ASSESSMENT OF URBAN ENCROACHMENT ON AGRICULTURAL LAND IN OFFA LOCAL GOVERNMENT AREA, KWARA STATE, NIGERIA

BY

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DECLARATION

I hereby declare that this thesis entitled "Assessment of Urban Expansion on Agricultural Land in Offa Local Government Area, Kwara State, Nigeria" is entirely my own research work under the supervision of Dr. Ibrahim Jaro Musa and Dr. David Nyomo Jeb. Where works of other persons have been used or referred to, such have been duly acknowledged.

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CERTIFICATION

This thesis entitled **"Assessment of Urban Expansion on Agricultural Land in Offa Local Government Area, Kwara State, Nigeria"** by MOHAMMED Surajudeen Ayobami meets the requirements governing the award of Masters Degree in Remote Sensing and Geographic Information System in Ahmadu Bello University, Zaria, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This work is entirely dedicated to Almighty Allah, the Eternal and Subtle who have been my source of inspiration and guidance throughout the period of my study; and late parents, Alh and Hajia Mohammed A.B , may Allah Almighty keep on showering His ultimate mercy and forgiveness on them till eternity Amin.

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ABSTRACT

Urban expansion constitutes one of the key agents of land use change with the impact felt at local, regional and global levels, such impact include spatial growth on agricultural land. This study assesses urban encroachment on agricultural land in Offa Local Government Area of Kwara State, Nigeria using Remote Sensing and Geographic Information techniques. Three imageries of LandSat TM 1990, LandSat ETM 1999 and Nigeria Sat X 2014 used processed, classified using supervised classification, and analyzed in Erdas Imagine 9.2 and ArcGIS 10.1 environment to assess the total spatial loss of agricultural land to urban expansion. Built – up and Agricultural land were extracted from the imageries and the spatial growth and loss within the study period was established. The findings revealed that the study area witnessed a significant reduction and increase in agricultural land and built – up respectively. Agricultural land occupying the highest coverage of 148.63 km² (65.36%) in 1990 decreased to 107.18 km² (47.14%) in 2014. The total spatial loss was 41.45 km² (27.89%) at an annual rate of 1.73 km² within the same period. While the built-up area expanded from 17.5km² in 1990 to 65.09 km² in 2014, total spatial change of 47.52 km² (270.40%) was experienced with at annual rate of 1.98 km² (11.27%) within the study period (1990 – 2014)**.** The comparison of these results shows that 43.50 km² (19.13%) of agricultural land in the study area was lost to urban expansion within the study period at an annual conversion rate of 1.81 km². From the foregoing, it is recommended that urban spreading to agriculture land should be controlled as this will have serious repercussions on food security, although urban expansion cannot be stopped, but with proper management and planning it can be directed in a desirable and sustainable way.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

The world is rapidly urbanizing, and it has witnessed a tremendous shift of its population from being predominantly rural to predominantly urban in the last two decades (De Sherbinin, 2007). The world's population is estimated to be 7.01 billion and by the year 2030, more than 60% of this population will be living in urban areas especially in developing countries, consuming close to three-quarters of the world's natural resources, and generating three quarters of its pollution and wastes (Peters, 2000; Redman and Jones, 2005). This growth will require unprecedented investment in new infrastructure and create serious challenges for political and social institutions.

Rapid expansion of urban centers in the world at large and specifically in developing countries has continued to pose great challenges such that evokes interests from ecologists, planners, civil engineers, sociologists, administrators and policy makers on how much expansion is taking place, the effects on agricultural land and possible solution. It serves as a strong agent of land use/land cover change, hence loss of agricultural land (Olawole, Msimanga, Adegboyega, and Adeshina, 2011), and equally contributes to development; a requirement for and a result of economic, cultural and social development, as well as engines of economic growth and poverty alleviation (World Bank, 2009**).**

The process of urban expansion is a worldwide phenomenon which could be seen in the history of all urban centers; it is one of the important areas of man's interaction with his environment and appears to have direct effect on the available agricultural land and food security. The continued

increase in human population, loss of agricultural lands, and the changing global climate are factors that may influence the ability of societies to sufficiently grow food to feed the world's population (Brown, 1995; Bender, 1997).

Urban expansion, according to Manish, Aruna, and Vivek (2012) is the horizontal or vertical outward extension of urban area over the adjacent agricultural land; it is a natural process which consumes many hectares of prime agricultural lands from their surrounding every year. It comes about through the transformation of non-urban land (for example, farmland) into urban land (such as residences, parks, shops and factories). Such a transformation of land is one way, and once transformed, it is very difficult to return urban land back to the original land use (Lin, Yohei, and Haihong, 2003). It also involves both the internal reorganization and outward expansion of the physical structure of urban areas which results in loss of prime agricultural farmlands and natural beauties (Shishay, 2011).

The term "urban expansion" has become synonymous with the creation of visual blight and the loss of natural habitat, not all of its effects are negative. In its simplest form, it is nothing more than expansion which normally occurs away from the dense areas of existing urban development. The need for urban expansion continues to escalate as the population continues to increase (Almeida, 2005). Typically, urban expansion is being perpetuated due to the low cost of the agricultural land that is being converted or transformed, accompanied with an increase in accessible transportation network which increases the ability of the workforce to move out from the densely developed, urban areas (Glaeser and Kahn, 2003). These expansions inevitably cover some agricultural land especially in developing countries, because there is either the absence of concrete land-use plan (strategic planning framework), laws and regulations, or where present,

they are not really effective as politicians and real estate interests avoids them (Hardoy, Mitlin and Satterthwaite, 2001**).** Thus, expansion is determined by how different individual or households, enterprises, businesses, companies (both in private and public sectors) deem fit to locate and build (either legally or illegally), resulting in urban areas expanding haphazardly over the nation's most productive agricultural land. Most urban centers grew where there were initially due to the presence of highly fertile soils and agricultural viability of the area (Abumere, 2003)

Urbanization is particularly rapid in the developing world, where globalization, major economic restructuring and lack of rural employment opportunities are provoking an exodus from rural areas to urban centers. Although much of the focus has been on the growth, infrastructural and environmental problems of megacities (those over 10 million in population), the reality is that most urbanization is taking place in the small to medium sized cities, and not just large or megacities (De Sherbinin and Martine, 2007**).** This poses numerous challenges to the environment, notably the conversion of agricultural to urban "built up" areas (De Sherbinin, 2007).

Nigeria, one of the most urbanized countries in Africa with estimated urbanization rate of 3.5% annually has witnessed tremendous urban expansion over the years and is losing about 400,000 hectares of vegetation annually (Adesina, *et al*, 1999; CIA World Factbook, 2010). According to Oyinloye (2013), the share of urban population out of the total population of Nigeria was less than 7% in 1931 but has continued to escalate over the years. The urbanization rate rose from about 10% in 1952, to 19.2% in 1991, to 48% in 2010 and it had reached 50% in 2012. By implication, about 50% of the total population of Nigeria now lives in urban areas; while the

remaining 50% lives in rural areas. The study further stated that there is a direct relationship between the rising urbanization and the rapid growth of cities, and that several factors responsible for the country's rapid urban growth pattern include natural increase (arising from high birth rate and fertility rate due to improvement in health facilities); rural urban migration; creation of states and local governments; sitting of universities, polytechnics, colleges of education, commercial centres, industrial centres, tourism resorts etc.

However, the loss of agricultural land to spatial expansion is mostly seen as a declining proportion of land used for agriculture around a city and may be accompanied by more intensive production for land that remains in agriculture (Bentinck, 2000). There is need to understand what has underpinned urban expansion in the past and how this is changing and might change in the future to be able to consider its implications for agricultural land loss hence agricultural production.

The integration of Remote Sensing and Geographic Information Systems (RS and GIS) has been widely applied and recognized as a powerful and effective tool in detecting, analyzing, monitoring and mapping urban expansion, urban land use, and land use/land cover changes (Ashbindu, Foresman, and Eugene, 2001). Satellite remote sensing collects multispectral, multi-resolution and multi-temporal data, GIS technology has platforms for storing, manipulating and analyzing geospatial data from various sources and turn them into valuable and reliable information such as Land use/cover maps for understanding and monitoring urban land processes, urban feature identification, change detection and database development.

1.2 STATEMENT OF THE RESEARCH PROBLEM.

Cities in developing countries are experiencing the most rapid spatial expansion of all regions which is largely a result of necessity, people move to the city in search of better employment and opportunities (Menon, 2004). This leads to an increase in size well beyond the limits of the city and the preference of living at the outskirts of the city, with open spaces at reasonable distances from cities. Often, these expansions are situated on agricultural land and lead to other problems associated with food supplies (Redman and Jones, 2005). Urban expansion is one of the foremost threat facing agricultural lands in Nigeria. It occurs in ever widening bands surrounding large urban centers, it often emanates from disconnected developments and single family homes that are established outside urban areas well beyond city limits, but usually within commuting distance to the urban core (Atu, Offiong, Eni, Eja, and Esien, 2012).

