GEOSPATIAL ANALYSIS OF THE EFFECT OF URBAN GROWTH ON AGRICULTURAL LAND IN JAJI TOWN, KADUNA STATE, NIGERIA

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

DEPARTMENT OF GEOGRAPHY,
FACULTY OF SCIENCE,
AHMADU BELLO UNIVERSITY,
ZARIA, NIGERIA

NOVEMBER, 2018

DECLARATION

I declare that the work in the dissertation entitled 'GEOSPATIAL ANALYSIS OF THE EFFECT OF URBAN GROWTH ON AGRICULTURAL LAND IN JAJI TOWN, IGABI LOCAL GOVERNMENT AREA, KADUNA STATE, Nigeria' has been performed by me in the Department of geography under the supervision of Prof. I.J. Musa and Dr. A.K Usman 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 presented for another degree or diploma at any university.

Kassim Adamu MOHAMMED

Name of Student	Signature	Date

CERTIFICATION

This Dissertation entitled 'GEOSPATIAL ANALYSIS OF THE EFFECT OF URBAN GROWTH ON AGRICULTURAL LAND IN JAJI TOWN, IGABI LOCAL GOVERNMENT AREA, KADUNA STATE, NIGERIA' by Kassim Adamu MOHAMMED meets the regulations governing the award of the degree of Master of Science of Ahmadu Bello University, Zaria, and is approved for its contribution to knowledge and literary presentation.

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Dr. A.K. Usman

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Dean, School of Postgraduate Studies	Signature	Date

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ABSTRACT

Urban Growth affects land cover at local, regional and global scales. Like other towns in Nigeria, Jaji 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 is to analyze the effect of urban growth on agricultural land, in Jaji town Igabi Local Government Area of Kaduna State, Nigeria using Remote Sensing and Geographic Information (GIS) techniques. LandSat Thematic Mapper (TM) 1994, Landsat Enhanced Thematic Mapper (ETM+) of 2004 and Lansat 8 (OLI) data of 2016 were used. The datasets were processed and classified into land use/land cover classes using supervised classification technique in ArcGIS 10.1. The built-up area and Agricultural land were extracted separately and the rates of growth between the periods (1994-2016) were ascertained. The built-up areas for the four time periods were overlaid in order to derive the urban growth map. The results revealed that built-up increased from 6.87 Km^2 in 1994 to 11.87 Km^2 in 2016 while agricultural land reduced from 68.9 Km^2 to 63.91 Km^2 within this same period. The built-up in the study area was increasing at the rate of 3.05% yearly while the agricultural land declined at the rate of 0.32% per annum within the period (1994-2016) studied. The finding in this study reveals that Jaji town is experiencing gradual encroachment of urban growth into agricultural lands. If this gradual encroachment is not address early, it will lead to rapid loss of agricultural lands. This will lead to reduction in food supply or agricultural produce in the study area. It is therefore recommended that Remote Sensing and Geographic Information System (GIS) technique which have proved to be efficient in the monitoring of urban growth and Agricultural activities be utilize efficiently to monitor urban growth encroachment into agricultural areas. This would help to control encroachment and reduce indiscriminate exploitation of Agricultural lands.

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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, 1999).

Urban growth simply means land conversion from nonurban to urban, or expansion of urban area into adjacent/ neighborhood agricultural, forest, wetland and other nonurban lands (Hasse and Lathrop, 2003). Urban expansion in itself may not be a problem, but rather the nature and patterns of the urban growth. Urban sprawl also known as suburban sprawl is multifaceted and encompasses multiple aspects of urban growth pattern and can be characterized based on urban land use pattern and its associated impact on urban spatial structure (form/morphology), rate of land conversion and land use intensity. The concept of sprawling includes spreading outwards (Hasse and Lathrop, 2003). 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, 2006). However, majority of the world's population today lives in urban areas thereby causing an unprecedented expansion of urban areas (Cohen, 2006; 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).

This process means that the natural environment suffers as more space is required for the construction of houses, roads, and 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; Brockehoff, 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).

However, due to rapid urban growth, coupled with poor monitoring strategy, this agricultural land is now threatened greatly which could be devastating if it is not properly managed. As built up areas are gradually encroaching into agricultural land. Hence the need to assess the effect of urban growth within the area especially as it affects the agricultural land.

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.

However, Jaji has witnessed influx of people because jaji is home to the armed forces command and staff college. Jaji is accessible through the Kaduna-Zaria express way and a railway station. Located in igabi local government area, Jaji features several commercial centers with prominent businesses. Jaji town is made up of sixteen villages' namely: Kargo dam, Labar, Husono, Sanho, Kanfanin fate, Babban rafi, Kanwa, Kwanan tsintsiya, Dan marke, Baru, Babban Bida, Doka, Unguwan Lauya, Kanzaure and Hayin kargo.

1.2 STATEMENT OF THE RESEARCH PROBLEM

Globally, urban centres over a half century ago in most developing countries have continued to witness unprecedented expansion in spatial urban growth. This expansion is premised on the perceived improvement in living conditions of the environment (Kombe and Kreibich, 2000). Thus, as settlements grow in size they become more complex with passage of time.

Cities in most developing countries like Nigeria have been undergoing unprecedented changes both in population and spatial extent (Adeboyejo and Abolade, 2006) and as a result are faced with a variety of problems such as uncoordinated land development, conflicting land uses, high densities in certain parts of the urban area and the absence of adequate road network which could ensure efficient intra-urban mobility within the city. One of the most important features of all of these centres is their increasing territorial extent and attendant poor spatial pattern of land use developments which are largely uncontrolled and unmonitored due to paucity of data and non-application of modern technology of information acquisition (Ikhuoria, 1995).

Base on my observation during the reconnaissance survey, Jaji town have started experiencing gradual urban growth expansion, urbanization and significant changes in its physical landscape.

The influx of people was due to several factors amongst which were employment, infrastructure and security due to the armed forces college situated at Jaji town. The increasing urbanization and sprawling pattern of development in Jaji have culminated into the gradual disappearance of fertile agricultural sites to peri-urban development and growth.

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).

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.

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.

Opeyemi, Zubair, Lazarus, Ojigi and Richard (2015) examined the Urbanization of Federal Capital City as a Catalyst for the Emergence of Squatter Settlements and Squalor in the Vicinities of the Federal Capital City**.** Landsat satellite images of Abuja in 1987, 2001 and 2006 were used in

mapping and analyzing the spatial growth of the city. The results of the study showed that squatter settlements and squalors have sprang up in and around the study area due to poor housing scheme, which made proper accommodation within the city unaffordable for low income residents of the city who were mostly civil servants. Their key recommendations includes periodic satellite image monitoring & mapping of the entire FCT as a means of detecting and controlling informal settlements across the territory and where it is practically impossible to relocate residents of the squatter settlements to a planned area, an upgrade of the existing squatter settlements should be considered.

Sunday and Abubakar (2013) examined the challenges of rapid urbanization on sustainable development of Nyanya in FCT Abuja. They used two Landsat ETM+ (30m resolution) satellite data images covering Nyanya settlement for year 2001 and 2010. They observed that the primary factor responsible for rapid urbanization of Nyanya within a short period is migration. Consequently, infrastructural services such as water supply, electricity power supply, good quality housing, good healthcare services are grossly inadequate. They recommended urgent need for the FCT Administration to embark on urban renewal of Nyanya. Also, a mechanism for periodic review and upgrading should be instituted to ensure qualitative built-urban environment.

Ade and Afolabi (2013) monitored urban sprawl in the Federal Capital Territory, Abuja using Remote Sensing and GIS Techniques. Multi-date Satellite images of 1987, 1999 and 2007 (Landsat TM, Landsat ETM+ and Nigeria Sat 1 respectively) were used. Supervised classification algorithm was used. They found out that the built-up area increased from 8% in 1987 to 22% in 2007. The results showed an average expansion rate estimated to be 5.23 square kilometres per year for the 1999-2007 periods. They recommended that, to support the increase in population and

physical growth rate observed, constant monitoring of urban growth is required to be sustained by anthropogenic activities.

Mahmoud, Alfred, Christopher, Michael and Halilu, (2016) analysed the spatiotemporal pattern of settlement expansion in Abuja, Nigeria. Three epochs of Land-use Land-cover (LULC) maps for 1986, 2001 and 2014 were derived from Landsat images using support vector machines (SVM). Accuracy assessment (AA) of the LULC maps based on the pixel count which resulted in overall accuracy of 82%, 92% and 92%, while the AA derived from the error adjusted area (EAA) method stood at 69%, 91% and 91% for 1986, 2001 and 2014, respectively. Quantitative spatiotemporal analysis was conducted to detect LULC changes with specific focus on the settlement development pattern of federal capital city (FCC). Logical transitions to the urban category were modeled for predicting future scenarios for the year 2050 using the embedded land change modeler (LCM) in the IDRISI package. Based on the EAA, the result showed that urban areas increased by more than 11% between 1986 and 2001. The value rose to 17% between 2001 and 2014. The LCM model projected LULC changes that showed a growing trend in settlement expansion, which might take over allotted spaces for green areas and agricultural land.

From the aforementioned works and other literature reviewed, none of the studies have attempted to monitor and measure the extent, rate and pattern of urban growth particularly in Jaji town. This is therefore the gap which this work intends to fill.

In order to achieve the purpose of this research work, the following guiding questions are devised:-

1. What is the extent and rate of urban growth in jaji town from 1994 to 2016?

2. What is the extent and rate of agricultural land loss in jaji town from 1994 to 2016?

3. What is the pattern of urban growth in the study area?

4. To what extent is urban growth responsible for the change in agricultural land within the

Study area?

1.3 AIM AND OBJECTIVES

The aim of this research is to analyze the effect of urban growth on agricultural land in Jaji town. The aim was achieved through the following objectives which are to:

i. examine the extent and rate of urban growth in Jaji town from 1994 to 2016.

ii. determine the extent and rate of agricultural land loss in Jaji town from 1994 to 2016

iii. determine the pattern of urban growth in the study area.

vi. determine the extent to which urban growth has affected agricultural land in the study area.

