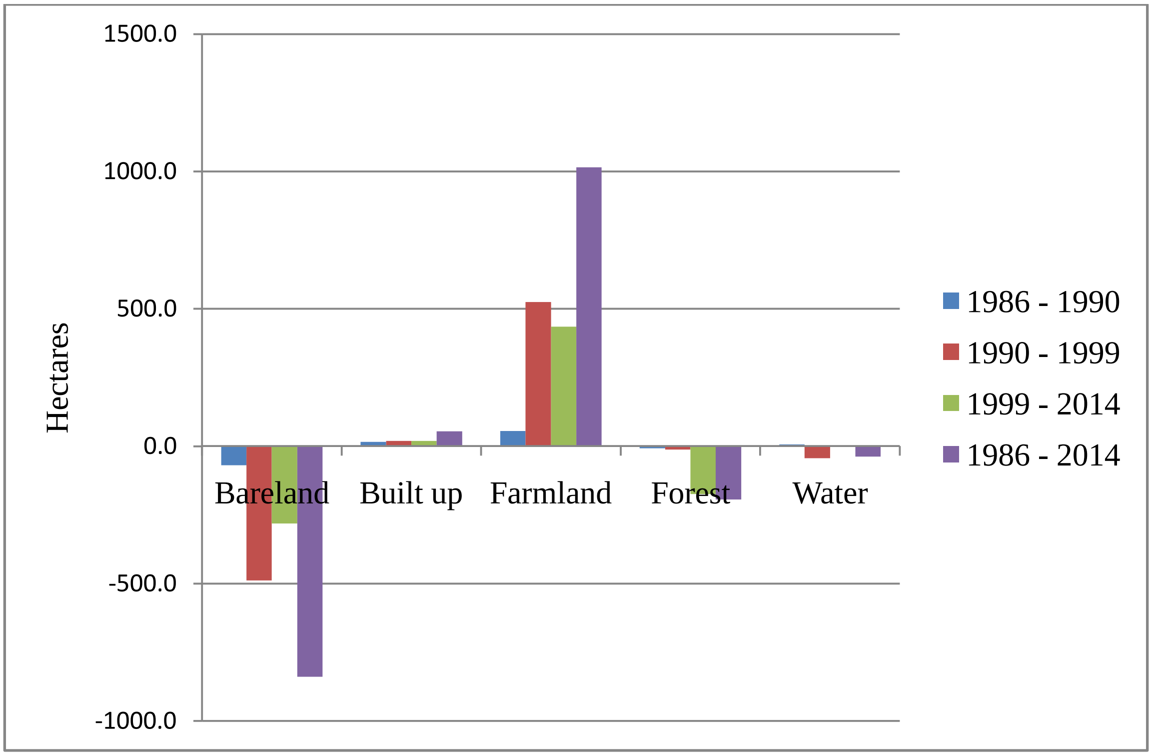

Fig: 4.5: Land use/Land cover Change

Source: Author's Analysis, 2014

From the analysis, it was observed that built-up and agricultural land witnessed a significant change at the expense of the forest. Under a high population pressure, it is therefore natural to expect some expansion in cultivated land as it reflects land exhaustion such that no much uncultivated land was available, a consequence of these is much; pressure must be applied to the already existing cultivated land into more intensification of farming activities (Ariyo, 1991).

Furthermore, this significant reduction in other land use/ land cover types could be attributed partly to urban expansion or population growth as well as increased in agricultural activities especially within and around the forest as seen in Fig 4.2 so as to meet with the growing demands of the growing population in the area.

Many writers confirmed that urban centers in Nigeria are faced with rapid urban expansion and development which of course collaborates with the findings of this research. For instance the works of Ati, Abbas, Sheyin and Mohammed (2010) in their bids to assessing changes in Kagoro forest in southern Kaduna, discovered that settlement increased by 17.77% between 1987 and 2005 respectively while undisturbed forest decreased by 24.06% within these same years. Also, Akande (2002) recorded a significant increase in built-up from 2.45% to 3.26% while other land use type decreased b between 1980s and 1990s in Kaduna South.

Akingbogun,Kosoko and Aborisade (2012), reported that the land use of Eleyele, Ibadan has changed significantly within the period 1984-2000. According to the Authors, the period recorded an increased in the urban land use at the rate of 17.08% annually while the forest land reduced from 12.5% to 0.13% within this same period.

4.3 RATE AND PATTERN OF LAND-USE/LAND-COVER CHANGE

The rate and pattern to which each land use/ land cover class is changing per year however is tabulated in hectares and percentage as shown in the Table 4.3:

Table 4.3: Annual Rate of Land use Land cover Change

	1986 - 1990		**1990 -1999**		**1999 -2014**		**1986 - 2014**	
Land use	Ha	%	Ha	%	Ha	%	Ha	%
Bare land	-17.3	-1.2	-54.3	-4.1	-18.7	-2.2	-30.0	-2.1
Built up	3.9	1.7	2.2	0.9	1.3	0.5	2.0	0.9
Agric/land	13.8	0.6	58.3	2.3	29.0	0.9	36.3	1.5
Forest	-2.0	-0.3	-1.3	-0.2	-11.6	-1.8	- 6.9	-1.0
Water	1.6	3.8	-4.8	-10.4	0.0	0.2	-1.3	-3.3

Source: Authors Analysis, 2014

The analysis as shown in Table 4.3 revealed that, between 1986-1990, built-up, agricultural land and water body increased at the rate of 1.7%, 0.6% and 3.8% per annum while forest, and bare land declined at the rate of -0.3%, - 1.2% annually. Between 1990 and 1999, built-up, and agricultural land increased at the rate of 0.9%, 2.3% annually while forest, bare land and water body declined at the rate of -0.2%, -4.1% and -10.4% annually within these same period. More so, in 1999 to 2014, built-up, agricultural land and water body increased at the rate of 0.9%, 1.2% and 0.2% annually while forest and bare land decreased at the rate of -1.8% and -2.2% per annum.