Offa, a prominent urban center in Kwara State has been experiencing tremendous urban expansion since its inception as a Local Government Headquarters in 1991. Developmental activities such as building, road construction, industrial expansion, increased commercial activities, presence of federal institutions, and various anthropogenic activities over the years has resulted in increased population, landscape consumption, modification and alterations which has affected various land uses in the city most especially the agricultural lands. These land use types tend to contend strongly with agriculture for space, and because they generate higher rents, they always edge out agriculture except where there are strong and practical land policies that favour agriculture over such land use types (Ariyo, 1991). Although this may not threaten the overall agricultural productivity but it does result in the alterations and declines in local agricultural activities and to the loss of agricultural land. The process, unlike in developed countries is taking place in the absence of significant industrial expansion (Kwasi, 2004).

However, up to date information that monitors the expansion of Offa is limited regardless of the changes the area has experienced. Muhammad (1990) studied the process of Peri – Urban Land use conversion in Offa between 1966 and 1986 with the aid of questionnaire survey, the author argued that farmers and in extension agricultural land are the most affected in the Peri-Urban Land use conversion, which is most noticeable in areas near built – up areas and in irregular conversion pattern and distribution.

Francis, Romanus and Raphael (2013) in their assessment of Urbanization and its impact on agricultural lands in growing cities of developing countries in Tamale in Ghana, used a mixture of qualitative and quantitative methods which includes interviews and questionnaires to collect and analyze data. The results showed that commercial activities and strategic location of Tamale is the main cause of rapid urbanization, which in turn have negative implications on the predominantly poor farming communities in the area, because prime agricultural lands have been converted to other land uses believed to be the highest and best use.

Olawole, Msimanga, Adegboyega, and Adesina (2011) also used Remote Sensing data and GIS techniques to monitor and assess urban encroachment into Agricultural Land in Harare, Zimbabwe. The result revealed that there has been rapid conversion of land covered by forest to nonagricultural use; about 1.38% of farmland has been lost to urbanization between 1976 and 2000, which also destroyed water bodies in the study area.

Omomoh and Adeofun (2005) assess Urban Agricultural Land Use Changes in Bukuru – Jos using Geospatial Information System. The result revealed that about 68% of agricultural land in the area was lost to urban development between 1986 and 2002, that is while urban spatial expansion is increasing agricultural land use is decreasing.

Oyinloye (2010) studied the spatial growth of Akure, Ondo State using three satellite imageries; LandSat (MSS) of 1972, LandSat (TM) of 1986 and Land sat Enhanced Thematic Mapping (ETM+) of 2002. The result showed that there has been a rapid conversion of agricultural areas to urban (non agricultural) land uses. Also, urban expansions of the city have destroyed fertile agricultural land which cannot be recovered as the residential land use continues to spread to and beyond the hitherto distant location relative to the city core.

Olayiwola and Igbavboa (2014) monitored the growth of Benin City between 1987 and 2008 using the contemporary remote sensing and geographic information system (GIS) techniques. The results showed that Benin City was expanding rapidly leading to an inverse spillover effect on the vegetation resources of the area, thus an imminent threat to the micro climate and food production in the area.

Ifeoluwa, Debo, Ahmed and Tobi (2011) also applied Remote Sensing and Geographic Information System (GIS) techniques to analyze urban expansion and land use changes in Akure, Nigeria between 1986 and 2007. The results indicated a rapid increase in built up and arable land but terrible depletion of the dense forest. Projection also revealed that change in the nearby future may likely follow the trend observed between 1986 and 2007.

These studies motivated the interest to assess urban expansion on agricultural land in Offa, Kwara State. Though previous attempts have been made to monitor and document the growth of Offa, but studies that used Remote Sensing and GIS techniques to assess the spatial dimension of urban expansion on agricultural land has been very limited if at all available. Hence, this research investigated urban expansion on agricultural lands in Offa LGA between 1990 and 2014 using Remote Sensing and Geographic Information System (GIS) techniques.

The study seek to answer the following questions;

i. What are the land use /cover classes in the area?
ii. What was the extent and rate of growth of the area between 1990 and 2014?
iii. What extent of agricultural land is lost to urban expansion?

1.3 AIM AND OBJECTIVES OF THE STUDY

The aim of this study is to assess urban expansion on agricultural lands in Offa LGA between 1990 – 2014. The specific objectives of the study are to:

i. map out different land use types in the area in 1990, 1999 and 2014.
ii. determine the extent and rate of urban growth in Offa between 1990 and 2014
iii. determine the conversion rate of agricultural lands to urban expansion.

1.4 SCOPE OF STUDY

Geographically, the study covers Offa and its environs (such as Atari, Adeleke and Atanoba,). These suburbs were considered because they are among the densely and rapidly populated areas of land use change in the study area. The study will look at the impacts of urban expansion on agricultural land, especially how agricultural it is being converted into residential and various land use at a rapid rate, and the accompanying effects in the area between 1990 and 2014. It will also attempt to provide an insight into the nature and dynamics of urban expansion which shall provide a comprehensive understanding of spatial development of Offa.

1.5 JUSTIFICATION OF THE STUDY

Urban expansion appears to have direct effects on the available agricultural land in and around the urban area which in turn affects food supply to the city. Food security and increasing losses of agricultural lands have become an issue of global concern (Brown 1995; Bender, 1997).

Today, rapid urbanization and sprawl in Nigeria has affects 400,000 hectares of vegetation annually (Adeshina, 2005).

While urban centers are growing in population and areal extent, the surrounding agricultural lands are undergoing rapid transformation, coming under increasingly intense pressure through construction to provide space for an array of urban land uses. Thus, with rapid population increase and a finite urban land area therefore, available land per individual shrinks pitilessly. These have tremendous effects such as low or reduced food production, low agricultural produce, ecological degradation, and environmental and socioeconomic challenge (Heimlich and Anderson, 2001).

Therefore there is the need to understand and monitor the effects of urban expansion on land, specifically on agricultural land for effective and productive land management. Though previous attempt has been made to monitor and document the growth of Offa, but application of Remote Sensing and GIS techniques that have less or no topographic limit have been very limited. The study shall amply demonstrates the use of Remote sensing and GIS to analyze and monitor the rate of urban expansion, its implications and the resultant loss of agricultural land through different years. It will assess how useful Satellite data are in monitoring and assessing extent of urban expansion in different periods, the direction and pattern of sprawl that is taking place, and also will highlight which land use type is encroaching into the other.

CHAPTER TWO

CONCEPTUAL FRAMEWORK LITERATURE REVIEW

2.1 INTRODUCTION

This chapter reviews extant literatures on urban expansion. The first part reviews literatures on the definition of major concepts such as urban expansion, causes and consequences; urbanization, urban areas, and agricultural land. While the following part deal with Geographical Information System (GIS), Remote Sensing; and the application of Remote Sensing and Geographical Information System GIS in Urban studies, growth and dynamics (detecting and monitoring, measuring and analyzing urban expansion).

2.2 CONCEPTUAL FRAMEWORK

2.2.1 Urban Expansion

Opinions are far from various on the concept of urban expansion. However, Manish, Aruna and Vivek (2012) define urban expansion as the horizontal or vertical outward extension of urban area over the adjacent agricultural land, which can be measured in term of acres of land or in terms of percentage (actual or percentage expansion respectively). The percent expansion refers to the percentage increase in the aerial strength of the urban center over a period of time.

According to Lin, Yohei, and Haihong (2003) Urban expansion is a natural process which consumes many hectares of prime agricultural lands from their surrounding every year, it comes about through the transformation of non-urban land (for example, farmland) into urban land (such as residences, parks, shops and factories). He further argued that such transformation is one way; once transformed, it is very difficult to return back to the original land use. Thus, urban expansion, like a diffusion process, is also temporal but it is not strictly continuous in time.

Minwuyelet (2004), also see urban expansion as a worldwide phenomenon or process that involves both the internal reorganization and outward expansion of the physical structure of urban areas which results in loss of prime agricultural farmlands and natural beauties. This process could be seen in the history of all urban centers, although the term (urban expansion) has become synonymous with the creation of visual blight and the loss of natural habitat, not all of its effects are negative. In its simplest form, it is nothing more than expansion which normally occurs away from the dense areas of existing urban development. The need for urban expansion continues to escalate as the population continues to increase (Almeida, 2005; Shishay, 2011).

However, European Environment Agency (2006), describes urban expansion as the physical pattern of low-density expansion of large urban areas, under market conditions, mainly into the surrounding agricultural areas where development is patchy, scattered and strung out, with a tendency for discontinuity. It is seen as 'horizontal spreading' or 'dispersed urbanization', uncontrolled and disproportionate expansion of an urban area into the surrounding countryside, forming low-density, poorly planned patterns of development and common in both high-income and low-income countries.