1.4 SCOPE OF THE STUDY

The spatial scope of this study is limited to Jaji town in Igabi Local Government Area which comprises of neighbourhoods like Kargo dam, Labar, Husono, Sanho, Kanfanin fate, Babban rafi, Kanwa, Kwanan tsintsiya, Dan marke, Baru, Babban Bida, Doka, Unguwan Lauya, Kanzaure and Hayin kargo. In terms of content, the study will look at the extent and rate of agricultural land loss, extent and rate of urban growth and to determine the pattern of urban growth on, especially how agricultural land is been converted into urban use in the area, while the temporal scope will cover the time periods of 22 years, that is from 1994 to 2016.

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 urban 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 urban growth 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 on the concept of urban, urban growth. 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 Area

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).

2.3 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 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. Jaji function road links several settlements together like Zaria and kano, to the Northwest and Abuja to the North to the 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). 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 LITERATURE REVIEW

Studies carried out by many researchers have stressed the significance of integrating Remote Sensing and GIS in urban studies (Jensen, 2005).

2.4.1 Measurement and Analysis of Urban Growth

Arvind and Nathawat (2006) carried out a study on land use land cover mapping of Panchkula, Ambala and Yamunanger districts, Hangana State in India. They observed that the heterogeneous climate and physiographic conditions in these districts have resulted in the development of different land use land cover. Digital analysis of satellite data indicates that majority of areas in these districts are used for agricultural purpose. The hilly regions exhibited fair development of reserved forests. It is inferred that land use land cover pattern in the area are generally controlled by agro – climatic conditions, ground water potential and a host of other factors.

Chigbu, *et al.,* (2011) analyzed Landuse and Landcover changes in Aba urban area between 1991, 2000 and 2005 using medium resolution satellite imageries (Landsat ETM+, of 2000 and Nigeria Sat-1, of 2005). The results reveal that from 1991, to 2005, the water increased from 15.1% to 22.1% and to 22.4% due partly to increasing activities within and around the waterways, built-up area increased from 21.7% to 26.8% and to 36.5%. Unlike river and built-up area, there is a significant disparity and trend in vegetation landcover due to rapid urbanization and socio economic activities. Thus, vegetation cover decreased from 63.2% in 1991 to 51.1% in 2000 and in 2005 it further decreased to 41.1%.

Davidson, Franka, Adams, and Ogbaje (2011) analysed urban expansion in Kogi state, central Nigeria, using Remote Sensing and GIS. LandSat TM of 1987, LandSat ETM+ (2001) and Nigeria

Sat-1 (2005) satellite imageries were used. Their analysis showed that the size of the built-up area (settlement) increased to 9.97 km^2 from 0.34 km^2within the period from 1987 to 2005, with over 162% growth rate indicating a rapid rate of physical development. Arising from this is thata substantial ecological resource is increasingly being lost due to the physical expansion. Other problems identified include flooding, over-stressed facilities and environmental pollution.

Akpu and Tanko (2012) determined the rate and pattern of the spatio-temporal Growth of Kaduna Metropolis, Kaduna State Nigeria, using GIS and Remote Sensing techniques. Visual interpretation method was used to sort the various datasets in to land use land cover classes. They found that the built-up area increased from 6,410.4ha in 1973 to 19,611.5ha in 2009, the city was growing at a rate of 5.72% annually and the areas towards the southern part of the River Kaduna was growing at a higher rate of 11.24% while the growth rate of the northern part was 3.71%.

Idoko, Bisong and Okon (2008) analyzed satellite imageries of 1987 and 2004 for the Federal Capital Territory, Abuja for land use change. The imageries were characterized into five classes using maximum likelihood algorithm. The classes were vegetation, built-up, rock outcrop, water body and farm land. The two classified imageries were compared to identify any changes. Also, a spatio-temporal change in land use type was obtained in quantitative terms. The analysis revealed that vegetation cover reduced by 85.22 per cent between 1987 and 2004. Again, the built-up area increased by 21.99 per cent and farm land increased by 0.14 per cent.

Oriye, (2013) analyzed urban expansion and urban land use in Ado Ekiti, Nigeria. The study used 10 years interval satellites images from 1956 to 2006 to monitor the change that have occurred in the study area. The data were analyzed in GIS for the expansion and questionnaires were dissemination to capture the land use changes that has resulted over the years. It was discovered

that Ado-Ekiti had an area of 2.5Km^2 in 1956, which increased to 6.9 Km^2 in 1996 and 36.7 Km^2 in 2006. It was also discovered that if nothing is done to stem the uncontrolled expansion, the area become 134.7 Km^2 in 2030.

Ade and Afolabi, (2013) monitored urban sprawl in the Federal Capital Territory of Nigeria Using Remote Sensing and GIS Techniques. Multi-date Satellite images of 1987, 1999 and 2007 (Landsat TM, Landsat ETM and Nigeria sat 1 were acquired and used in analyzing the physical expansion of the city overtime. Using supervised classification algorithm, the images were classified into built up, rock-outcrop, vegetation and water bodies and used to carry out change detection or time series analysis. The result showed that the built-up area increased from 8% in 1987 to 22% in 2007, rock-outcrop decreased from 74% to 37%, vegetation decreased from 40% to 17%, while the area occupied by water body has remained constant overtime. Also projection was done for population in the next nine years and 1,925,464.089 figures which are about 37% is expected. To support this increase in population and physical growth rate observed, constant monitoring of the urban growth is required to be sustained by anthropogenic activities.

Mahmoud, Alfred, Christopher, Michael and Halilu, (2016) analysed the spatiotemporal pattern of settlement expansion in Abuja, Nigeria. Three epochs of Land-use Land-cover (LULC) maps for 1986, 2001 and 2014 were derived from Landsat images using support vector machines (SVM). Accuracy assessment (AA) of the LULC maps based on the pixel count which resulted in overall accuracy of 82%, 92% and 92%, while the AA derived from the error adjusted area (EAA) method stood at 69%, 91% and 91% for 1986, 2001 and 2014, respectively. Quantitative spatiotemporal analysis was conducted to detect LULC changes with specific focus on the settlement development pattern of federal capital city (FCC). Logical transitions to the urban category were modeled for predicting future scenarios for the year 2050 using the embedded land change modeler (LCM) in

the IDRISI package. Based on the EAA, the result showed that urban areas increased by more than 11% between 1986 and 2001. The value rose to 17% between 2001 and 2014. The LCM model projected LULC changes that showed a growing trend in settlement expansion, which might take over allotted spaces for green areas and agricultural land.

Adepoju et.al (2013) explored the applications of an Integrated Remote Sensing and Geographic Information Systems to efficiently map, monitor, and provide spatial intelligence to effectively manage slum development in Nigeria. The NigeriaSat-2 and Ortho-rectified Spot-5 images were used for identifying, mapping and monitoring of Abuja slum development. The pixel-based classification technique that was applied to locate the spatial spread of the slums, effectively revealed through parameters such as irregular street patterns that are mostly unpaved or absence of roads, small size structures with high densities, less vegetation, tone difference due to roof covers amongst others. It was however found that informal settlements (slum) occupied a total of 340 hectares and were mostly found within the phase 2 of FCC. The result clearly indicates the spatial spread and the magnitude of the problems that is associated with its monitoring, management of the challenges that comes with it. It is obvious that Abuja slum development has continuously re-evolves despite government concerted effort at its total elimination through demolition. The need for a paradigm shift was emphasized in the approach such that slums will become integrated in to the city development through the provision of basic socio-economic amenities to upgrade and integrated them with the main city since it has become practically impossible to eliminated or even reduce the growth and spatial spread of the slums.

Opeyemi, Zubair, Lazarus, Ojigi and Richard (2015) examined the Urbanization of Federal Capital City as a Catalyst for the Emergence of Squatter Settlements and Squalor in the Vicinities of the

Federal Capital City. Landsat satellite images of Abuja in 1987, 2001 and 2006 were used in mapping and analyzing the spatial growth of the city. The results of the study showed that squatter settlements and squalors have sprang up in and around the study area due to poor housing scheme, which made proper accommodation within the city unaffordable for low income residents of the city who were mostly civil servants. Their key recommendations includes periodic satellite image monitoring & mapping of the entire FCT as a means of detecting and controlling informal settlements across the territory and where it is practically impossible to relocate residents of the squatter settlements to a planned area, an upgrade of the existing squatter settlements should be considered.

Deka, Tripathi, and Khan (2012) integrated remote sensing (RS), Geographic Information and Shannon entropy for urban growth trend analysis in North-East India in order to maintain a systematic urban growth pattern at regional or global level. The study was carried out to quantify the urban growth in Jorhat district of Assam using Shannon's Entropy Approach. The entropy values obtained in the study were 2.32 in 1996 and 2.49 in the year 2010 which are closer to the upper limit of log (n), i.e. 2.63, indicating a dispersed development.

Singh (2014) analyzed Urban Growth Using Shannon's Entropy in Rohtak City. The study makes use of Shannon's Entropy with the help of Geographic Information System (GIS) and Remote Sensing technique. The study was carried out over a period 38 years. On the basis of Survey of India Toposheet and satellite images, built up cover of Rohtak was classified for different time periods and Census of India was also used. The result revealed that the growth rate of built-up area was around three times more than population growth rate during 1989-2002. The growth rate in built-up area was 24.14% and population growth rate was 14.47% during 2002-2005.

Alsharif, Pradhan, Mansor and Shafri (2015) examined and assessed the urban expansion of Tripoli spatially and temporally by using remotely sensed data, geographic information systems (GIS), and the statistical relative Shannon entropy model. Remotely sensed data (four satellite images from 1984, 1996, 2002, and 2010) and GIS were used to determine the extent of urban area and urban growth in Tripoli in five different directions. Shannon's entropy model was implemented to analyze and assess urban expansion trends as a process and pattern in the study area. The results showed that the Tripoli metropolitan area has a high level of sprawl along its urban expansion history. The hypothesis employed for Shannon's entropy zone division produces good insights on overall urban growth, urban growth direction, and specific urban growth over time. The obtained results also provided good guidance for modelling urban sprawl processes, understanding urbanization causative factors, and predicting future urban patterns

Al Mashagbah, (2016) quantified the urban growth and trend in Zarqa city during the period between 1990 and 2014 using GIS and Remote sensing techniques with Shannon's Entropy statistical method. Three Landsat images for 1990, 2005 and 2014 were used for land use classification by using supervised maximum likelihood classification techniques to extract and assess the changes of urban lands. The results indicated that the urban areas in Zarqa city increased by 22.15% in the period from 1990 to 2005 and 14.86% from 2005 to 2014, with a rate of expansion of 0.96 and by 1.31 km2/ year for the two time periods respectively. The entropy value increased from 1.20 in the first period to 1.38 in the second, while the entropy value for the NE, NW, SE and SW zones showed high values, which confirmed that urban expansion and sprawling had existed in the past twenty four years in the study area.