In general, between 1986-2014, the built-up and agricultural land increased at the rate of 0.9%, 1.5% per annum within the period of study. On the contrary, forest, bare land and water body were declining at the rate of -1.0%, -2.1 and -3.3% per year. Going by this rate, if no adequate measure is put in place to monitor and protect the forest reserve, it may be lost completely.

4.4 URBAN EXPANSION

The extent of built-up land within these study periods is shown in Fig. 4.2 and Fig. 4.3. Table 4.4 shows the extent of the urban expansion between the various time periods.

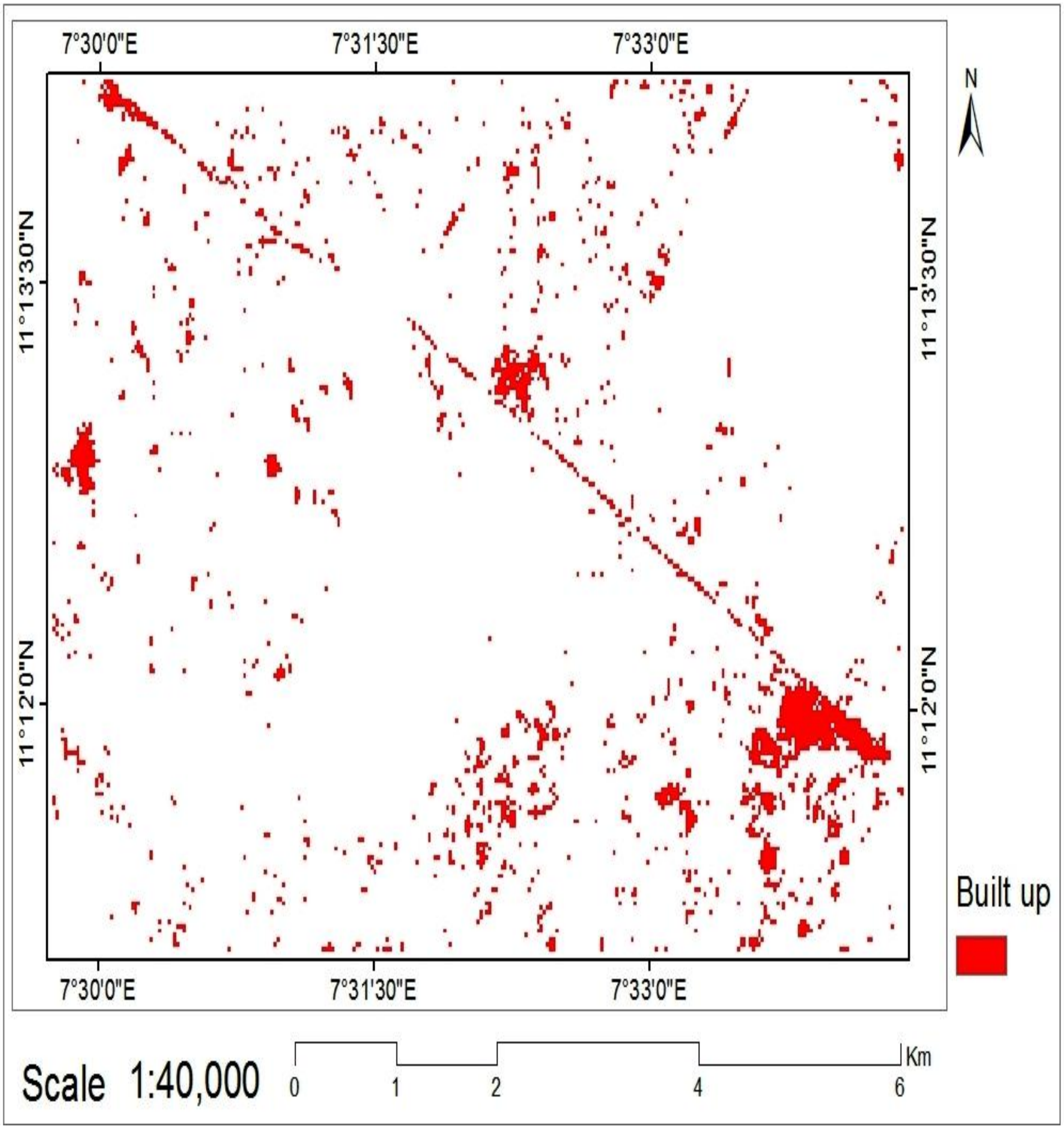

Fig 4.6: 1986 Built-up Map of the Study Area

Source: Authors Analysis, 2014.