Urban expansion**,** which is synonymous with urban sprawl, is the extension of the attentiveness of people or urban settlement to the surrounding area whose functions are non-agricultural. It is characterized by a scattered population living in separate residential areas, with long blocks and poor access, often over dependent on motorized transport and missing well defined hubs of commercial activity (Unicef, 2012).

Glaeser and Kahn (2003) states that the reason urban expansion is perpetuated is due to the low cost of the agricultural land which is being converted. The transformation of low cost

agricultural land accompanied with an increase in accessible transportation networks increases the ability of the workforce to move out from the densely developed, urban areas. This, in turn, creates new areas for economic expansion and the overall increase of the tax base for local government.

In most of the developing countries, urban expansion is an inevitable economic and social functionality of towns and cities; their growth is characterized by both absolute increase of the number of people and spatial increase of the city, (Madulu, 2004). For example in Nigeria, 400,000 hectares of vegetation cover is lost annually. Most of this vegetation is deliberately removed to make way for development of infrastructure such as roads, railway and expansion of settlements among others (Adesina *et al*, 1999;, Adesina, 2005).

2.2.2 Urbanization

There is no generally accepted definition of urbanization as different scholars defined it as applicable due to the differences in socio-cultural backgrounds, professions, socio-economic and population disparities in countries (Harvey, 2000). Urbanization, which refers to the expansion in the proportion of a population living in urban areas, is one of the major social transformations sweeping the globe especially developing countries. It represents the movement of people from rural areas to urban areas with population growth equating to urban migration. According to UNHABITAT (2006), the global urban population has quadrupled since 1950s, and cities of the developing world now account for over 90 percent of the world urban growth

Ujoh, Kwabe, and Ifatimehin (2010) defined urbanization as the process that refers to the growth both in size and numbers of urban centers. Agbola (2004); Olotuah and Adesiji (2005) defined it as the agglomeration of people in relatively large number at a particular spot of the earth surface.

Conversely, another school of thought believes that urbanization is not about the population size, but must satisfy certain conditions like modernization, physical and economic development, as well as the heterogeneity in occupation (Harvey, 2000).

The former definition of urbanization reflects the perspective of what urbanization is in the developing countries, while the latter school of thought reflects what urbanization is in the developed world. Thus, urbanization process in the developed countries is as a result of rapid development, modernization and industrialization, and not agglomeration of people which usually results from rural-urban drift. While the urbanization in Nigeria like most other developing nations, is a consequence of the "push" of the rural areas and the "pull" of the urban centres (Aluko, 2010). The push and pull in this regard are with respect to the population, which can be traced to the effects of regional imbalances.

Summarily from the foregoing, the term urbanization can be defined as the rapid development and transformation of a region including increases in the size, population and human activities at a given period of time, also (on the basis of the process that results in the conceptual emergence of urban expansion) as the expansion of a city into its surrounding agricultural or peri-urban lands, leading to rapid and massive growth of, and migration to, large cities (Shishay, 2011).

The proportion of the world's population living in urban areas, which was less than 5 % in 1800 increased to 47% in 2000 and is expected to reach 65 % and 70% in 2030 and 2050 respectively; with Africa and Asia being projected as the regions that will experience the largest growth in urban populations (Harriet, 2011; Oyeleye, 2013). In Nigeria, urbanization is mainly caused by urban growth, which could be due to natural population growth, reclassification of urban and rural system; and rural-urban migration. Previous studies and projections suggest that

Nigerian urban population will reach 100 million by 2020, even though the urban population growth rate which was 5.7% in 1985, 5.8% in 2004 is now declining to the current rates of 4.0%, which is still far higher than Nigeria overall population growth rate (Agbola, 2004; Oyeleye, 2013). It is also evident that the rapid rate of urbanization in Nigeria and the consequential explosion of urban population have not been matched by a corresponding commensurate change in social, economic and technological development, resulting in nearly stagnant economy and negligible growth of industrialization (Oyeleye, 2013).

Urbanization usually expands and grows urban areas to its surrounding areas at the expense of fertile/prime agricultural farmlands. This urban rapid growth results from fast population growth (natural increase, rural-urban migration), high demand of urban land (lack of access) and other reason that results in urban physical/horizontal built-up area expansion into the surrounding agricultural land (Shishay, 2011).

2.2.3 Urban Area

There is no internationally agreed conceptual meaning of urban area, the definition of the concept depends on the social, economic and political organization of the country involved. Countries of small or relatively rural population may simply declare one or more settlements as urban, regardless of the size or function (Drescher and Iaquinta, 2002).

But generally, an urban area is characterized by higher population density and vast human features in comparison to areas surrounding it. They are created and further developed by the process of urbanization. It is argued that the term urban has been interchangeably used often to mean a city without regard to the inherent differences between a town and a city. It is asserted

that whiles all cities are urban areas, not all urban areas are cities. The term urban is therefore conceptualized as being a subjective concept.

According to Aluko (2010), urban area is an agglomeration of people that are organized around non-agricultural activities. He further stated that they are areas that contain a settled population not directly involved in primary production of food and other raw materials. This means an urban area is characterized by a great variety of interdependent activities, the provision of high order services (such as banks, universities and high speed transportation network).

Moreover, urban area can be defined in any number of ways including by population size, population density, administrative or political boundaries, or economic function (Choen, 2005) or by physical borders, population size, geographic limits associated with administrative responsibilities or governance (Keiser, De Castro, Smith, Tanner, and Burton, 2004). They can also be defined based on different population sizes in different countries; an urban centre in Japan has at least 30,000 people, 50,000 in United State, 20,000 and above in Nigeria, 10, 000 in Greece. Some countries have much lower figures; France use 2000 and above, while in Canada it is 1000 and above. This indicates that, there is no global standard for the classification of urban area (Aluko, 2010).

Urban areas are expanding rapidly with the current trend of particular urban expansion being exhibited in developing countries (Deng, Huang, Rozelle, and Uchida, 2008; UNHABITAT, 2006). This high rate of urban expansion in developing countries is predicted to upsurge even in the future (United Nations, 2010; Angel, Parent, Civco, Blei, and Potere, 2011) and problems associated to the conversion of agricultural land into built-up area are also more severe than developed countries (Deng et al., 2008). So, well managing of cities is in this era of high

urbanization, is important to achieve the United Nation's Millennium Development Goals (Cohen, 2006).

2.2.4 Agricultural Land

According to FAO (2014), Agricultural land refers to the share of land area that is arable, under permanent crops, and under permanent pastures. Arable land includes land under temporary crops (double-cropped areas are counted once. Land under permanent crops is land cultivated with crops that occupy the land for long periods and need not be replanted after each harvest, such as cocoa, coffee, and rubber, while Permanent pasture is land used for five or more years for forage, including natural and cultivated crops.

Agricultural land' is the land base upon which agriculture is practiced. Typically occurring on farms, agricultural activities are undertaken upon agricultural land to produce agricultural products. Although agricultural land is primarily required for the production of food for human and animal consumption, agricultural activities also include the growing of plants for fibre and fuels (including wood), and for other organically derived products (pharmaceuticals, etc).

According to Francis *et al* (2013), agricultural lands are most affected by rapid urbanization and its functions of demand. Land uses for residential, industry and commercial, civic and culture tend to dominate agricultural lands in the bid for space in the urban place. This dominance tends to deprive farmers of arable land to cultivate thereby reducing agricultural productivity. And the key challenge of the urbanization process is the rapid conversion of large amount of prime agricultural land to urban land uses (mostly residential construction), in the urban periphery. The effect is the unavailability of prime agricultural lands. The consequence is low agricultural productivity, low standard of living and food insecurity.

The conflict between agricultural and urban areas began back at the time of population explosion all over the world. According to Walton (2003), most settlements began as an agrarian society and settlement was most desirable in areas that had viable agricultural lands. He further argued that these new agricultural communities that were successfully attracted to other industries which in turn lead to population increment and thus make the towns expanded. The levelled good soils of farm fields were attractive for developers and development alike. "The very resource that attracted settlement is ultimately being consumed by it".

Agricultural land enhances the quality of life for many. "It contributes to green space, wildlife habitat, rural character and access to fresh, high quality, locally grown produce" (Walton 2003).

Agriculture is the largest single form of land-use in most OECD countries and most land currently used for crop and livestock production is unlikely to change uses substantially in the foreseeable future. But there are parcels of farmland that are susceptible to a change in use. The majority of this land is either adjacent to urban areas. In fact, is well known that the development of the urban areas is able to transform landscapes formed by rural into urban life styles and to make functional changes, from a morphological and structural point of view. Historically, urban development (driven by the population increase) and agriculture are competing for the same land: cities expansion has typically take place on former agricultural use (Antrop, 2000; 2004).