CHAPTER THREE

STUDY AREA AND METHODOLOGY

3.1 INTRODUCTION

This chapter is concerned with the description of study area in terms of location, climate, geology, population, vegetation and soil. It has also enumerated all the required data collected and used to carry out the research and further explained how both the spatial and non-spatial data were processed; ranging from vectorization to the creation of Geo-database. The chapter also demonstrated the sampling technique adopted in selecting the LGAs within the study area and ultimately explained the methods of which the processed data were analyzed.

3.2 THE STUDY AREA

3.2.1 Location and Size

Jaji lies between Latitudes 10°48′0″N and 10°50'0"N of the equator and Longitudes 7°32′0″E and 7°35'0"E of the Greenwich meridian as shown in Fig. 3.1. Jaji town is in Igabi Local Government Area with an area of 3,727 km² (ZEDA, 2015), and an area density of 156.0/km².

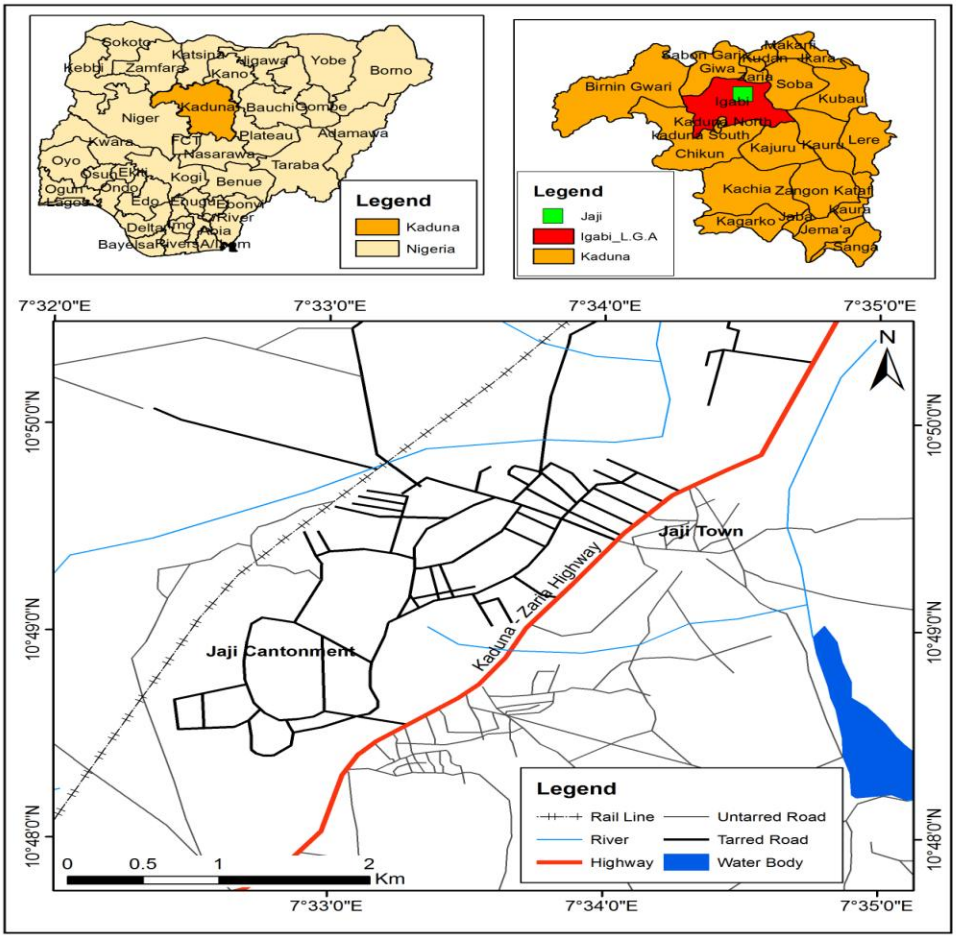


Figure 3.1: Jaji town
Source: Google earth, 2018.

3.2.1 Climate

The study area has a tropical continental climate type characterized by wet and dry season. The tropical continental is more pronounced in the dry season particularly in December and January. The dry season is dominated by the north-east trade winds called Hamattan which prevails between November to February. The dry season is also rainless from October to April. The wet season is dominated by the tropical maritime trade winds which start around May to October. The area has a mean daily temperature showing a major peak in April. As such, temperatures are hot all year round except for the dry cool and dusty

months of Hamattan in November to February. The maximum temperature seldom falls from about 36°c as in April to about 27°c in the heart of rainy season (August-October).

The annual rainfall is about 1000mm. These seasons are control by the movement of an imaginery line known as inter-tropical discontinuity (ITD), which is in turn dictated by two dominated trade winds, which are the tropical continental and tropical maritime. While according to Thornwaites moisture index the climate falls under the dry sub-humid type (Ayoade, 1988). This low and seasonal character of rainfall makes mark on the vegetation which assumes various shades of green in the rainy season and turn brown or yellow in dry season (Mortimore, 1970).

3.2.2 Soils and Vegetation

Generally, the soils and vegetation are typical red brown to red yellow tropical ferruginous soils and savannah grassland with scattered trees and woody shrubs. The soils in the upland areas are rich in red clay and sand but poor in organic matter. However, soils within the "fadama" areas are richer in kaolinitic clay and organic matter, very heavy and poorly drained, characteristics of vertisols. Fringe forests ("Kurmi" in Hausa) in some localities, and especially in the southern LGAs of the state, are presently at the mercies of increasing demands for fuel wood in the fast growing towns and urban centres (Mortimore, 1970).

The natural vegetation of the study area is that of the northern savannah with grass dominating and scattered trees hardly higher than 15ft with broad leaves. Meanwhile the seasonal character of rainfall in the study area has influenced the vegetation which turns evergreen during the wet season and pale brown in the dry season respectively. Thus the

dominant true species Arew Isoberlina Doka, Dodonea spp and grass communities consist of Hyperhenia and Andropgon species. In the city, proper the vegetation is characterized by silk cotton, Baobab and other protected trees. However man have greatly affected the vegetation formation in the area through his activities like; Bush burning, Cultivation of crops grazing, Lumbering, Urbanization and industrial activities among others. The vegetation formation varies and associated with distinct ecological site with particular regard to the nature of the soil (Oguntoyinbo, 1983).

3.2.3 Geology and Relief

The bedrock geology is predominantly metamorphic rocks of the Nigerian Basement Complex consisting of biotite gneisses and older granites. In the southeastern corner, younger granites and bathyliths are evident. Deep chemical weathering and fluvial erosion, influenced by the bioclimatic nature of the environment, have developed the characteristic high undulating plains with subdued interfluves (Mortimore, 1970). In some places, the interfluves are capped by high grade lateritic ironstone especially in the Northwest. However, rocky granitic residuals form inselbergs of varying sizes and shapes, and constitute the main local relief (relative relief is less than 150m).

The valleys are shallow but wide, stretching several tens of kilometres into the headwater areas with gentle sloping valley sides; imperceptibly grading into flat moist to marshy alluviated bottom lands or floodplains, called "fadamas" in Hausa. Although stream valley incisions and dissections of the high plains are evident in several areas, especially in the Igabi region, they are due more to anthropogenic influences and climatic factors than regional geologic instability (Mortimore, 1970).

3.2.4 Population

At the 2006 census, jaji town had a population of 30,168 people (NPC, 2006) and is one of the fastest growing town in kaduna state. Igabi Local Government Area was created in 1989 out of the Zaria Local Government. The L.G.A. is made up of three districts namely: Igabi, Rigachukun and Rigasa. It is one of 774 local governments Area (LGAs) in Nigeria and has a population of about 581,500 and a growth rate of +3.05 %/year (2006 → 2016) (NPC Projection, 2016).

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 urban growth and agricultural lands in the study area.

3.3.2 Types and sources of Data

In order to achieve the aim and objectives of this study, the types and sources of data used for the study are represented below (Table 3.3.2).

Table 3.1 Types and sources of Data

Types of data	Sources of data	Date of acquisition	Resolution
LandSat Thematic Mapper (TM)	Glovis	7-12-1994	30 meters
Lansat Enhanced Thematic Mapper (ETM+)	Glovis	27-11-2004	30 meters
Lansat 8 (OLI)	Glovis	19-10-2016	30 meters
	Literature materials Journals papers, Thesis, seminar paper, conference paper, text books and other related sources		

Source: Author's Analysis, 2018.

3.3.3 Data Processing

3.3.3.1 Image Sub-setting

The Satellite imageries were imported into ArcGis 10 environment. A subset covering the area of interest was extracted from the larger scene of Landsat MSS, Landsat TM and Landsat ETM+. 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.

3.3.3.2 Image Geo-referencing

The Landsat TM with a spatial resolution of 30meter, Landsat ETM+ with a spatial resolution of 30m and Landsat 8 (OLI) with spatial resolution of 30meter. The Landsat were imported into ArcGis 10 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.

3.3.3.3 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 3.2: Land use/Land cover Classification Scheme

Land use/Land cover Categories	Description
1 Built-up land	Residential, commercials, transportation and communication.
2 vegetation	Forest land, Natural forest, natural 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 Data Analysis

3.3.4.1 Land use/land cover change of the area for the period 1994-2016

The Land use/land cover change of the area was determined through broadly classifying the images into five different categories/ polygons viz: built-up, vegetation 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 (km2) 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 1994 minus the area coverage of built-up in 2004).

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

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

3.3.4.2 The extent and rate of the change of agricultural land within the study periods

To determine the extent of agricultural land in the study area, the urban growth and agricultural land 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 to produce the land use / land cover map and then extent of the agricultural land change was determined by subtracting the agricultural land extent/area from the reference year of 2016 from that of the base year of 1994.