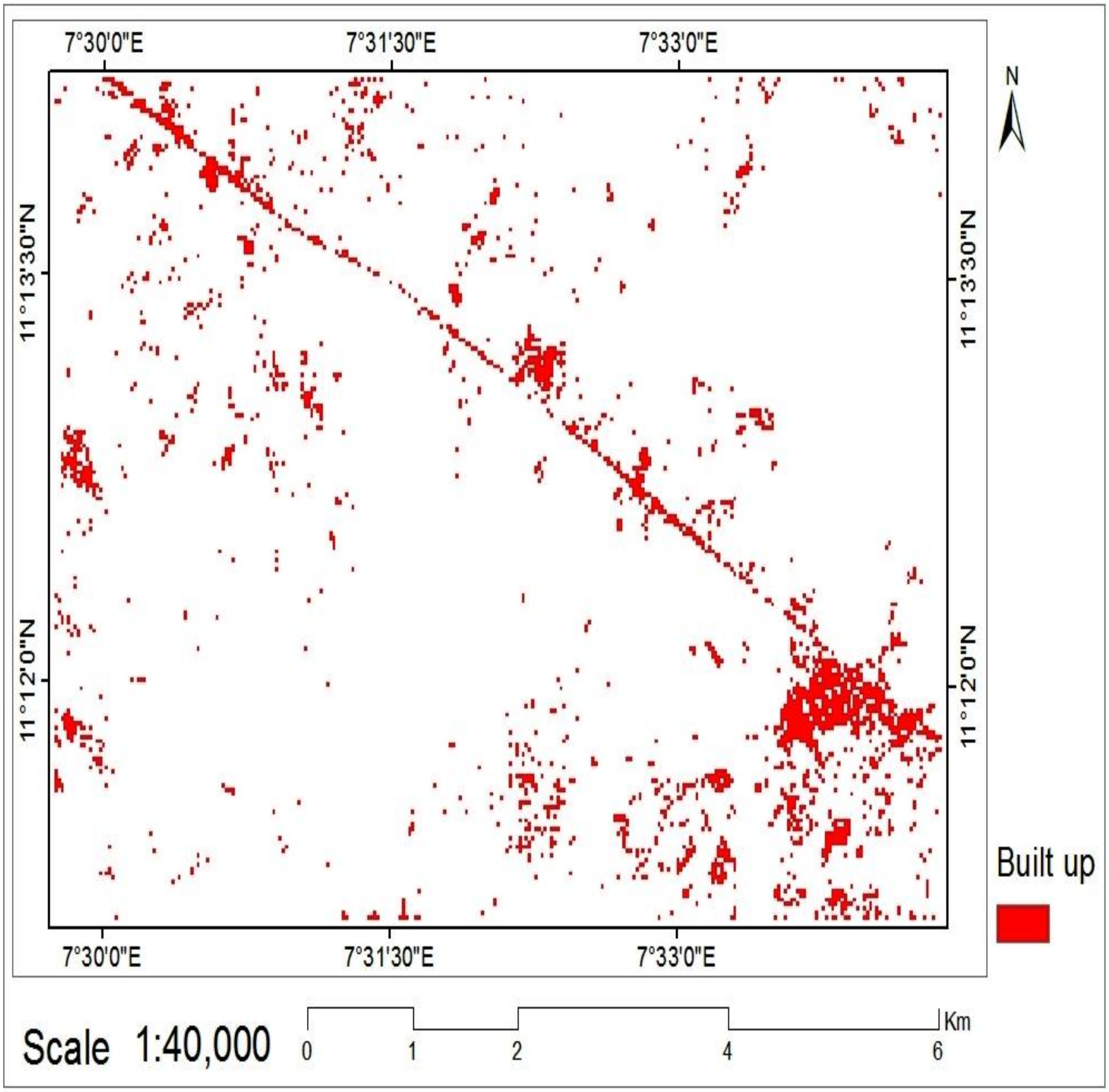

Fig 4.7: 1990 Built-up Map of the Study Area

Source: Authors Analysis, 2014.