2.2.5 Remote Sensing and Geographic Information System

In broad terms remote sensing is the field of study associated with extracting information about an object without coming into physical contact. Schowngerdit (2007) defined Remote Sensing as the measurement of object properties on the earth's surface using data acquired from aircraft and satellites. Although the earth is the most frequent target in remote sensing study, the science of

remote sensing in its broadest sense includes aerial, satellite, and spacecraft observations of the surfaces and atmospheres of the planets in our solar system (Smith, 2006).

Remote sensing techniques have been useful in the quantification of urban growth and expansion, urban land use changes, etc especially from arable land to impermeable surfaces (Milesi *et al*, 2003).They monitor the spatio-temporal and dynamic changes in land use/land cover at regular intervals, using multi-temporal remote sensing satellite data such as Landsat TM images.

According to Turner, 2003 and Lambin *et al*, 2001, the modern technology of remote sensing which includes both aerial as well as satellite based systems, allow us to collect lot of physical data rather easily, with speed and on repetitive basis, and together with GIS helps us to analyze the data spatially, offering possibilities of generating various options (modeling), thereby optimizing the whole process. This information system also offers interpretation of physical (spatial) data with other socio-economic data, and thereby providing an important linkage of different processes and making it more effective and meaningful. The satellite remote sensing and its ability to provide the accurate and reliable information monitor and measure the spatio-temporal and dynamic changes in land use/land cover at regular intervals, using multi-temporal remote sensing satellite data such as Landsat TM images to produce maps that depicts various facts of urban changes and development. These changes are of significance in the field of environmental change. Geographical information system provides the platform on which data on such images are stored, processed and analyzed for decision making.

Geographic Information System (GIS) is an organized collection of computer hardware, software, geographic data, procedures, and personnel designed to handle all phases of geographic

data capture, storage, analysis, query, display, and output (Alimbekova *et al*., 2010). It allows user to integrate database generated from various sources on signal platform and analyze them in a spatiotemporal domain. GIS store data as spatial database which is based on Relational Database Management System (RDBMS) that store information in tables that relate to each other through common fields and thus can be easily accessed. The term GIS comprises Three integrated parts;

Geographic - Geographic of the world, the spatial reality, the geography

Information - Data and information, their meaning and use

System - The computer technology and support infrastructure

Although GIS has three parts, information is its heart without which 'Geography' and 'System' are unrelated.

Different people defined GIS, according to its capability and purpose for which it is applied but summarily, it can be said to be a computerized system that deals with both spatial and non spatial data A very brief description of GIS is that it is a computerized system (tool) that deals with spatial and non-spatial data from different or multiple sources in various formats to produce desirable answers for different applications (Santosh, 2011).

2.3 LITERATURE REVIEW

2.3.1 Remote Sensing And Geographic Information System In Urban Study.

The 19^{th} and 20^{th} centuries witnessed a trickle of urbanization and the emergence of metropolises. This rapid and haphazard urban growth and increasing population pressure is resulting in loss of productive agricultural land surface water bodies, green open spaces, besides causing air pollution, health hazards and contamination of water.

The cities are growing in all directions resulting in emergence of metropolises, rapid and haphazard urban growth, large-scale urban expansion and changes in urban land use. The spatial pattern of such changes is clearly noticed on the urban fringes or city marginal rural areas, than in the city centre. Unconsciously this is resulting in loss of productive agricultural land, forest cover, surface water bodies, green open spaces, and increased built up areas causing air, water and land pollution; health hazards and contamination of water. It is widely agreed that disintegration of land use is also harmful to biological conservation. Thus there is a demand to regularly observe such changes and distinguish the processes for taking helpful and corrective actions towards a planned and healthy development of urban areas. As such, in recent times, Remote Sensing (RS) and Geographic Information System (GIS) have been recognized as powerful and effective tools and widely applied in detecting the spatio-temporal dynamics of land use and land cover and in extension urban changes dynamics (Long, Wu, Wang, and Dong, 2008), thereby presenting new tools for advanced ecosystem management, agriculture and environments (Ray and Dadhwal, 2001; Jiang *et al*, 2004; Kato and Yamaguchi, 2007).

In similar vein, Santosh (2011) also stated Remote Sensing data is being widely used for mapping and monitoring of urban growth and expansion of cities. The spatial patterns of such growth and expansion over different time periods, can be scientifically mapped, monitored and accurately assess from satellite data in company with conventional ground data.

The most recent advancement in the research of urban expansion has come in the field of GIS. The spatial analysis tools provided by GIS, coupled with the development of highspeed access to standardized data sets of large geographic areas, have given more recent researchers tools to which previous researchers did not have access. GIS and Remote Sensing has been used to

monitor, analyze, predict and identify visual patterns of urban growth and expansion over time-based data in some of the most populous places on Earth. These new GIS / Remote Sensing tools and techniques have also been used to create urban growth models whose purpose prevent unplanned / irregular urban growth and expansion from happening (Chad, 2007).

Geneletti and Gorte (2003) stated that urban expansion monitoring and mapping have becomes necessary to make efficient policy for development and controls of further growth of urban centers. Such monitoring requires reliable data at regular interval. Remotely sensed data, remote sensing techniques (RS) and geographic information systems (GIS) tools have become the veritable tools in the acquisition, monitoring, evaluation and mapping of urban expansion. Land use/cover maps produced through the use of RS and GIS are the most reliable information in urban growth studies. The combined use of RS imagery and GIS techniques is a powerful tool of data generation for urban change analysis, and for storing, measuring, modeling and analyzing spatial data.

In the same vein, Tran (2006) also argued that the integration of Remote Sensing and Geographic Information Systems (GIS) has been widely recognized and applied as a powerful and effective tool in detecting urban land use and land cover change. Satellite remote sensing collects multispectral, multiresolution and multitemporal data and turns them into information valuable for understanding and monitoring urban land processes and for building urban land cover datasets. GIS technology provides a flexible environment for entering, analyzing and displaying digital data from various sources necessary for urban feature identification, change detection and database development.

Today the use of modern Remote Sensing and Geographic Information Systems techniques has significant success in monitoring and managing urban land-use/land cover changes and to measure the degree of urban growth. A number of urban expansion and related studies were conducted using GIS and Remote Sensing.

Shahab (2000) uses remote sensing data (aerial photographs and satellite images) combined with field checks and surveys to measure the loss of agricultural land to urban expansion in Saharanpur City between 1988 and 1998. These data were used to produce urban land use and transformation maps of the area. The final details of these maps were transferred unto a base map which was resampled to a common resolution, digitized and transferred to a GIS environment for analysis. The results shows in detail shows among other things how such techniques allow a detailed mapping of land use changes, including details of the location of the agricultural land losses, the nature of the land use changes that caused these and the quality of the agricultural land that was lost.

Zhi-Yong Yin, Dona, Stevan, and Jared (2005) used image processing and analysis in a GIS environment to assess spatial change in urban land use patterns and population distribution. Here, unsupervised classification was used to classify the images into land use classes. In this research, satellite imageries for the year 1984, 1997, and 2000, were used to produce a landuse map of Shaoxing city in China and its surroundings. The result shows that undoubtedly a lot of changes occurred between 1984 and 1997 when compared with those of 2000, due to the sufficient time gap. It was observed that residential area development was mainly at the expense of agricultural land use.

Tran (2006) also used Landsat TM and ETM satellite images of 1989 and 2002 combined with fields check and existed maps to study Urban Expansion and Loss of Agricultural Land in the North of Hochiminh City. Maximum Likelihood Classification was carried out on each image for analyzing the nature, rate and location of urban expansion compared with loss of agricultural land. A resulting image of residential area was extracted from each original image and the urban expansion image was further overlaid with geographic reference images to help analyze the patterns of urban expansion, including image of district boundary, major roads. These layers were built in a vector GIS environment and converted into a raster format. His results shows agriculture land reduces is transformed into land for housing, roads and industry as housing demand increases and city develops due to population explosion, thus valuable agricultural land is lost to urban expansion.

Shalaby (2012), used Landsat TM satellite images of 1984 and 1992, and Landsat ETM+ of 2006 to study the impact of urban sprawl on agricultural land in the Nile Delta. He employed Visual interpretation using on screen digitizing and change detection techniques to monitor urban sprawl by combining the soil and land capability maps, in one hand, and the urban thematic layers, in another hand. GIS techniques was use to point out the risk of urban expansion on the expense of the highly capability class. The results show the total expansion of urban area (about 2536.3 km2) between 1984 and 2006 at the expense of fertile agricultural land and soils. He concluded that the urban sprawl is one of the dominant degradation processes in the Nile Delta.

2.3.2 Remote Sensing and GIS in Urban studies in Nigeria

Remote Sensing and Geographical Information System techniques have equally recorded remarkable success in Nigeria's urban growth and dynamics studies.

Adebayejo and Abolade (2006) used satellite imageries of 1978 and 1995 and updated topographical maps of 2003 to study urban expansion of Ogbomoso town, Oyo State. While Oyinloye (2010) studied the spatial growth of Akure, Ondo State using the satellite imageries of 1972, 1986 and 2002. The results of both cities showed that there has been a rapid conversion of agricultural areas to urban (non agricultural) land uses. Urban expansions of these cities have destroyed fertile agricultural land uses. Urban expansion of these cities have destroyed fertile agricultural land which cannot be recovered, the residential land use continues to spread to and beyond the hitherto distant location relative to the city core.