Mathematically represented as:

$E_T = B\text{-}A$ (1)

A = the base year (1994)

B = the reference year (2016)

E_T = the total extent of change of agricultural land e.g. between 1992 and 2014.

In order to determine the rate of the agricultural land, statistical analysis was employed using the resulting values generated from the extent of agricultural land change to compare the data set for1994, 2004 and 2016 to get the change in kilometers, and was divided by the number of the years between the two time periods and subsequently converted to percentage to obtain the rate of change between the spatio-temporal periods of 1994-2016. It is mathematically represented as:

$R = E_T$

$$R = \frac{E_T}{\text{number of years}} \quad (2)$$

Where R = Rate of agricultural land change

E_T = Total extent of Agricultural land change

To get the percentage = $\mathcal{R} = (R)/\ 100\%$ (3)

3.3.4.3 The extent and rate of urban growth within the study period

To determine the extent of urban growth in the study area, the urban growth 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 to produce the land use / land cover map and then extent of the urban growth was determined by subtracting the urban growth extent/area from the reference year of 2016 from that of the base year of 1994.

Mathematically represented as:

E_T = B-A (1)

A = the base year (1994)

B = the reference year (2016)

E_T = the total extent of urban expansion e.g. between 1992 and 2014.

In order to determine the rate of the urban growth, statistical analysis was employed using the resulting values generated from the extent of urban growth to compare the data set for1994, 2004 and 2016 to get the growth in kilometers, the total growth in kilometers was then divided by the

number of the years between the two time periods and subsequently converted to percentage to obtain the rate of urban growth between the spatio-temporal periods of 1994-2016. It is mathematically represented as:

$$R = E_T$$

$$R = \frac{E_T}{\text{number of years}} \quad (2)$$

Where R =Rate of urban expansion

E_T =Total extent of urban expansion

To get the percentage = $\mathcal{R} = (R)/\ 100\%$ (3)

3.3.4.4 The extent to which urban growth has affected agricultural land in the study area (Pattern of urban growth).

The land use/ land cover maps prepared from the images were used to assess changes in land use land cover. The built-up and agricultural land was overlaid to show the level of urban encroachment into agricultural lands 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 agricultural land in the study area over the periods.

Statistical analysis was employed using the resulting values generated from the extent of urban expansion to compare the data set for1994, 2004 and 2016 to get the expansion in kilometers, the total expansion in kilometers was then divided by the number of the years between the two time periods and subsequently converted to percentage to obtain the extent to which urban growth has affected agricultural land in the study area between the patio-temporal periods of 1994-2016.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 INTRODUCTION

This chapter deals with presentation and discussion results obtained from the analysis. This was carried out under the following sub-themes: characterization of land-use/land-cover, land-use land-cover change, extent, rate of agricultural land loss and urban growth, pattern of urban growth, as well as the extent to which urban growth has affected agricultural land 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 agricultural land within the study area.

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

The land-use/land-cover classes of Jaji town in 1994, 2004, and 2016 were characterized into five prominent classes which include: Built-up, Agricultural land, Forest land, Bare land and Water bodies. The area and percentage coverage of each of the class is depicted in Table 4.1 as shown below.

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

	1994		2004		2016	
Land Use	Ha	%	Ha	%	Ha	%
Agric land	59.74	66.70	68.59	76.58	63.91	71.35
Built up	6.87	7.67	8.90	9.94	11.48	12.82
Vegetation	10.84	12.10	9.60	10.72	9.72	10.85
Bare land	11.78	13.15	2.10	2.34	4.20	4.69
Water body	0.34	0.38	0.38	0.42	0.26	0.29
Total	89.57	100	89.57	100	89.57	100

Source: Author's Analysis, 2018.

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 1994 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 (59.74%), followed closely by bare land (11.78%) while vegetation, built-up and water body amounted to 10.84%, 6.87% and 0.34% respectively.

The image classification resulted from 2004 Landsat TM (Fig4.2), shows that agricultural land still remains the major land use land cover with an increase to 68.59%, Bare land and vegetation has decreased to 2.1% and 9.6% while built-up and water body increased slightly by 8.9% and 0.38%.

Results generated from Landsat ETM 2016 (Fig4.3) recorded a decrease in the proportion of agricultural land (63.91%) and built-up areas increases to (11.48%) while vegetation, bare land increase to 9.72%, 4.2% and water body still experienced a tremendous decline by 0.26% within that same study period. The Land-use/Land-cover maps for the three years of the study depicting the five Land-use/land-cover classes were generated and presented in Fig. 4.1, 4.2, and 4.3.

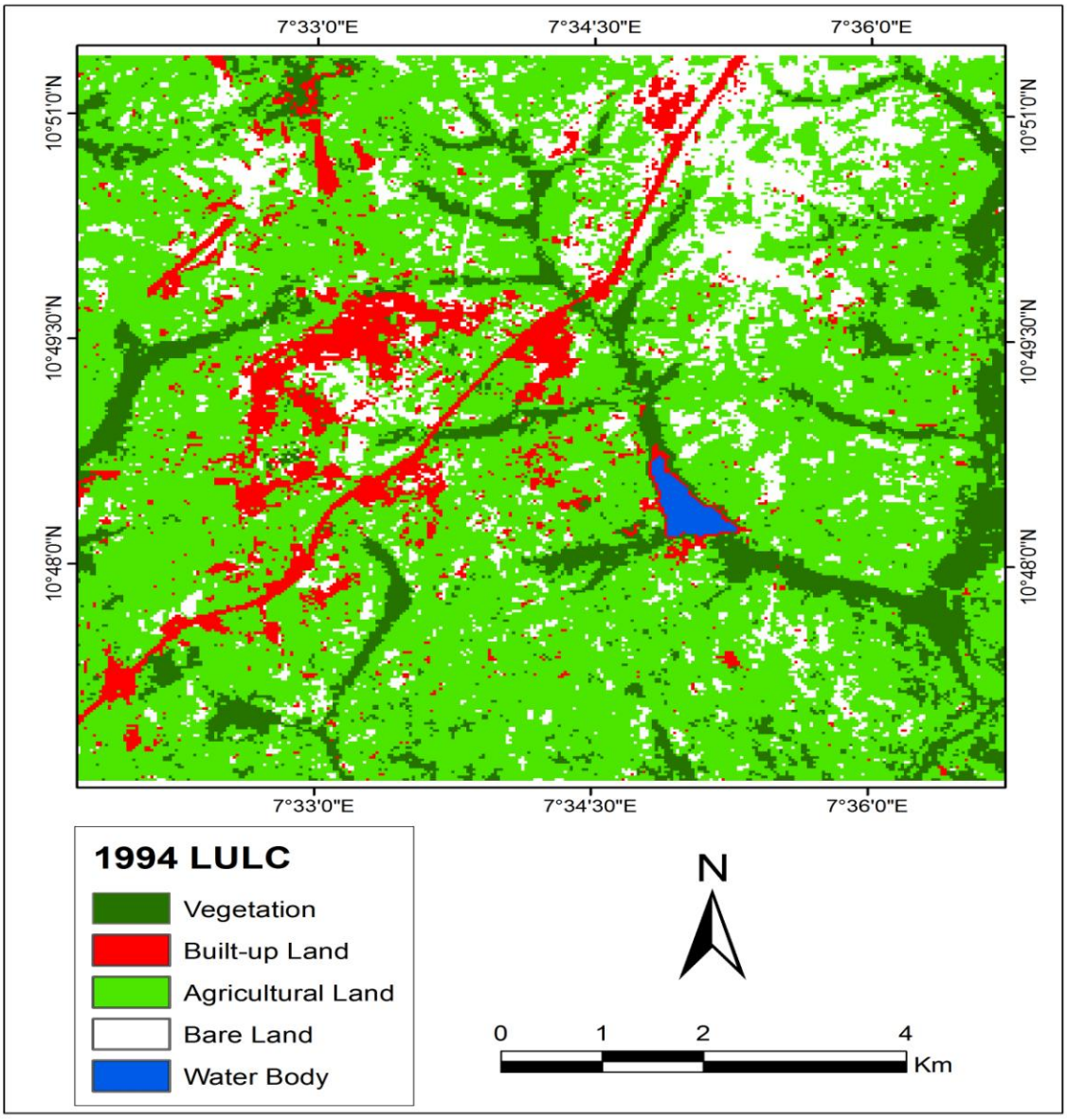


Fig 4.1: Land use/Land cover of the Study Area 1994
Source: Authors Analysis, 2018.