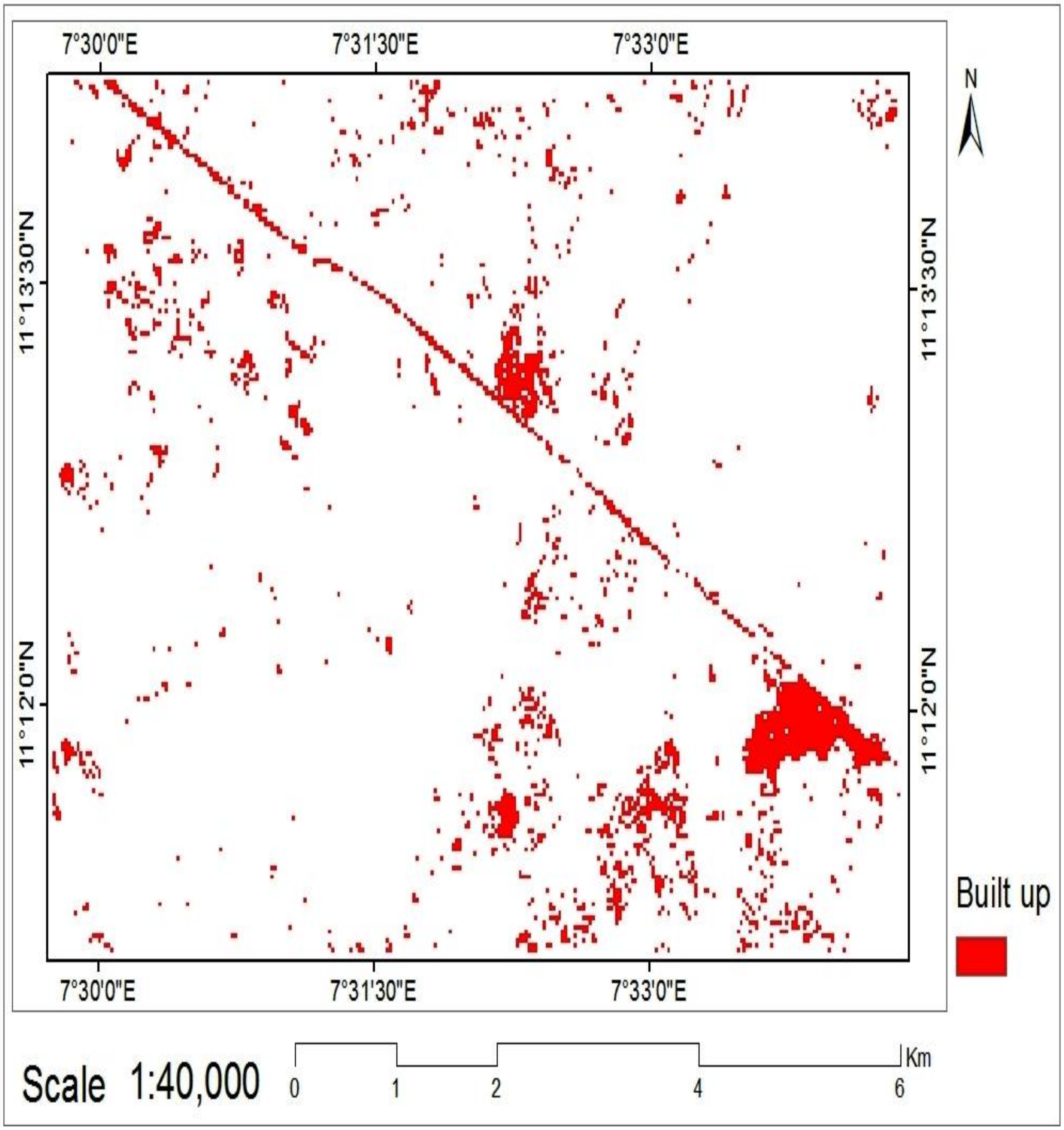

Fig 4.8: 1999 Built-up Map of the Study Area

Source: Authors Analysis, 2014.

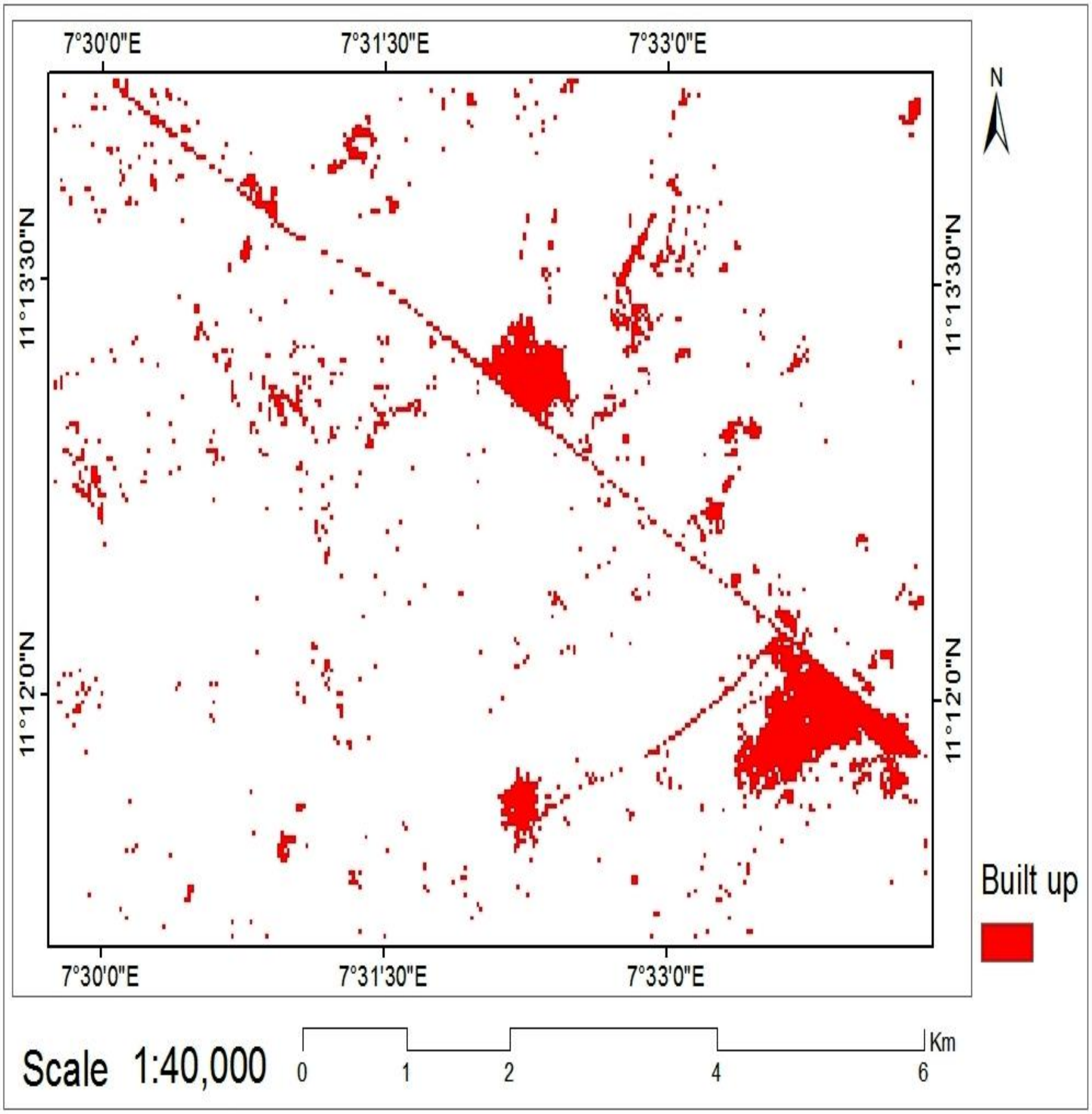

Fig 4.9: 2014 Built-up Map of the Study Area

Source: Authors Analysis, 2014.

Table 4.4: Extent of Urban Expansion in the Area

Period	Year	Built Up (Ha)	Change Ha	Change %	Growth Rate Ha/Year	Growth Rate %/Year
1986-1990 (4years)	1986	224.8	15.9	7.0	3.9	1.7
	1990	240.5				
1990-1999 (9years)	1990	240.5	19.6	8.2	2.2	0.9
	1999	260.1				
1999-2014 (13years)	1999	260.1	19.4	7.5	1.3	0.5
	2014	279.5				
1986-2014 (26years)	1986	224.8	54.7	24.3	2.0	0.9
	2014	279.5				

Source: Author's Analysis, 2014.