Adediji and Ajibade (2008) used Landsat- TM and Landsat-ETM+ of 1986 and 2002 respectively to assess the dynamics of major dams (Ede-Erinle and Eko-Ende reservoirs) in Osun State, Nigeria. In addition, changes in the land uses around the dams between 1986 and 2002 were also examined. The results of the reduction. The surface area of the reservoirs declined by 37.49% at Ede-Erinle and 45.42% at Eko-Ende respectively in year 2002 due to reasons attributed to human activities such as farming and urban expansion. For instance, settlements around the dams increased in size by 96.49% and 68.61% around Ede-Erinle and Eko-Ende reservoirs respectively; farming activities around the dams increased by 98.12% at Ede-Erinle reservoir and 94.47% around Eko-Ende reservoir study showed a sharp decline in the surface area of the reservoirs.

Also, Zubair (2008) used Remote Sensing and GIS approach in monitoring the growth of settlements in Ilorin, Kwara State. He discovered that there was rapid growth in built-up land between 1972 and 1986 while the periods between 1986 and 2001 witnessed a reduction in the

rate of growth. The research demonstrates the ability of GIS and Remote Sensing in capturing and analyzing spatial-temporal data.

Ifeoluwa, Debo, Ahmed and Tobi (2011) in their research employed Remote Sensing and GIS to analyze urban expansion and land use changes in Akure**,** Nigeria**,** using Landsat TM satellite imageries of 1986, 2002 and 2007 combined with administrative and boundaries map; and population data of the study area. The Change Detection Analysis shows a rapid change in built up and arable land is noted to have increased by more than 30% and the dense forest depleted terribly from about 49. 19% in 1986 to 20.91% in 2002, and 15.32% in 2007. Solid minerals discovery, sitting of the Federal University and other tertiary institutions are among the reasons attributed to these changes.

Oyinloye (2013) used topographic map and multi temporal remotely sensed data to study the Geospatial Analysis of Urban Growth in Akure, Nigeria from 1986 to 2009. The maximum likelihood supervised classification was carried out on reflective bands (4, 5 and7) for the three images individually with the aid of ground truth data collected during field trips. Topographic map of 1966 and a Land cover map of 1986 were used to assess the accuracy of the classification results. Post-classification detection techniques were used to produce change image through cross–tabulation. The results shows that in particularly, the build - up areas have increased by more than 152% between the period (1986 to 2009) which results in a very remarkable decreases in the sizes of farm lands, loss of agricultural land and forest in the study area within the same period.

In similar vein, Etim and Dukiya (2013), used questionnaires, remotely sensed images and GIS analysis to assess the level of Abuja's urban encroachment on agricultural land in Kuje Area

Council of FCT. The results reveals that urban encroachment into agricultural lands is alarming at the rate of 15.7 Km^2 annually, and a total of 509 Km^2 of agricultural land have been lost to urbanization within the 35 years under review. This encroachment is attributed to the continuous increase in developmental activities of migrants from all over the country which is geometrically increasing the demand for accommodation and other urban needs.

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 using supervised classification techniques into eight categories. The results revealed that the land use land cover of the area has changed significantly over the study periods (1973-2009) with that built-up land increasing from 11.52 km^2 in 1973 to 37.13km^2 in 2007 and natural forest reduced from14.06km^2 to 8.64 km^2 within these same periods.

Albert, Edmund and Yaw (2006) used Landsat imageries of 1984 and 2000 to study the implication of rapid expansion in metropolitan Lagos for Land Administration using GIS and Remote Sensing Techniques. The imageries were classified into four categorized and analyzed with the results revealing that the land under water had declined from its initial extent of 29,040 Hectares in 1984 to 24,708 Hectares in 2000 (14.91%), while vegetation reduced from 180,384 Hectares in 1984 to 140, 568 Hectares in 2000. Agricultural land increased from 9,806 Hectares to 112.48% and built - up change with 159.02% at an annual rate of 5.8%.

2.3.3 Causes of Urban Expansion

According to Feyera (2005), the urban expansion to the periphery (agricultural land in most cases) is derived from two sources namely urban development and urban population increase.

The first source of urban expansion to the periphery is stirred up by the 'economic development projects' or 'urban clearance' or 'industrialization'. Space is needed for accommodation, industry, socio-economic infrastructure, communication and road networks that require reorganization and redevelopment of the space already inhabited. This need for space induces extended urban settlement to rural territory that had been already occupied by perhaps rural farming community.

The second reason for urban expansion to the periphery is the increase in urban population. Population growth rate is very high in developing country compared to developed countries. Natural population growth is a major element in urban growth (hence urban expansion) for all countries, but rural urban migration contributes even more in many developing countries (Balchin, Isaac and Chen 2000). Migration contributes to fast growth of urban population due to the economic development that attracts people to urban nuclei for commerce, employment and education. Of developing regions, Africa shows the highest urban population growth with faster urbanization (Feyera, 2005).

As urban population increases, people compete for the site first for residence and second for investment depending upon accessibility within the urban framework. The structure of local government and its policy may or may not be favourable to the community who are supposed to leave their place of habitual residence to accommodate the increasing population in urban settlement. Therefore, urbanization, urban growth and urban expansion have become central problems in the conversion of agricultural land to non-agricultural use (Feyera, 2005).

Cohen (2005) also stated that urban expansion is caused by a number of different factors including rural–urban migration, natural population increase, and annexation. He further argued

that high rates of overall population growth, together with significant rural–urban migration, have contributed to the rapid and unplanned expansion of low-income settlements on the outskirts of many large cities, which has occurred without a concomitant expansion of public services and facilities. However, Xiaoqing and Jianlan (2007) argued that urban expansion is determined by the interaction of three broad phenomena: the physical constraints of geography and environment; the demand for land by the households and firms who inhabit the city; and the policy constraints that govern land use and spatial interactions in the city.

Glaeser and Kahn (2003) are of the opinion that urban expansion is being perpetuated due to the low cost of the agricultural land that is being converted or transformed, accompanied with an increase in accessible transportation network which increases the ability of the workforce to move out from the densely developed, urban areas.

In Africa, natural population increase and migration are significant factors in the growth of cities and major causes of rapid urban expansion. Even though many urban areas in African countries offer few jobs for the youth, they are often attracted by the, free access to investment, transformation of infrastructure, amenities of urban life and social services. These combined with the high population growth and in some case income growth accelerates the physical and horizontal expansion of urban centers, consequently cause urban expansion (Adem and Mezgebe, 2006).

In Nigeria, however, Oyinloye (2013) believed there is a direct relationship between the rising urbanization and the rapid growth and expansion of urban centers in Nigeria, and that several factors responsible for the country's rapid urban growth pattern include natural increase,

migration, creation of states and local governments; and sitting of universities, polytechnics, colleges of education, commercial centres, industrial centres, tourism resorts etc.

2.3.4 Consequences of urban expansion

2.3.4.1 The Impacts of urban expansion on agricultural land

The extent of dependable agricultural land available for agriculture has been declining in recent decades, due to the consumption of agricultural land for urban uses and other nonagricultural uses (Hofmann, 2001). This rapid loss of agricultural lands as a result of urban expansion is prevalent throughout the world and much more evident in developing countries (Mason, 2010).

Jiang, Deng, and Seto (2013) also stated that the urban expansion on agricultural land is associated with both shrinking agricultural land area and a higher level of urban development. The former triggers greater land pressure and the latter indicates increasing off-farm employment opportunities. However, expansion and economic development can lead to rise in the agricultural land use intensity, off-farm opportunities and the resulting labor shortage in the agricultural sector (Wu, Fisher, and Pascual., 2011). These have posed additional challenges for the security of food provision and the preservation of natural ecosystems. The nature and magnitude of their relationship directly influence agricultural production and food provision which may have further outcomes on the patterns of a nation's agricultural land (Jiang et al 2013).

According to López (2001), agricultural censuses in Puerto Rico showed rapid losses of agricultural lands have occurred since 1950, with the highest rate of change occurring between 1964 and 1974 due to urban expansion. This loss of potential agricultural lands to irreversible nonagricultural uses reduces its capacity for the future.

The cities of Debre Zeit and Nazareth in Ethiopia also illustrate the desolation created by urban expansion: on each side of the main highway, rows of ugly and disorganized buildings are rising up to replace hectare after hectare of fertile agricultural land (Sahlu, 2004). While Japan lost more than half of its cropland to urban expansion within 44 years (1950 – 1994) to make it highly dependent on import grains; 25% in 1950 and 70% in 1985, (López, 2001). Egypt also lost more than 10 percent of the countries productive farmland to extended urban settlement (Hardoy *et al*, 2001).