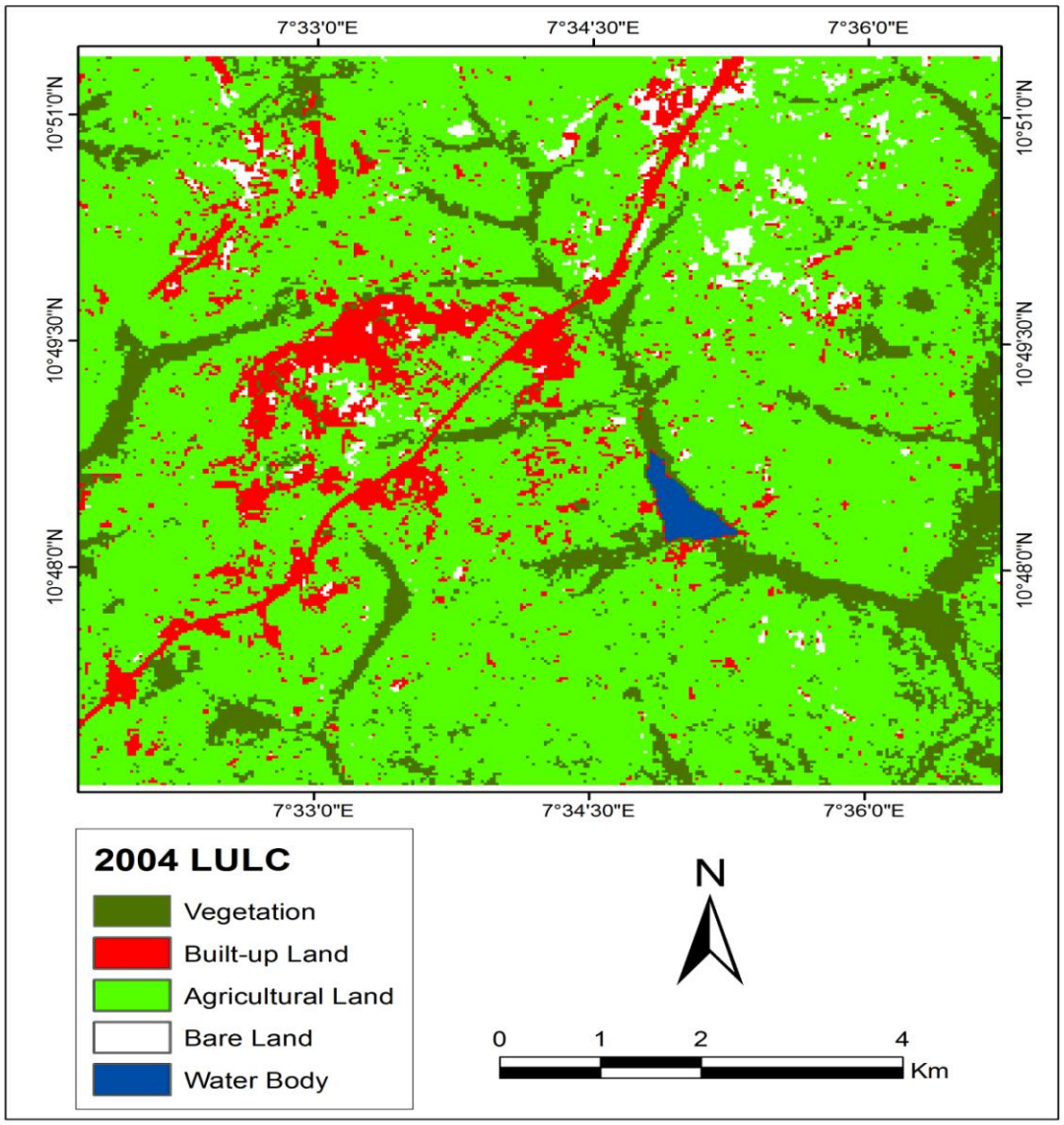


Fig 4.2: Land use/Land cover of the Study Area 2004
Source: Authors Analysis, 2018.

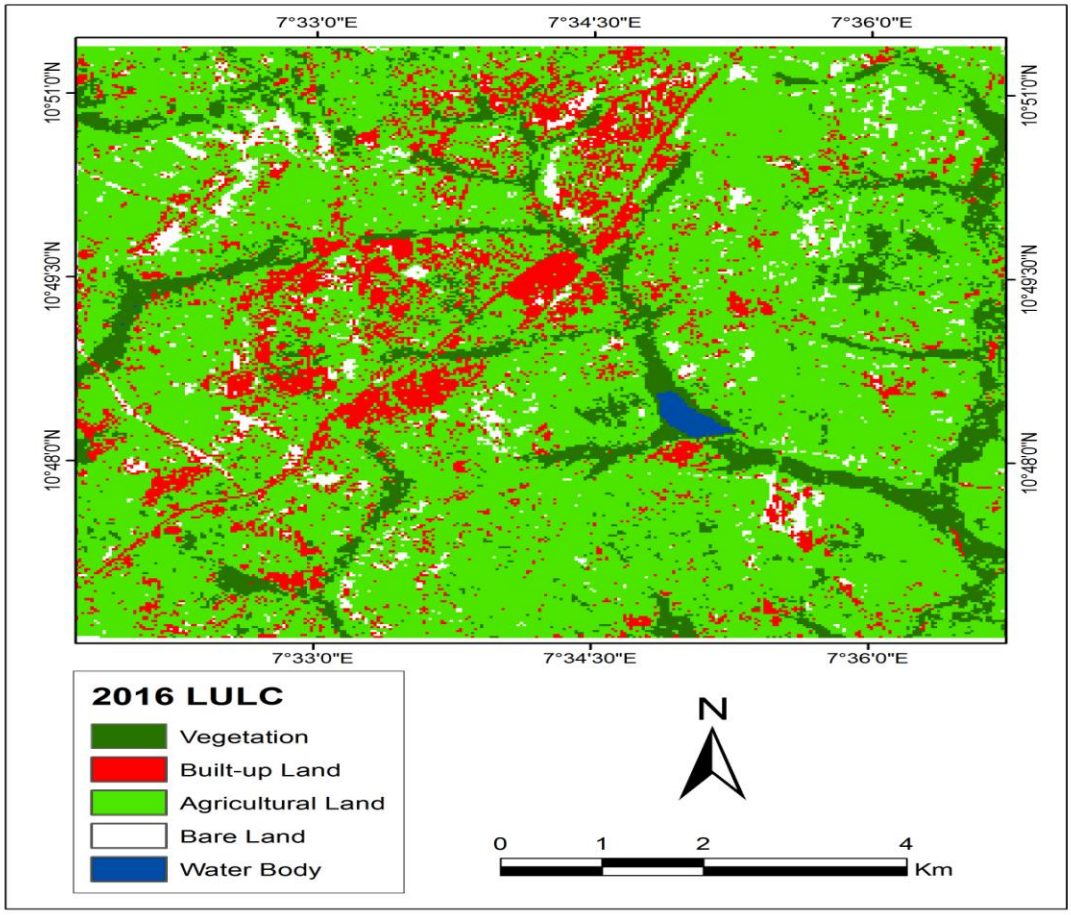


Fig 4.3: Land use/Land cover of the Study Area 2016
Source: Authors Analysis, 2018.

This implies that built-up is fast encroaching into the agricultural 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 agricultural 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 on the other area occupied by agricultural land 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 vegetation due to clearing as well as along or on roads mostly when it is unpaved.

4.3 Extent and Rate of Urban Growth

The result of Extent and Rate of Agricultural Land Loss of the study area between from 1994-2004, 2004-2016, and 1994-2016 is presented in Table 4.2.

Table 4.2 Extent and Rate of Urban Built-up from 1994 and 2016

Built-up Land			Extent of Expansion		Rate of Expansion	
Period	Year	Km^2	Km^2	%	Km^2/Year	%/Year
1994-2004	1994	6.87	2.03	29.55	0.20	2.96
10Years	2004	8.90				
2004-2016	2004	8.90	2.58	28.99	0.22	2.42
12Years	2016	11.48				
1994-2016	1994	6.87	4.61	67.10	0.21	3.05
22Years	2016	11.48				

Source: Author's Analysis, 2018.

Table 4.2, revealed the extent and rate of urban growth from 1994 to 2016 in the study area. In 1994 to 2004 built up was at 29.55% (2.03 Km^2) and in 2004 and 2016 built up areas has slightly decreased to 28.99% (2.58 Km^2) and drastically increase to 67.10% (4.61 Km^2) at an annual rate of 3.05% (0.21 Km^2) respectively from 1994 to 2016. This may be due to the creation of Igabi Local Government Area was created in 1989 out of the Zaria Local Government. More so, jaji is accessible through the kaduna-zaria express way and a railway station located in igabi local

government area, jaji is home to the armed forces command and staff college. Jaji features several commercial centers with prominent businesses.

The improvement or rather increase in the built-up area could be attributed to the location of the armed forces college which triggered the need for people to acquired land to build on, and the security enjoy 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 increase in human population over time. More so, the evidence of this urban expansion could be seen in built-up map of the study area in Fig.4.4, 4.5 and 4.6.

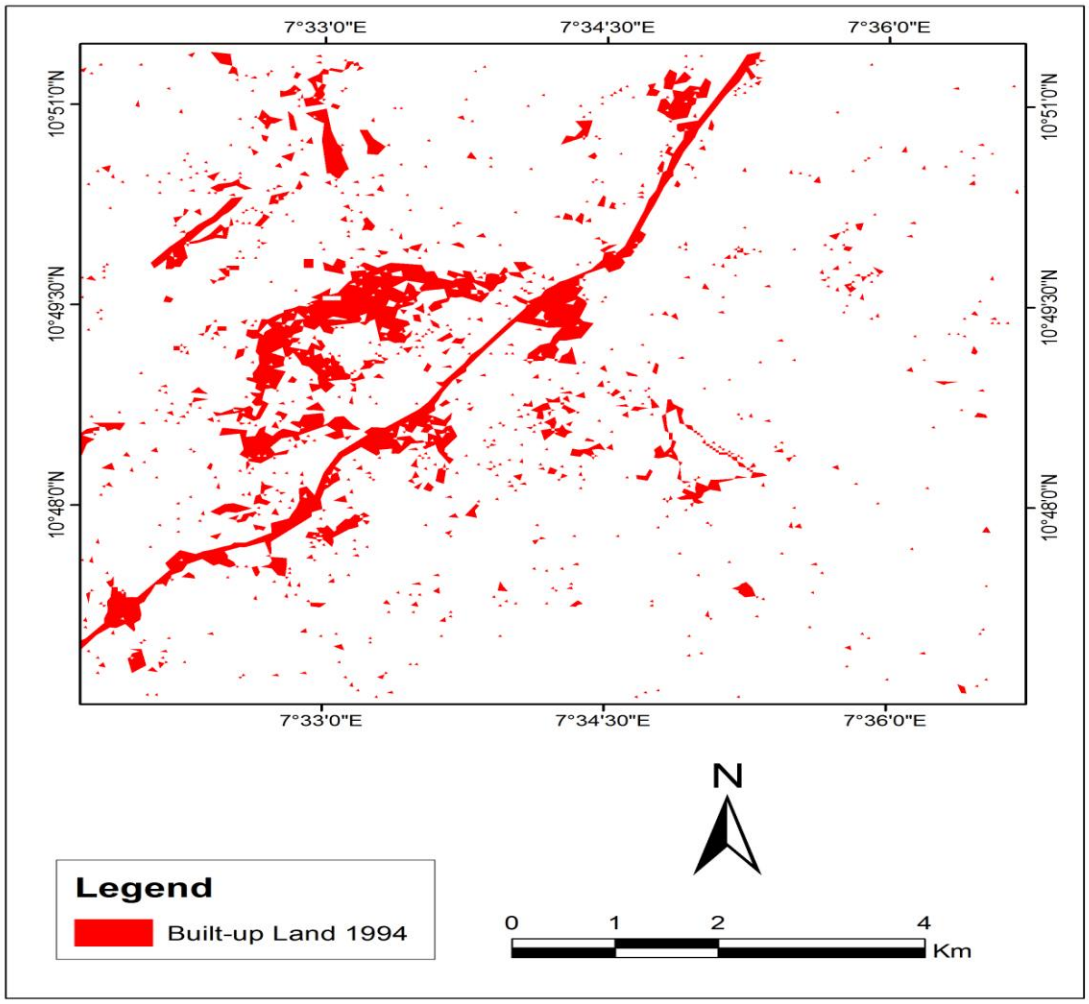


Fig 4.4: Built-up Area 1994
Source: Authors Analysis, 2018.