The results shown in Table 4.4 revealed that, between1986-1990 the built-up area increased to about 7.0%, while in 1990-1999, it increased to about 8.2%. By 1999-2014, there was an increased in built-up area of about 7.5% while 1986-2014, there was a dramatic increased in built-up to about 24.3%. The Shika area was growing at the rate of 0.9% within the period (1986-2014) studied.

Between 1999-2012, about 19.4 hectares of land which amounted to about 7.5% was added to built-up land use and within these same periods it recorded an annual growth rate of about 0.5%. In other word about 1.2 hectares of land was built-up yearly at that period.

More so, the evidence of this urban expansion could be seen in built-up map of the study area in Fig.4.10, 4.11, 4.12 and 4.13 above. The improvement or rather increase in the built-up area could be attributed to the relocation of the teaching hospital to its permanent site which triggered the need for people to acquired land to built on, this also attracted lot of commercial activities in this area. A lot of people could afford to build their own houses. This mounted pressure on the land and consequently, built-up land use increased at the detriment of other land cover types in the area as seen in the figures. This means that the rate at which the land-use was increasing is attributed to increased in human population over time.

4.5 VEGETATION CHANGE

The extent of forest change from 1986 to 2012 is shown in Figs. 4.3. Table 4.4 shows the extent to which forest has been loss between the various time periods.

Table 4.5: Extent of Forest Loss

Period	Year	Forest (Ha)	Change Ha	Change %	Growth Rate Ha/Year	Growth Rate %/Year
1986-1990	1986	673.1	-7.8	-1.2	-2.0	-0.3
(4years)	1990	665.3				
1990-1999	1990	665.3	-12.0	-1.8	-1.3	-0.2
(9years)	1999	653.3				
1999-2014	1999	653.3	-174.2	-26.7	-11.6	-1.8
(15years)	2014	479.1				
1986-2014	1986	673.1	-194.0	-28.8	-6.9	-1.1
(26years)	2014	479.1				

Source: Author's Analysis, 2014.

The results as shown in Table 4.6 reveal that the forest land decreased from -7.8 hectares in 1986 to 1990. The forest land was declining at the rate of - 0.3% within the period (1986-1990) studied. The period between 1990 and1999 recorded a loss in forest land of about -12.0 hectares and was decreasing at the rate of -0.2% per annum. More so, from 1999 to 2014, about -174.2 hectares of forest land which amounted to about -26.7% was loss annually, the period recorded an annual growth rate of about -1.8%. In other word about -11.6% hectares of forest land was loss to built-up yearly at that period.

Generally, the period between 1986 to 2014, about -1.1% of the forest was loss to other land use type. The result indicates that each year the forest land is been loss giving room to urban expansion as shown in Table 4.5 above. The period 1990-1999 recorded the highest decreased in forest land with an annual growth rate of - 0.2%.

4.6 EXTENT TO WHICH URBAN GROWTH HAS AFFECTED FOREST COVER IN THE STUDY AREA

Using overlay analysis the portion of the study area occupied by built-up for each study year was clipped on the forest cover to see the amount of the original forest land displaced by the built-up as shown in Fig. 4.10, 4.11, 4.12 and 4.13.