As pointed out by Dayong (2004), uneven urban expansion occupying considerable valuable agricultural land around urban centers, will causes sensitive contradiction and conflicts with the farmers who are displaced from their farmland. As urban centers expand by occupying fertile agricultural land and displacing farmers, it leads to reduction in the quality and quantity of agricultural production and also causes number of farmers to migrate to the nearby urban centers. As a result, farmers with their large family size will be exposed to unemployment and poverty for the reason that they are not well educated and skilled rather depending on their agricultural production.

Kamere, Tostensen and Tvedten (2002) noted that urban centers produce more solid waste products than they can absorb within their own borders, thus predominantly polluting the rural landscape. Industrial, residential and institutional waste in urban area is often dumping directly on to the farmland of their peri-urban areas.

Furthermore, Ichimura (2003) argued that conversion of agricultural land and forest for urban uses and infrastructure is associated with widespread removal of vegetation to support urban ecosystem and put additional pressure on nearby areas that may be even more ecologically

sensitive. UN-HABITAT (2010) also affirmed that the uncontrolled physical expansion of cities and towns in developing country create an impact on urban environment and economy. This unplanned and uncontrolled development makes provision of housing, roads, water supply, sewers and other public services too expensive. The other impact mentioned on the report was the loss of agricultural land as most cities and towns built on productive agricultural land.

Atu, Offiong, Eni, Eja and Esien (2012) in their work "*Effects of Urban Sprawl on Peripheral Agricultural Lands in Calabar, Nigeria***"** discovered that between 2000-2010, there was massive conversion of agricultural land to residential estates on the urban periphery, developed either by government, the private sector for their workers or by property developers for sale. The consequences of burgeoning urban growth for peripheral agricultural lands were enormous as the few remaining peripheral lands are worked more intensively to feed the immediate needs of the large urban population leading to loss and degradation of farm space.

He argued further that though all cities in Nigeria are experiencing expansion, Calabar's case is exceptional because of the rate, scale and type of development on the city's most agriculturally productive land which he described as 'break-neck pace'; over 5, 200 hectares of agricultural land has been converted within a decade.

Also, Essien and Akpan (2013) in their work argued that urban expansion in Uyo metropolis grossly affect agricultural land as there was no more available arable land in the outskirt to work on. Twenty years after the State was created and Uyo made the capital of the State, 90% of the surrounding arable land has been lost to suburbanization by urban development and expansion. Secondly, no feasible presence was seen of able bodied workforce for farming. All together, over 80% of the able men and women who previously occupied and worked the arable farm to sustain

a living now worked in the urban, and preferred to reside only in the rural-urban fringe and commute to town to work.

In similar studies Adebayejo and Abolade, (2006); Oyinloye, (2010) postulated that the rapid conversion of fertile agricultural land to urban (non agricultural) land uses as a result of urban expansions in Ogbomsho and Akure have destroyed fertile agricultural land which cannot be recovered.

Oyeleye (2013) believed that the high rate of rural-urban migration in developing countries threatens food security in both urban centres and rural areas. According to him, high numbers of people involved in agricultural activities in rural areas have abandoned agricultural activities as they migrate to the urban centres to seek jobs in manufacturing and processing industries and some into informal activities. Lesser number of people are into agriculture in Nigeria, as more agricultural land in the suburbs have given way for suburban developments and large expanse of land in rural areas are left uncultivated, as rural areas are more dominated with the aged people who have no strength for agricultural activities. This justifies why importation of food (especially rice, the major Nigerian food) is very high. The prices of all types of foods are very high, which makes it difficult for many poor in the society to afford the three square meals a day, as recognized in Nigerian society. Furthermore, Mba, Ude, Ume, and Uchegbu (2004) identified several environmental problems which stems from urban expansion with both direct and indirect effects on agricultural land. These problems are classified as ecological, poaching and habitat loss, increasing desertification and soil erosion.

In summary, as much as urban expansion have many positive impacts such as employment opportunities, adequate access to production and distribution of goods and services; commercial

and industrial development, increased social amenities and facilities, etc; its impacts on agricultural land are basically negative such as its impacts on agricultural land are basically negative such as loss of farmland, increased solid waste disposal and land degradation, enclosed surrounding villages to urban territory, over-exploitation of natural resources, and land conflicts among others.

CHAPTER THREE

THE STUDY AREA AND METHODOLOGY

3.1 INTRODUCTION

This section discusses the study area and the various methods that were employed in generating data for the study. The section also explained the types and sources of data, tools and procedure for data analysis using Remote Sensing and GIS in the study area.

3.2 STUDY AREA

3.2.1 Historical Background

Offa is a traditional ancient and Nigerian town, which like other such towns in the country exists long before the advent of British colonial rule. There is no exact information on the age of the town but it is commonly believed that the original settlers were Yoruba from Ile – Ife which is widely regarded as the main origin of the Yoruba people.

Traditionally, the town is divided into four major quarters known as Esa, Ojomu, Shawo and Balogun, each of these quarters is managed by a local chief who assist the 'Olofa' (traditional king of Offa) in their governance and have their individual office named after this quarters. These quarters still maintained their names till today even though they even been further segregated for political governance.

3.2.2 Location and Size

Offa is located near the southern boundary of Kwara State in the Central Zone of Nigeria, approximately between Latitudes 8° 12^1N – 8°70^1 N and Longitudes 4° 40^1 E – 4°70^1 E (Fig. 3.1), it is bounded by, Ajase-Ipo, to the north, Ojoku, Igbonna, and Ikotun to the west, Igosun and Ipee to the east, Erin Ile to the south, and Ilemona to the south west with about 56 km and

59km away from Ilorin the state capital and Osogbo, the Osun State Capital respectively. Offa is a medium- sized urban center with an aerial extent of about 14,922 square Kilometers, the second largest town in the State and the Headquarters of its Local Government created in 1991. Offa Local Government was carved out of the defunct Oyun Local Government which was created in 1977 with Headquarters at Offa; it is one of the most popular towns in Nigeria in terms of education and politics; and according to Fawole (2007), Offa is one of the fastest growing urban centers in Nigeria with its population growth rate much higher than other cities in the country, it also has grown in both population and aerial extent at a fast pace since 1967 (Oyegun, 1983).