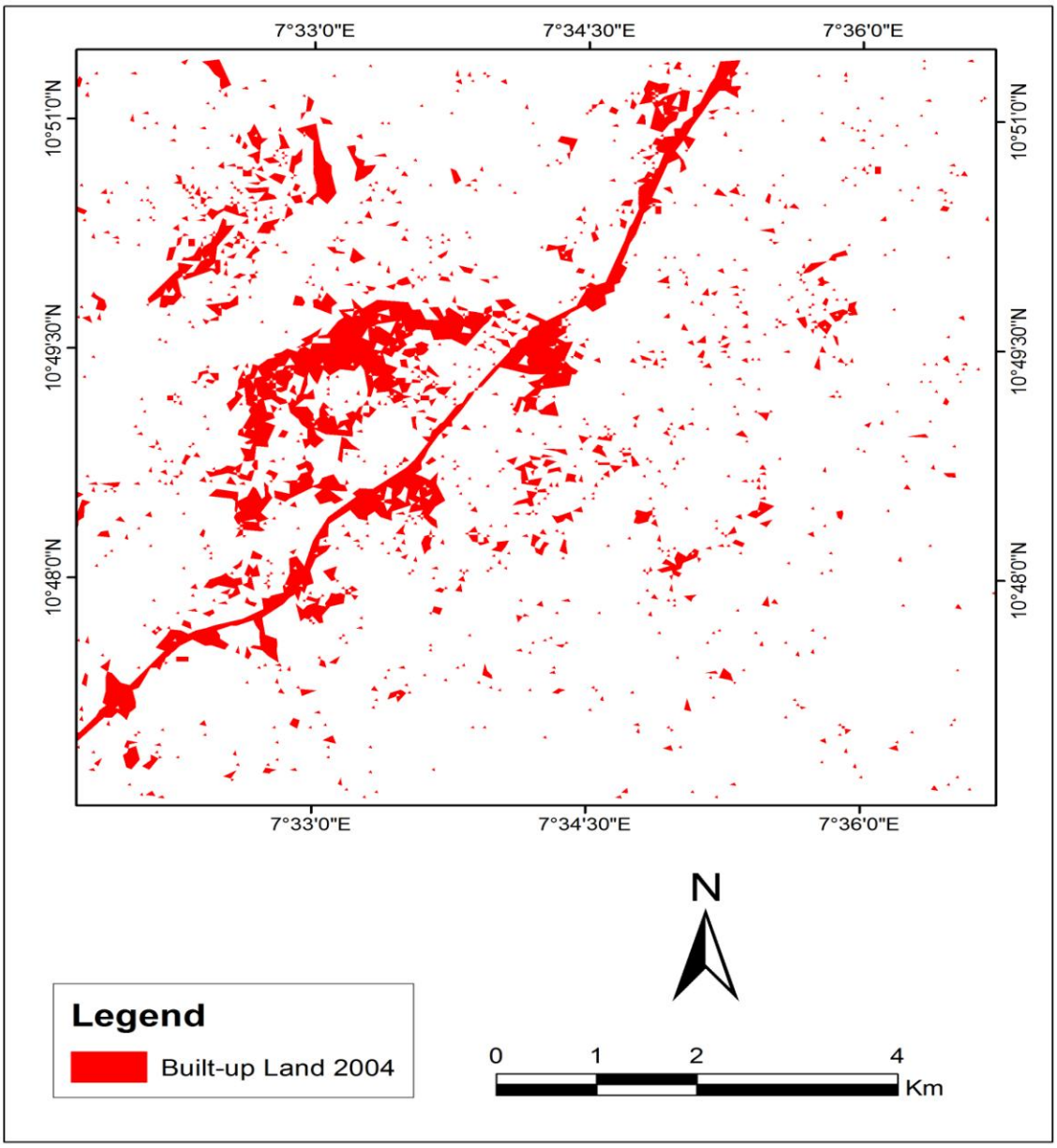


Fig 4.5: Built-up Area 2004
Source: Authors Analysis, 2018.

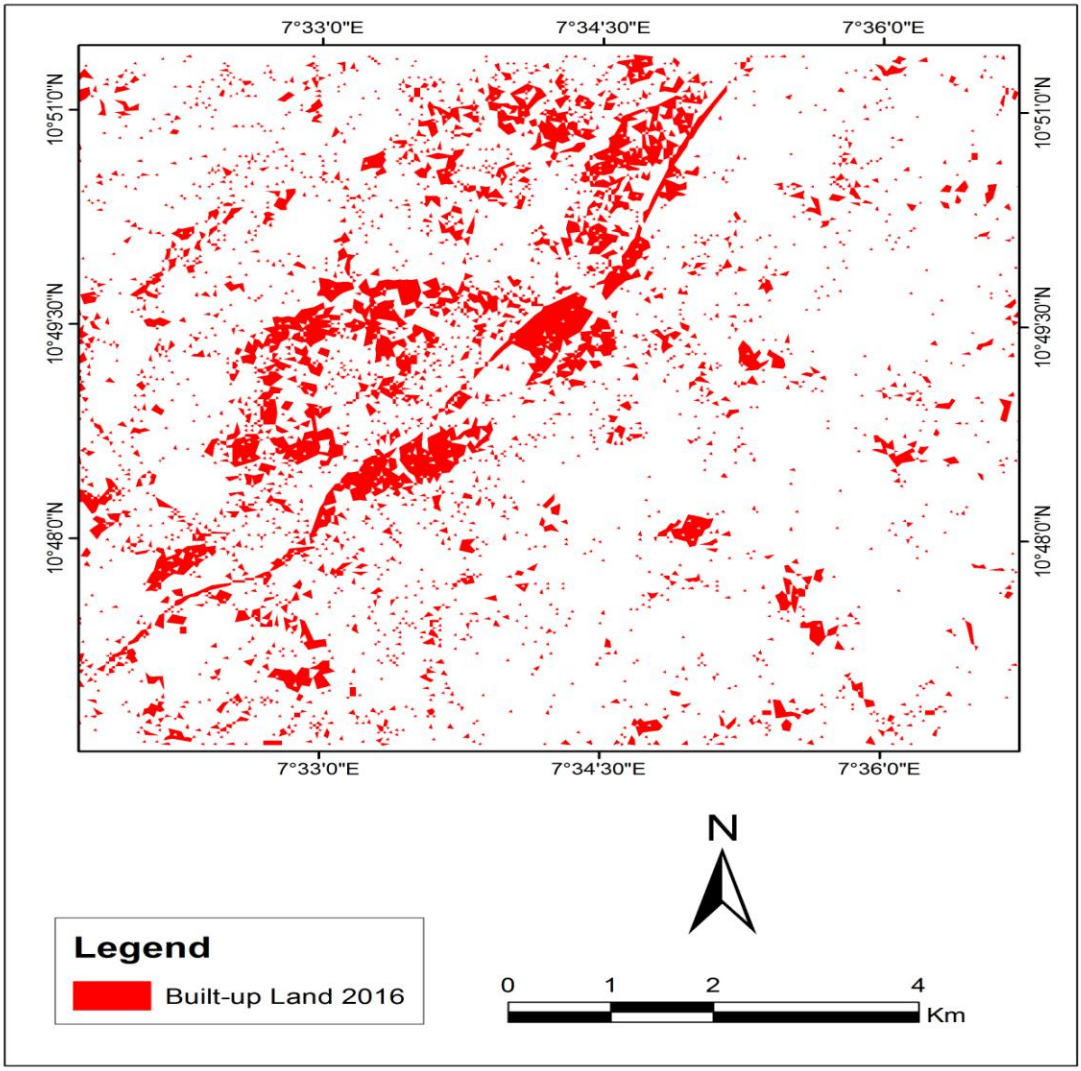


Fig 4.6: Built-up Area 2016
Source: Authors Analysis, 2018.

4.4 Extent and Rate of Agricultural Land Loss

The result of Extent and Rate of Agricultural Land Loss of the study area between from 1994-2004, 2004-2016, and 1994-2016 is presented in Table 4.3.

Table 4.3: Extent and Rate of Agricultural Land Loss from 1994 and 2016

Agricultural Land			Extent of Expansion		Rate of Expansion	
Period	Year	Km^2	Km^2	%	Km^2/Year	%/Year
1994-2004	1994	59.74	8.85	14.81	0.89	1.48
10Years	2004	68.59				
2004-2016	2004	68.59	-4.68	-6.82	-0.39	-0.57
12Years	2016	63.91				
1994-2016	1994	59.74	-4.17	-6.98	-0.19	0.32
22Years	2016	63.91				

Source: Author's Analysis, 2018.

Table 4.3, revealed the extent and rate of agricultural land loss from 1994 to 2016 in the study area. In 1994 to 2004 agricultural land was at 14.81% (8.85 Km^2), in 2004 to 2016 agricultural land decreased by - 6.82% (-4.68 Km^2) and - 43.5% respectively. From 1994 to 2016, agricultural land has drastically reduced by -6.98%, (-4.17 Km^2).

Using overlay analysis the portion of the study area occupied by built-up for each study year was clipped on the agricultural land cover to see the amount of the original agricultural land displaced by the built-up as shown below in Fig. 4.7, 4.8 and 4.9.