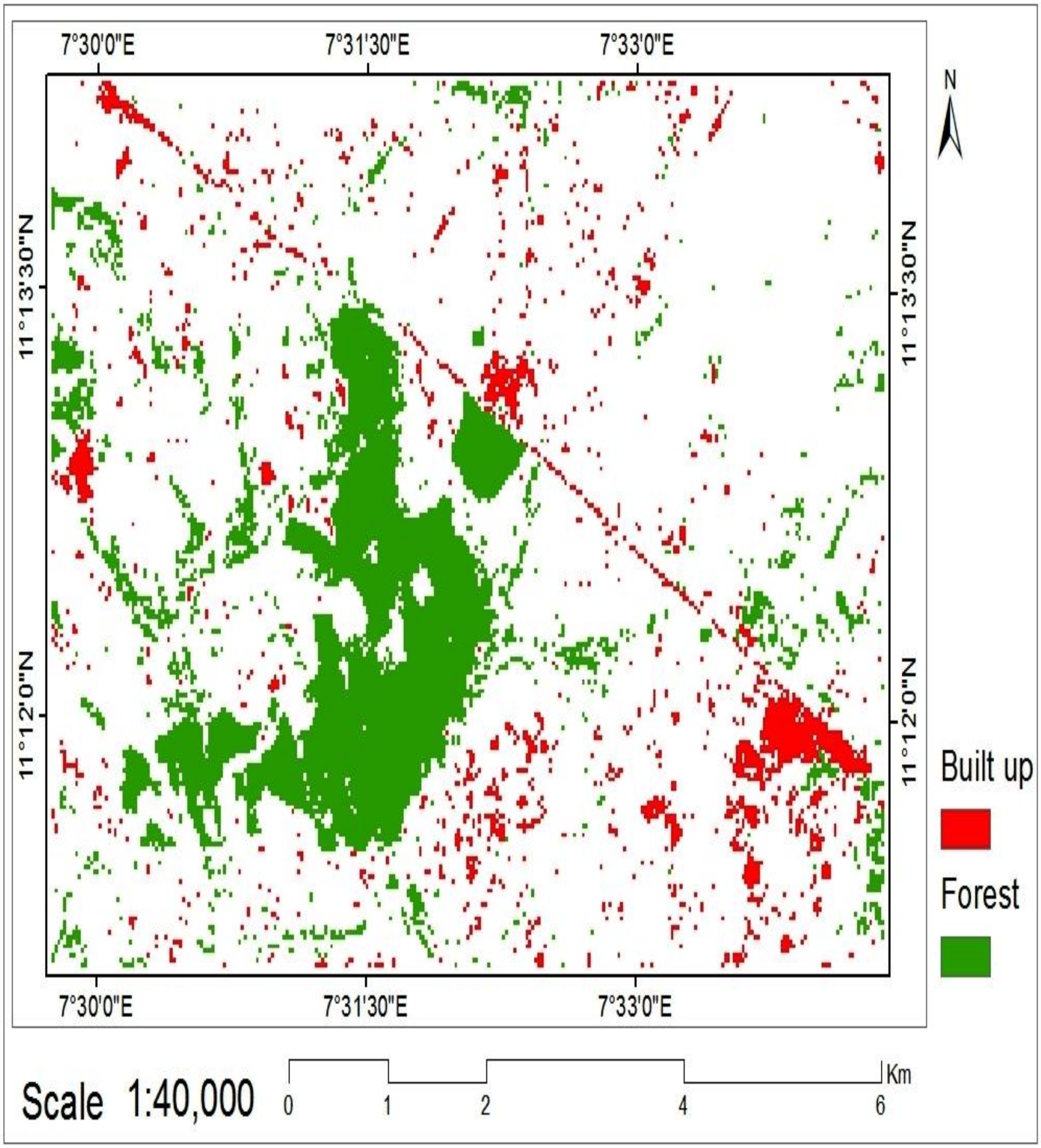

Fig 4.10: 1986 Overlay Map of Built-up on Forest land of the Study Area.

Source: Authors Analysis, 2014

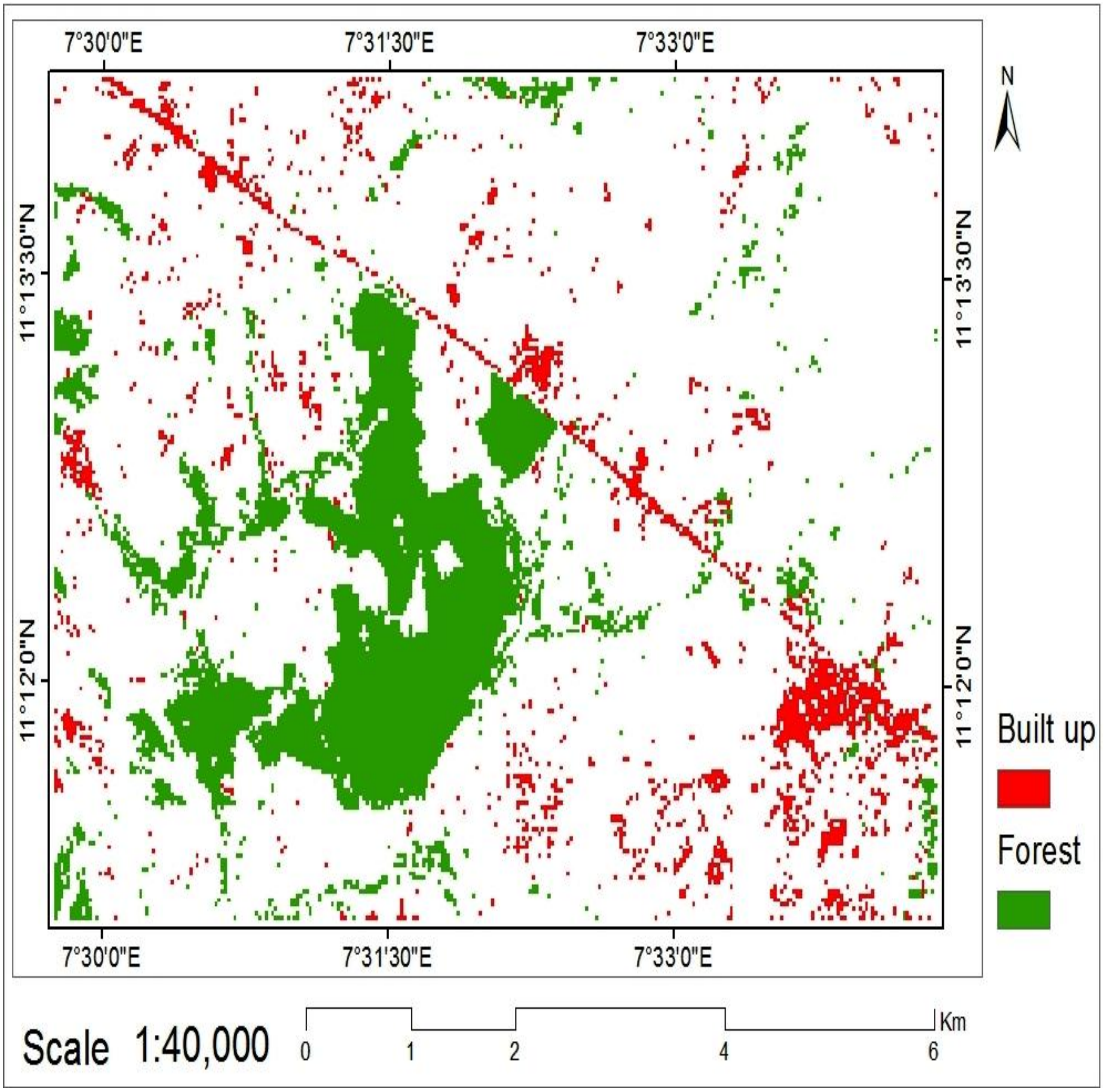

Fig 4.11: 1990 Overlay Map of Built-up on Forest land of the Study Area.