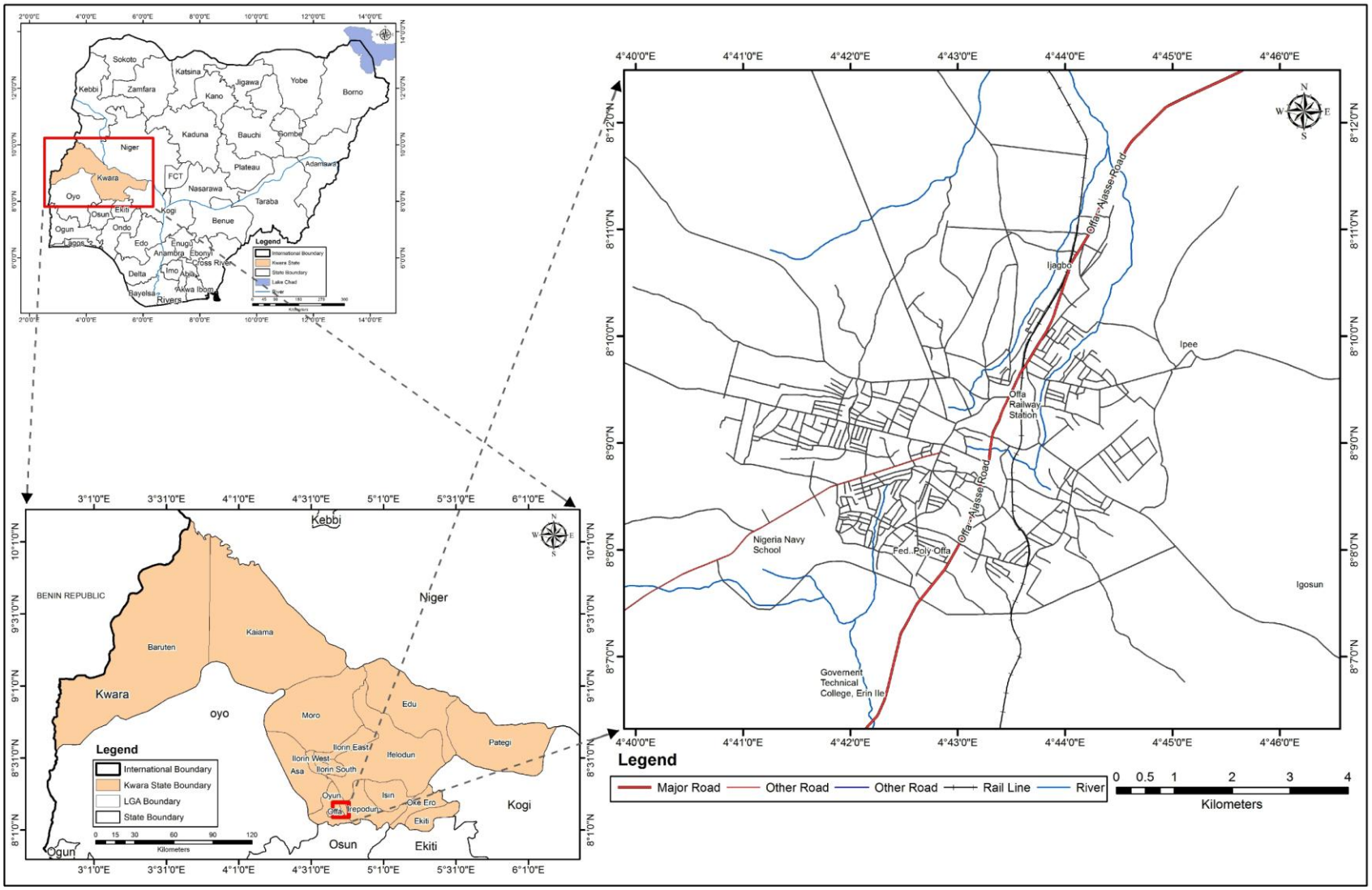


Figure 3.1: Offa Local Government
Source: Modified from Google Maps, 2014

3.2.3 Population

The National Population Census of 1991and 2006 put the population of Offa Local Government Area at 74,924 and 88,975 respectively (NPC), but presently with an estimated population of 113, 830 and 197, 457 in 2010 and 2014 respectively (Geonames Geographical Database, 2010). The town's morphology has changed over time to assume its present status and the accompanying land use problems, as experienced in similar medium sized urban centers in Nigeria continue to grow.

3.2.4 Climate

Offa has two main seasons; the wet season (from late April to October) and the dry season (from November to April). Each of these seasons is characterized by a specific type of prevailing wind; the Southwest and Northwest winds respectively. It is located on the western highlands of Nigeria at an altitude of about 600m above sea level which gives it its relatively cool weather condition throughout the year. It falls within the Guinea Savannah region with an annual rainfall of 1000mm and a relative humidity that ranges between 65% and 80% in the dry and rainy seasons respectively (Fawole, 2007). The temperature can be very high during the dry season being situated in the transitional zone; between the forest and the savanna region of Nigeria i.e. the North and the West coastal region, it therefore serves as a "melting point between the northern and southern culture" (Oyebanji, 1993)

3.2.5 Soil and Vegetation

The major soils in the area are alluvial and hydromorphic, they are basically underlain by basement complex of the pre- Cambrian to upper Cambrian period which have strong influence on their morphological characteristics. These soils have high water table with well decomposed

organic matter content with the layers becoming heavier with depth. They are of medium to high productivity due to their long period of metamorphic activities, thus encourages agricultural activities (Fawole, 2007).

The natural vegetation of the area is the guinea savannah vegetation which broadly consists of rain forest and wooded Savannah and is well suited for the cultivation of a root crops, grains and wide variety of food crops like yams, sw.eet potato, cassava, maize, beans, rice, sorghum, millet, sugarcane, fruits, vegetables, etc; and rearing of livestock such as cattle, goat, and sheep.

3.3 METHODOLOGY

A reconnaissance survey was carried out in order to acquaint the researcher with the current state of urban expansion as well as the processes involved in the conversion of the surrounding agricultural land into urban land use.

3.3.1 Types and Sources of data

In an effort to achieve a better and meaningful result for this study, the researcher made use of both primary and secondary data. The primary data used for this study are mainly satellite images acquired from National Center for Remote Sensing, Jos. They include the following;

i. LandSat TM (Thematic Mapper) of 27th November, 1990 with a spatial resolution of 30 meters,
ii. LandSat ETM^{+} (Enhanced Thematic Mapper Plus) of 27th October 1999 with a spatial resolution of 30 meters
iii. Nigeria Sat X of 19th March, 2014 with a spatial resolution of 22 meters.

Population data of the study area between 1990 and 2014 obtained from various the National Population Commission; Topographic and Administrative maps of Offa which were obtained from the Office of the Surveyor General of the Federation (OSGOF) and the Kwara State Ministry of Land and Survey respectively formed the secondary data. Literatures were derived from relevant dissertations, thesis, conference papers, journal articles, research papers, textbooks, published and unpublished works, reports from multilateral organizations on Urbanization /Urban expansion (like United Nations and World Bank) and the internet based documents formed the secondary data.

3.3.2 Data Processing

Processing of the data involved, scanning; geo-referencing and digitizing for the topographic and administrative maps while the processing of the Remote Sensing data (Satellite Images) are largely concerned with four basic operations: Image Pre-processing, Image enhancement, Image classification, and Urban Detection and Analysis.

The software used are ArcGIS 10.1 and ERDAS Imagine 9.2

3.3.2.1 Scanning

The topographical maps of the study area containing the identified boundaries were scanned using 300dpi resolution in tiff format to have them in digital format so that further processing should be easy.

3.3.2.2 Geo-referencing

The scanned toposheets which contained undefined spatial reference were then imported into ***ArcGIS 10.1*** for geo-referencing. The Universal Transverse Mercator was used as a spatial

reference using well distributed Ground Control Points acquired during the reconnaissance survey of the study area.

3.3.2.3 Digitizing

After the image was geo-referenced, on-screen digitizing was performed in ArcGIS. Different features were extracted by pointing and tracing the cursor along parcel boundaries in order to prepare the study area map. The features include; Local Government Area boundaries built up areas, major and minor roads, rail line, and rivers.

3.3.2.4 Satellite Image Processing

Satellite Images are normally subjected to various processes to ensure qualitative extraction and interpretation such as Pre-processing, enhancement, and resampling. These were also done in this study to achieve accurate change detection. The multi-temporal images were pre-processed both geometrically and radiometrically to correct errors arising from imaging sensors, atmospheric effect and earth's curvature. The Image enhancement was to optimize their appearance to the visual system i.e. to improve the visual quality and recognition of features in attaining specific goals of interpretation. This was done by displaying individual wavelength bands of the original satellite data through an appropriate colour combination to obtain a 'false colour composite'. According to Lu and Weng (2006), the challenges of urban mapping using Landsat imagery include spectral mixing of diverse land cover components within pixels and spectral confusion with other land cover features. Therefore, Image enhancement is almost a pre-requisite in Image processing. However, both pre-processing and enhancement were already been done from the ground station before the images were obtained.

3.3.3 Image Classification

The intent of the Image classification is to categorize all pixels in a digital image into one of several land cover classes, or "themes". This categorized data may then be used to produce thematic maps of the land cover present in an image (Reddy, 2008). In this study, supervised classification technique using Maximum Likelihood Algorithm (which classifies images according to the covariance and variance of the spectral response patterns) was used to classify the images.

From visual and digital interpretations of the satellite images, different land use and land cover categories were distinguished in the study area and since emphasis was mainly given for urban expansion and its impact on agricultural lands, therefore based on Jensen (2005) land use / land cover classification scheme, the various land use / land cover types within the study area were classified into five; they are; Built-up land, Natural vegetation, Agricultural land, Water body and Bare surfaces as shown in table below

Table 3.1 Land Use Land Cover Classification Scheme

LAND USE	DESCRIPTION
Built-up:	These include all types of man-made surfaces including residential, commercial, industrial, public and semi – public place, recreational areas. There are mostly irregular in shape and linked by road network.
Agricultural Land	This is broadly defined as the land used primarily for production of food & fiber, it include cropped areas, fallow lands & plantation areas.
Natural Vegetation	This includes areas of natural vegetation of any plant species, trees, deciduous and ever green forest lands.
Bare Surfaces	These include exposed surfaces, rocky outcrops, sandy area, strip mines, quarries, and other human induced stripped lands etc. they are usually devoid of any type of vegetation.
Water Body	These include areas that are persistently covered with water, such as Rivers, Streams, Lakes, and Reservoirs. It also includes artificial impoundment of water used for irrigation, flood control, municipal water supplies, recreation, etc.

Source: Adapted from Jensen (2005)

In testing for the accuracy of the classification, 25 Ground truth points for each land use types were randomly obtained from the field with GPS. These points were imported into ArcGIS 10.1 environment and Kappa tool used to assess the accuracy of the classification. According to Congalton (1991), Kappa coefficient expresses the proportional reduction in error generated by a classification process compared with the error of a completely random classification. Kappa

coefficient value of 0.64 was obtained which indicated moderate classification accuracy (Anthony, Viera and Joanne, 2005).

3.3.4 Data Analysis

3.3.4.1 Post Classification

Post classification in this study involves mapping out various land use types in the study area between the period; 1990, 1999 and 2014. These Land use maps were used to a statistical table showing the areal extent (in km²) and percentage of different land use type in the area for each study year (1990, 1999, and 2014) and bar charts created to display the statistics for easy comparison.