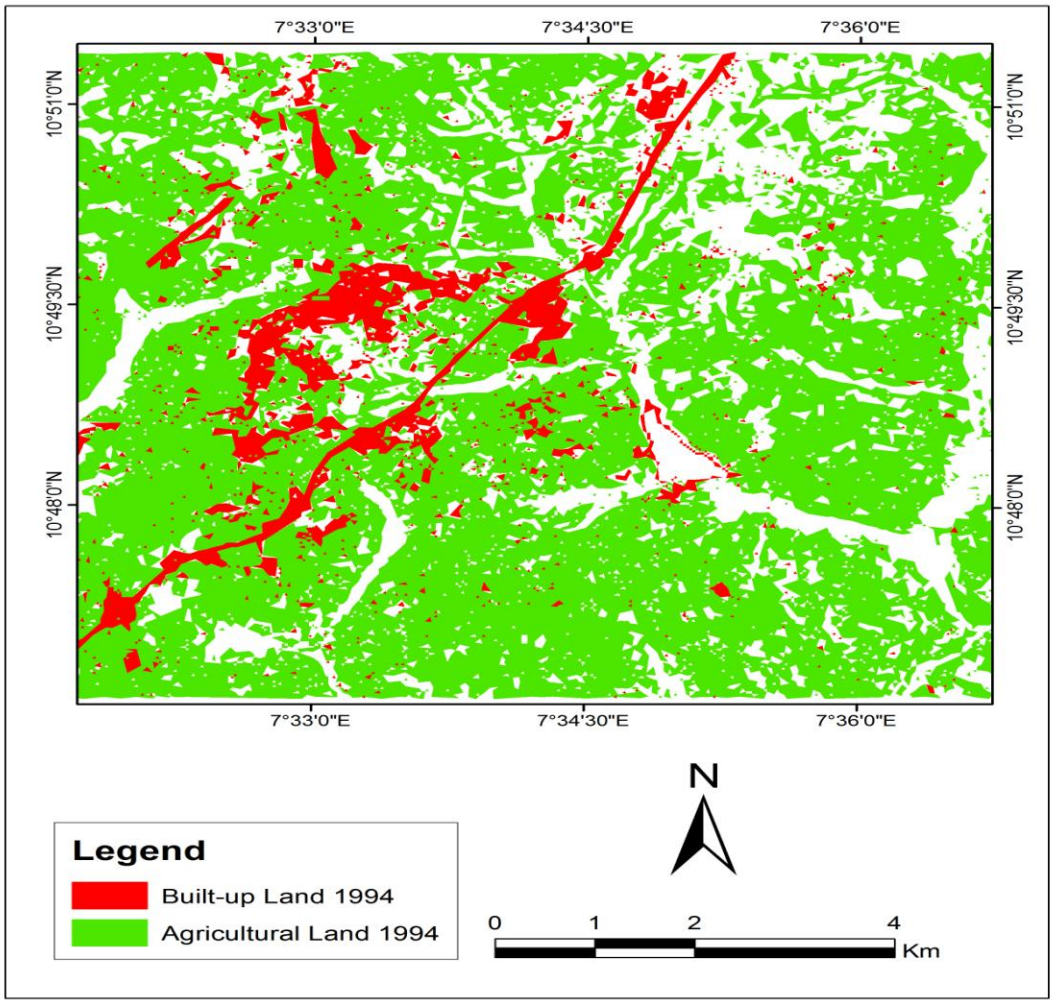


Fig 4.7: Overlay built up on Agricultural Land of the Study Area1994
Source: Authors Analysis, 2018.

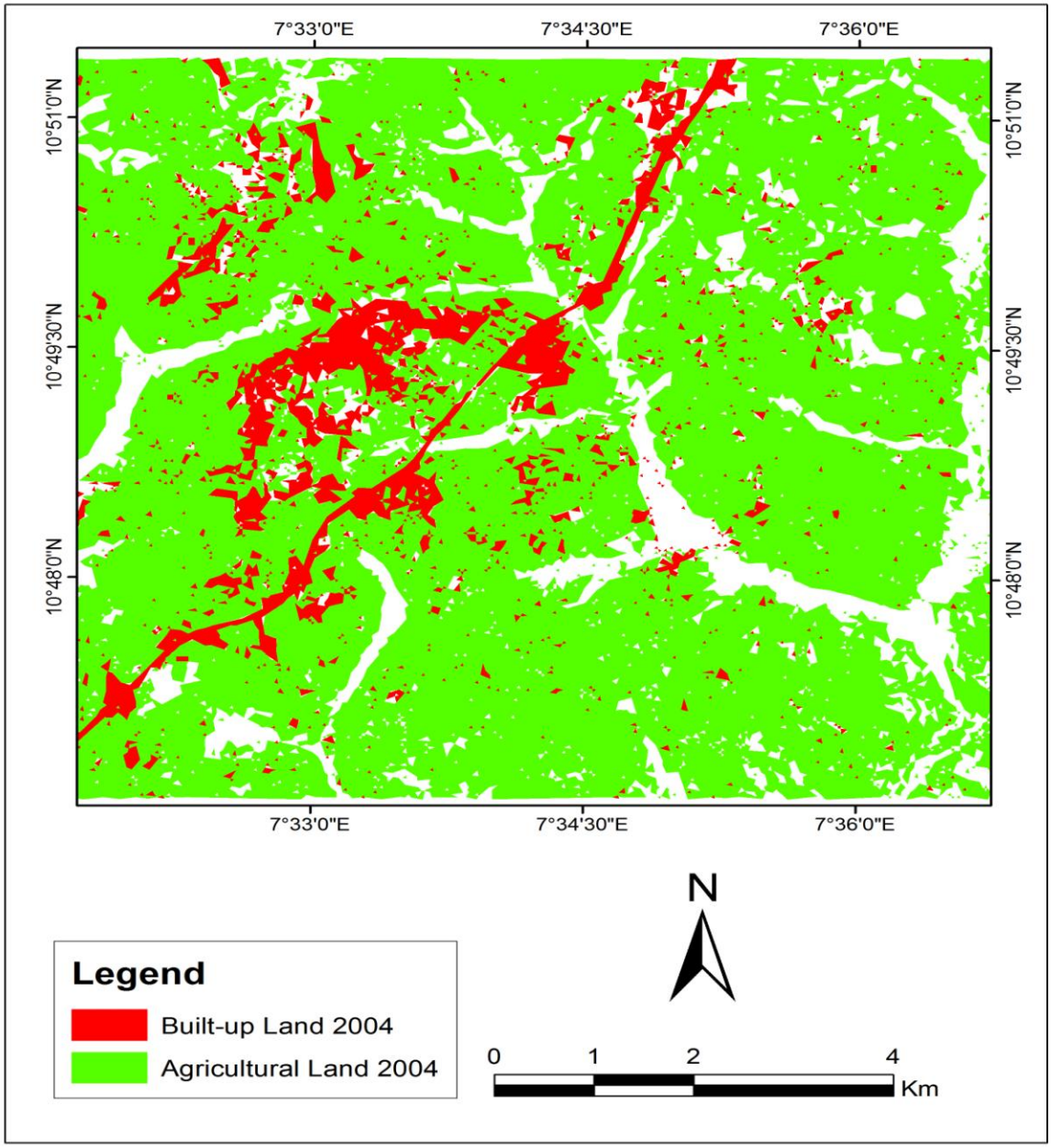


Fig 4.8: Overlay built up on Agricultural Land of the Study Area 2004
Source: Authors Analysis, 2018.

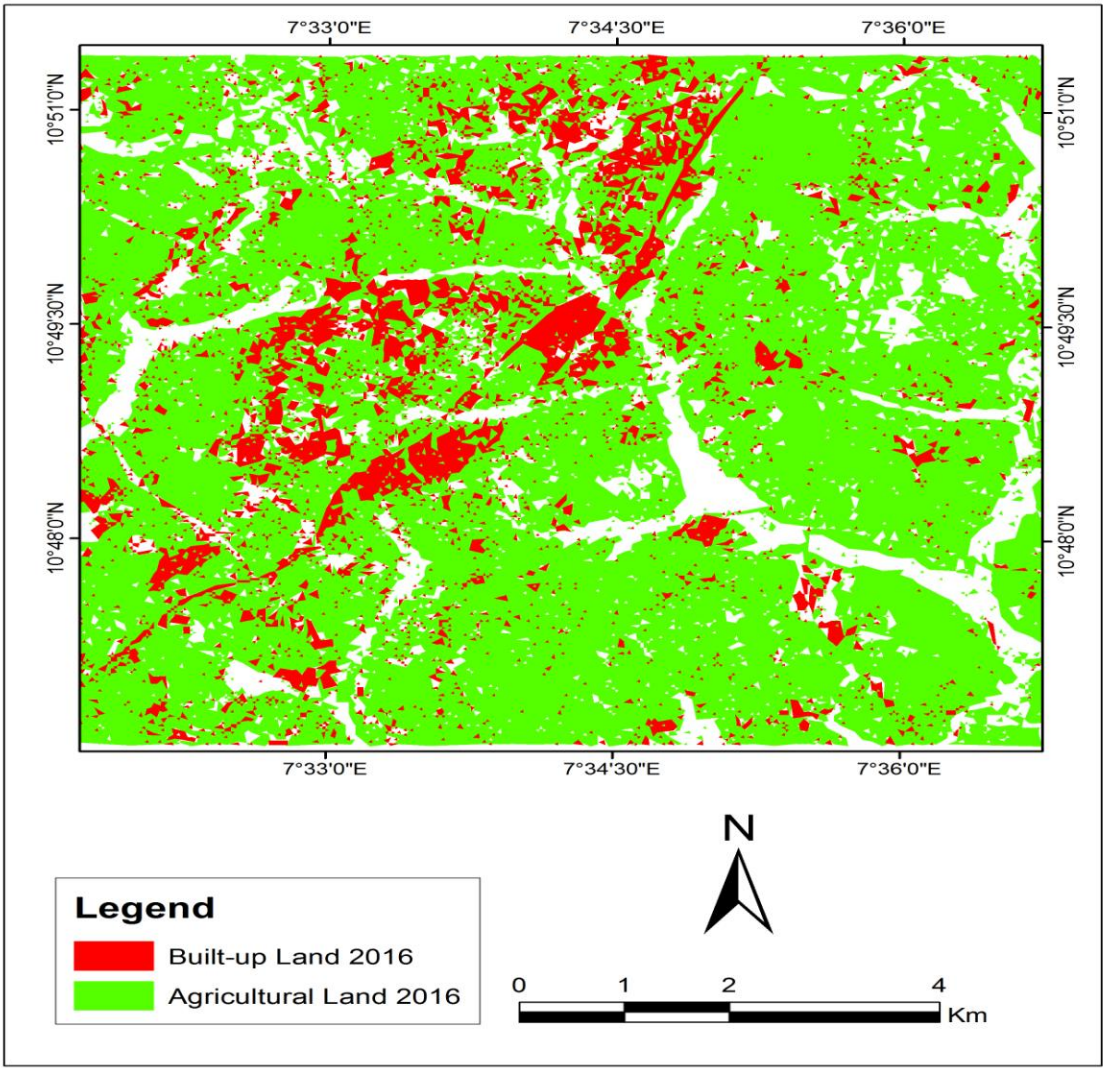


Fig 4.9: Overlay built up on Agricultural Land of the Study Area 2016
Source: Authors Analysis, 2018.