Source: Authors Analysis, 2014

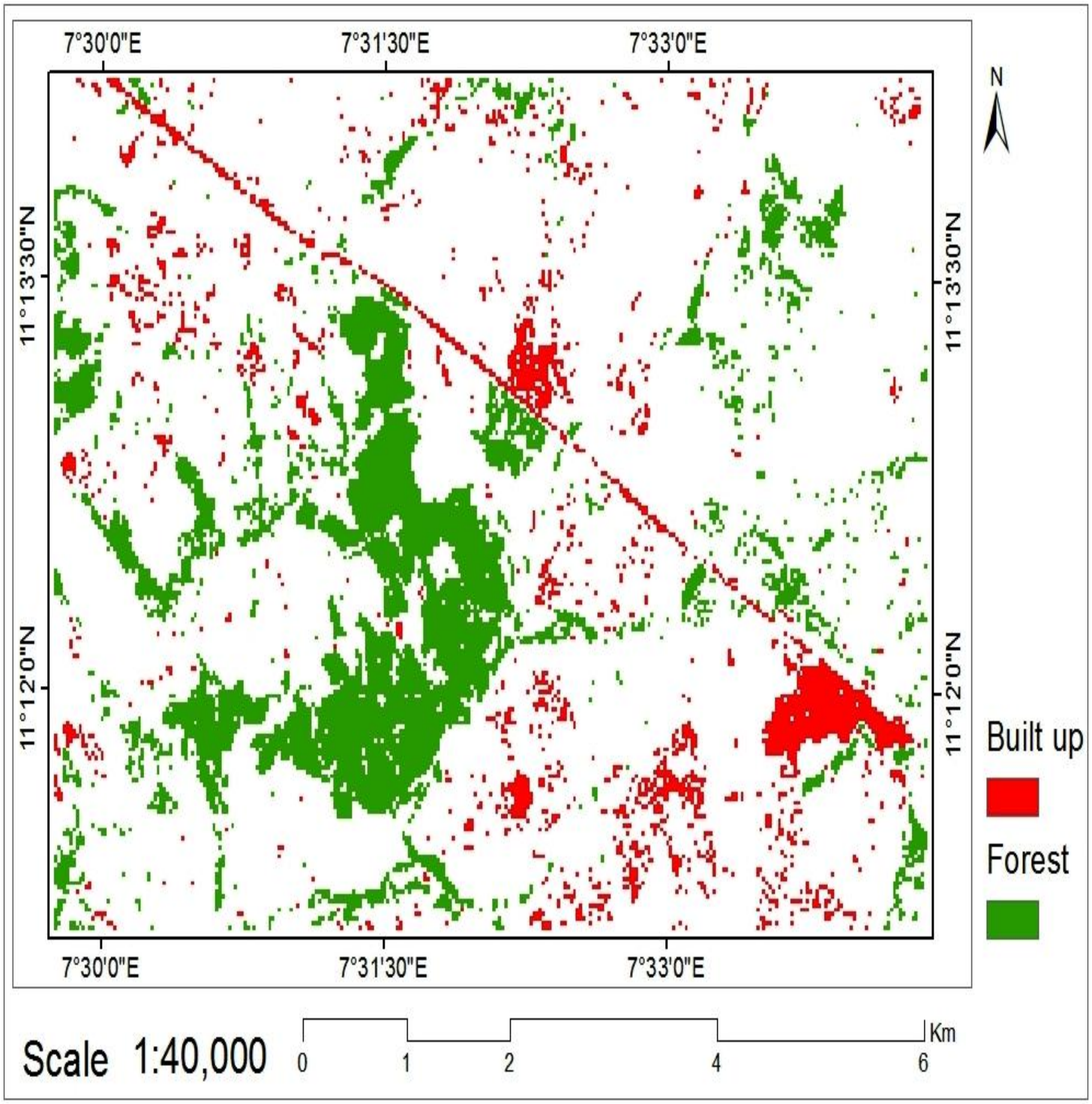

Fig 4.12: 1999 Overlay Map of Built-up on Forest land of the Study Area.

Source: Authors Analysis, 2014

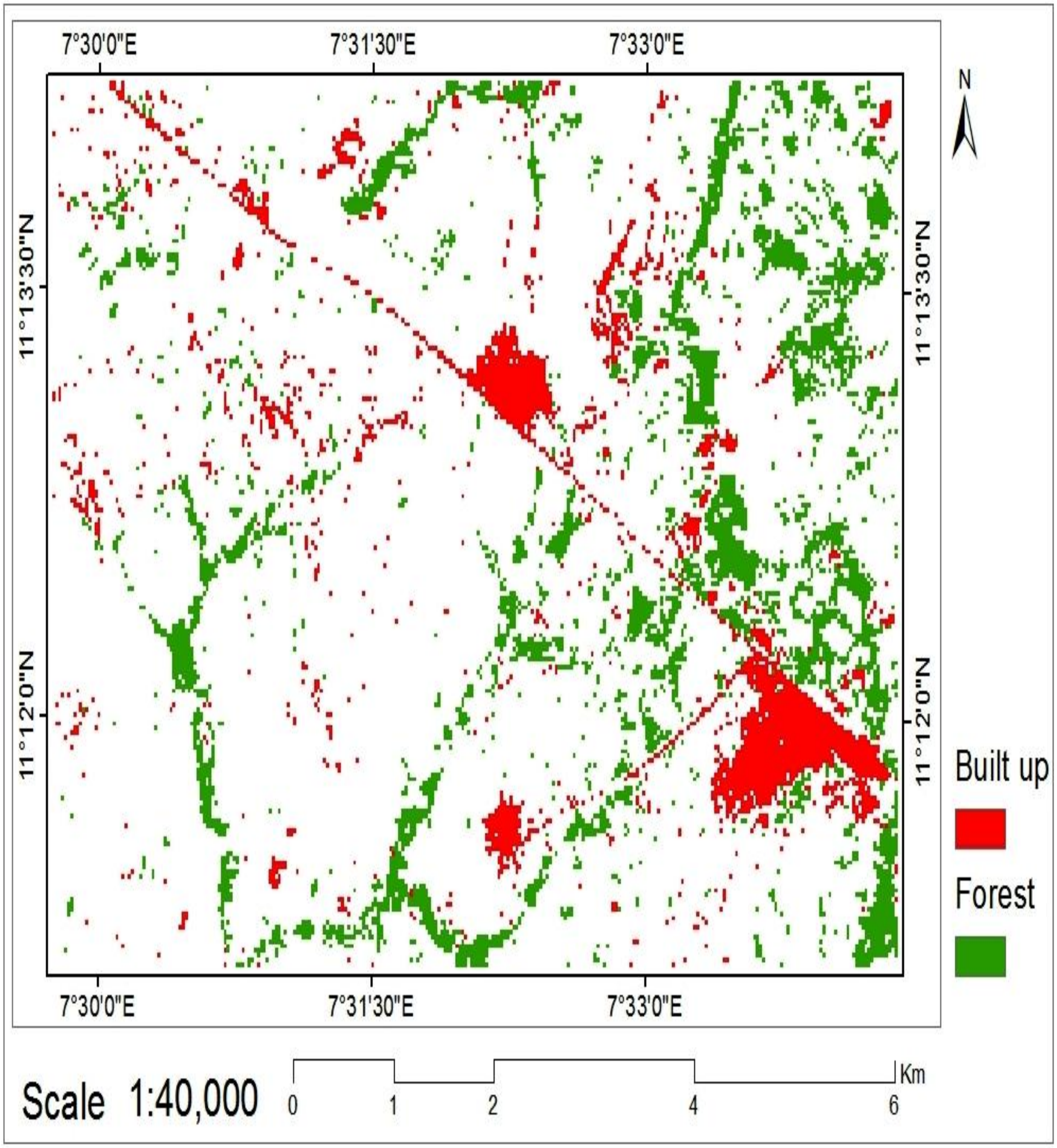

Fig 4.13: 2014 Overlay Map of Built-up on Forest land of the Study Area.

Source: Authors Analysis, 2014

Table 4.6: The Extent of Built-up and Displaced Forest land

Land use	Forest Displaced(ha)	Built Up Extent(ha)	Encroachment (ha)
1990	665.3	402.5	2.25
1999	653.3	260.1	2.16
2014	479.1	279.5	11.07

Source: Authors Analysis, 2014.

From Table 4.7, it was observed that in 1990, about 665.3 ha of forest land was displaced by built-up while in 1999, about 653.3ha of forest was displaced by built-up. In 2014, a larger portion of forest land was displaced (479.1 ha) by built-up. The above overlay analysis in Fig.4.10, 4.11, 4.12 and 4.13 shows a clear evidence of physical expansion encroaching into the forest land. Furthermore, the period between 1999-2014 experienced a rapid urban encroachment, areas formally occupied by the forest land has almost being cleared completely giving room for physical development in the area. This succession could also be attributed to the movement of the Ahmadu Bello University Teaching (ABUTH) from Kaduna, Malumfashi and Tudun- Wada, Zaria to its present permanent site in the year 2005 as well as the creation of Giwa Local Government Area in September 1991 which has triggered increased in human population, physical development as well as urban expansion in the area. This increase in population growth as well as urban expansion has therefore led to a gradual elimination of forest land in the study area as shown in the Map of the overlay analysis above.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 INTRODUCTION

This chapter describes the summary of the major findings of this research work, conclusion derived from the findings as well as recommendations for enhancing effective land-use/land-cover management within the study area in particular and the state in general.

5.2 SUMMARY OF MAJOR FINDINGS

The study provided an insight on the effect of urban encroachment on Guga forest reserve in Giwa Local Government Area of Kaduna State. The finding of this research revealed evidence of gradual urban expansion over the study period as the land cover had percentage coverage of 4.7% in 1986, 5.0% in 1990, 5.4% in 1999 and 5.08% in 2014.The built-up area and agricultural land have shown a continuous increased within the period of study while forest/vegetation and bare land declined. However, the analysis revealed that built-up and agricultural land has eating up the forest land, most part of the study area is still rural as most people within the study area still engage in agricultural activities.

The period 1986-1990 recorded the highest annual growth (1.7%) while the average annual growth rate within the study period (1986 - 2014) was 0.9%.Unplanned expansion has led to conversion of forest and bare land into physical development. The highest proportion of forest loss was noticed between 1990 - 1999 with an annual rate of 0.2%, within this same study period, about 19.6 hectares of land which amounted to about 8.2% was added to built-up land.

5.3 CONCLUSION

This study reveals high rate of urban encroachment in the Guga forest reserve area. There is serious encroachment of physical development and cultivation on the forest cover. These could be attributed to unplanned urban growth and inadequate monitoring of the forest reserve. If this situation continues at this rate, the vegetation cover in the area would soon be lost to the detriment of the environment.

5.4 RECOMMENDATIONS

Based on the identified changing nature and rate of various land-use/land-cover types identified in the study area especially from 1986 to 2014, the following are recommended:

- Proactive measure should be taken by all stakeholders in Giwa Local government area and Kaduna State as a whole towards a better understanding of the changing pattern of land-use and land-cover types of the area so as to be better equipped in order to manage various environmental challenges that might be associated with such changes.

- The management of Guga forest reserve should adopt Remote Sensing and Geographic Information System (GIS) techniques which have proved to be efficient in the monitoring of vegetation cover. This would help to control encroachment and illegal logging in the area.

- The urban planning and development Authority in the state should adequately plan for the rapid urban growth being experienced in the area. This would control such encroachment.

- The people should be sensitized through enlightenment campaigns on the consequences of indiscriminate tree felling. Alternative sources of cooking energy should also be emphasized.

- Afforestation and reforestation should be encouragement and adopted by the ministry of forest in the State especially around the study areas in order to resuscitate lands that are devoid of vegetal cover.

- Reforestation of degraded areas is also suggested in order to speed up the process of rehabilitation and regeneration of the forest. This entail more annual tree planting and provide tree seedling to farmers to encourage agro forestry or better still, this will enhance resource management and reduce indiscriminate exploitation of forest cover.

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