The overlay analysis shows a clear evidence of physical expansion encroaching into the agricultural land. Furthermore, the period 1999-2016 experienced a rapid urban encroachment, areas formally occupied by agricultural land is almost being cleared giving room for physical development in the area. This succession could also be attributed to Jaji town been home to the armed forces command and staff college. Jaji town features several commercial centers with prominent businesses. 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 agricultural land in the study area as shown in the Map of the overlay analysis above.

Lastly, the rate of urban growth from 1994- 2004 revealed that, built-up has encroached agricultural land at the rate of 2.96% (0.20 Km^2), in 2004 to the rate of 2.42% (0.22 Km^2) Within the 22 years study period, urban growth has increase to the rate of 3.05% (0.21 Km^2) from 1994 to 2016.The result showed a clear indication that physical development has and is taken over, as represented in fig 4.10.

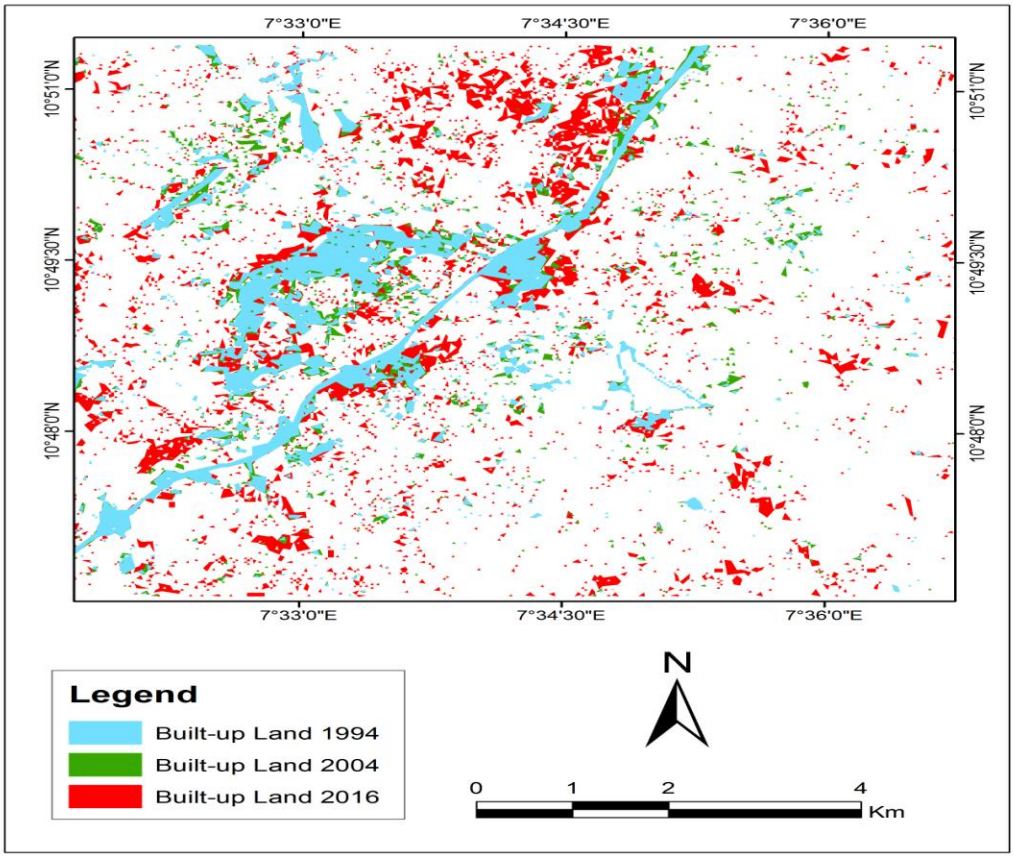


Fig 4.10 Pattern of Urban Growth
Source: Author's Analysis, 2018.

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 Jaji town 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 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.

4.5 EXTENT TO WHICH URBAN GROWTH HAS AFFECTED AGRICULTURAL LAND IN THE STUDY AREA

The rate of the change on agricultural land between 1994- 2004 revealed that, built-up has encroached agricultural land at the rate of 1.48%, in 2004 to -0.57%. Within the 22 years study period, on the other hand, agricultural land reduced at the rate of -0.32%. The result showed a clear indication that physical development has taken over, as represented in fig 4.11.

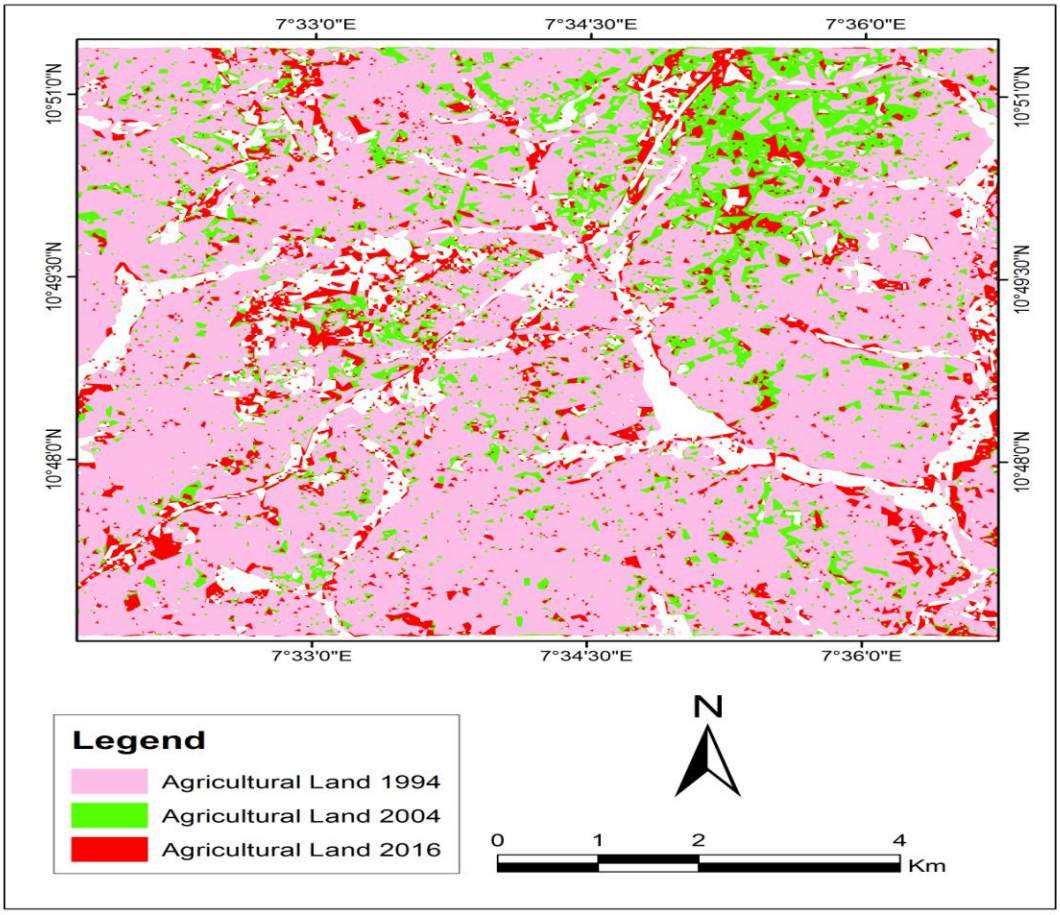


Fig 4.11 Extent to which urban growth has affected Agricultural Land
Source: Author's Analysis, 2018.

The increase in physical development coupled with inadequate monitoring of the land administration led to the encroachment. The sharp increase was attributed to the development in transport network, presence of some basic amenities, primary health care as well as the movement of Armed Forces College. 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 urban growth resulted in the removal of agricultural land in the area mostly for the purpose of construction, cultivation, cooking energy and electric poles.

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).

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

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 Agricultural land in Jaji town of Igabi Local Government Area of Kaduna State. The finding of this research revealed evidence of gradual urban growth over the study period as the land cover had percentage coverage of 7.67% in 1994, 9.94% in 2004 and 12.82% in 2016.The agricultural land have shown a continuous decrease the built-up area shows a continuous increased within the period of study while vegetation and bare land declined. However, the analysis revealed that built-up has eating up the agricultural land most part of the study area is still rural as most people within the study area still engage in agricultural activities.

The period 2004-2016 recorded the highest annual growth (2.42%) while the average annual growth rate within the study period (1994 - 2004) was 0.20%.Unplanned expansion has led to conversion of agricultural land and bare land into physical development. The highest proportion of agricultural land loss was noticed from 1994-2016 with an annual rate of 3.05%, within this same study period, about 4.17 km^2 of land which amounted to about 6.98% was added to built-up land.

5.3 CONCLUSION

This study reveals high rate of urban encroachment in Jaji town. There is serious encroachment of physical development and these could be attributed to unplanned urban growth and inadequate monitoring of the agricultural land. If this situation continues at this rate, the agricultural land and 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 1994 to 2016, the following are recommended:

Proactive measure should be taken in Jaji town and Igabi 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 Ministry of lands and survey and country planning, now (KADGIS) 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 in the area.

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

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