3.3.5 Urban Expansion Analysis

To determine the extent and rate of urban growth in the Study Area between 1990 – 2014

In determining the extent and rate of rban growth in the Study Area between 1990 and 2014, the classified images were converted from raster to vector in order to obtain the extent (area in km²) of each class. The comparison of the landuse/landcover statistics assisted in identifying the percentage change, To characterize the landuse/landcover change of Offa in 1990, 1999 and 2014, Calculation of the area in kilometers square of the resulting landuse/land cover types for each study year and subsequently comparing the results. In achieving this, a table was developed showing the area in kilometers and the percentage change for each year (1990 and 2014) measured against each landuse/land cover type.

To determine the percentage change, change was first calculated by subtracting the initial value from the former value of the same land use class; i.e.

Change in square kilometres = the latter area coverage of land-use/land-cover type of interest minus the former area coverage of the same land-use/land-cover type (for example, the area coverage of built – up in 2014 minus the area by built - up in 1999).

The Percentage Change was then obtained by subtracting the initial value from the former value and dividing by initial value then multiplying by 100 as shown in the formula:

$$\text{Percentage Change} = \frac{\text{Former-Initial}}{\text{Initial}} \times 100$$

Also expressed as:

$$\text{Percentage change of class} = \frac{\text{observed change}}{\text{Base year}} \times 100$$

Source: Yeates and Garner (1976)

To determine the annual rate of change (AR), the Percentage Change (PC) was divided by the number of study year, multiplied by 100. The number of study years between 1999 and 2014 = 2014 – 1999 = 15.

$$AR = \frac{PC}{\text{No of years}}$$

Where AR = Annual Rate

PC = Percentage Change

Source: Yeates and Garner (1976)

To determine the Annual Change Rate in percentage, the Percentage Change is divided by the number of study years multiplied 100.

$$AR = \frac{PC}{\text{No of years}} \times 100$$

Source: Yeates and Garner (1976)

3.3.6 Determining the conversion rate of agricultural land to urban expansion (built-up)

The conversion rate of agricultural land to urban expansion (built-up) was carried out by extracting the built up areas in 1999 and 2014 and overlaying and clipping each of them on the agricultural land in 1990. The total area of the clipped portions was the calculated. This gave the areas that were formerly agricultural land in 1990 but later got converted to built-up areas. The rate of loss was obtained by dividing the total area lost in each period by the number of the study years.

In summary, Land use maps were created to identify major land use types in the study area within the study periods (1990, 1999 and 2014), Change, Percentage Change and Annual change rates were calculated (in both km^2 and percentage) to determine the rate and extent of urban growth. Images of urban/built-up were extracted from the classified images and overlaid (clipped) to obtain an urban expansion images within the study period. Spatial loss of agricultural land and the urban expansion maps with statistical tables were generated from these images for the study period i.e. 1990, 1999 and 2014.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 INTRODUCTION

This chapter dwells on the presentation and analysis of result obtained from the research analysis; the objectives of this study formed the basis of all the analysis carried out in this chapter. The results are presented in figures 4.1, 4.2, 4.3 4.4; and tables 4.1, 4.2, 4.3. and 4.4. The presentation and analysis of the data have been carried out under the following sub-themes; land use and land cover classes; extent, percentage and rate of land use land cover change; spatial loss of agricultural land to other land uses; and the rate of agricultural land conversion to urban built – up (urban expansion) trend, pattern and rate of land use land cover change.

4.2 DIFFERENT LAND USE TYPES IN THE STUDY AREA

The mapping out of different land use types of Offa Local Government Area in 1990, 1999 and 2014 was carried out by classifying and polygonizing the satellite imageries into five major land use types as stated earlier. See Fig 4.1

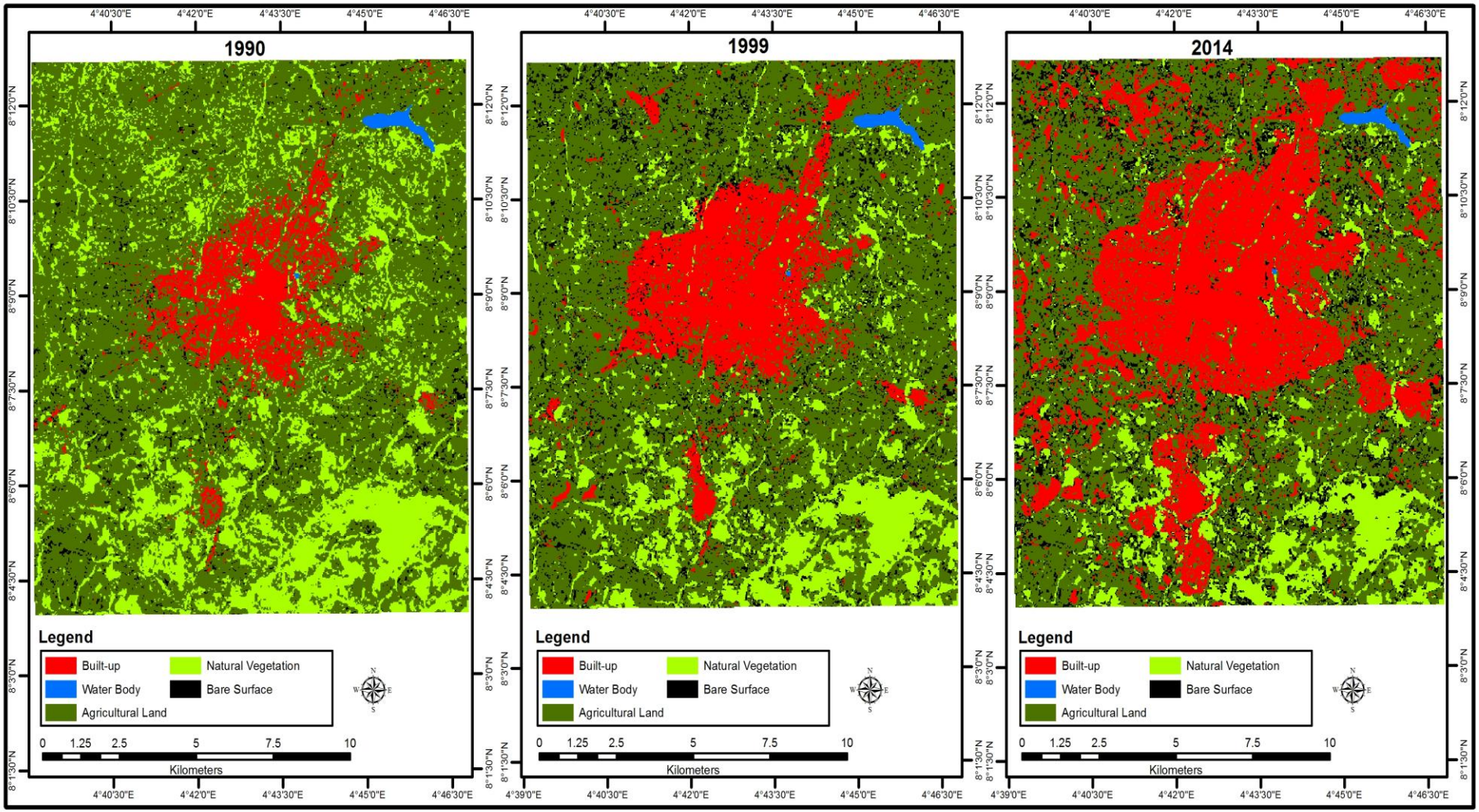


Figure 4.1: Land use/Land cover types of Offa of 1990, 1999 and 2014

Source: Author's Analysis, 2014

Table 4.1: Different Land use Types in Offa between 1990 and 2014 (in km2 and %)

LAND USE TYPES						
	1990		1999		2014	
Land use	**Area (Sq.Km)**	**%**	**Area (Sq.Km)**	**%**	**Area (Sq.Km)**	**%**
Built-up	17.57	7.73%	32.00	14.07%	65.09	28.63%
Agricultural Land	148.63	65.36%	135.57	59.62%	107.18	47.14%
Natural Vegetation	53.53	23.54%	36.30	15.97%	26.97	11.86%
Bare Surface	6.77	2.98%	22.66	9.96%	27.34	12.03%
Water Body	0.89	0.39%	0.85	0.38%	0.80	0.35%
Total	227.38	100	227.38	100.00	227.38	100.00

Source: Author' Analysis, 2014

As shown in table 4.1, Built-up occupied which occupied small portion of the total area in 1990 increased drastically to almost double of the initial size in 1999, the same level of increment was also noticed between 1999 and 2014. The rapid increase can be attributed to the creation of a Local Government Area with the headquarters in Offa, the sitting of federal and military institutions, in addition to industrial, transportation, commercial, physical development of the area, locating and upgrading of new and existing social amenities, and the accompanying rise in socioeconomic indices. Influx of people (majorly due to employment opportunities also contribute substantially to population growth and sets off the process of urban expansion.

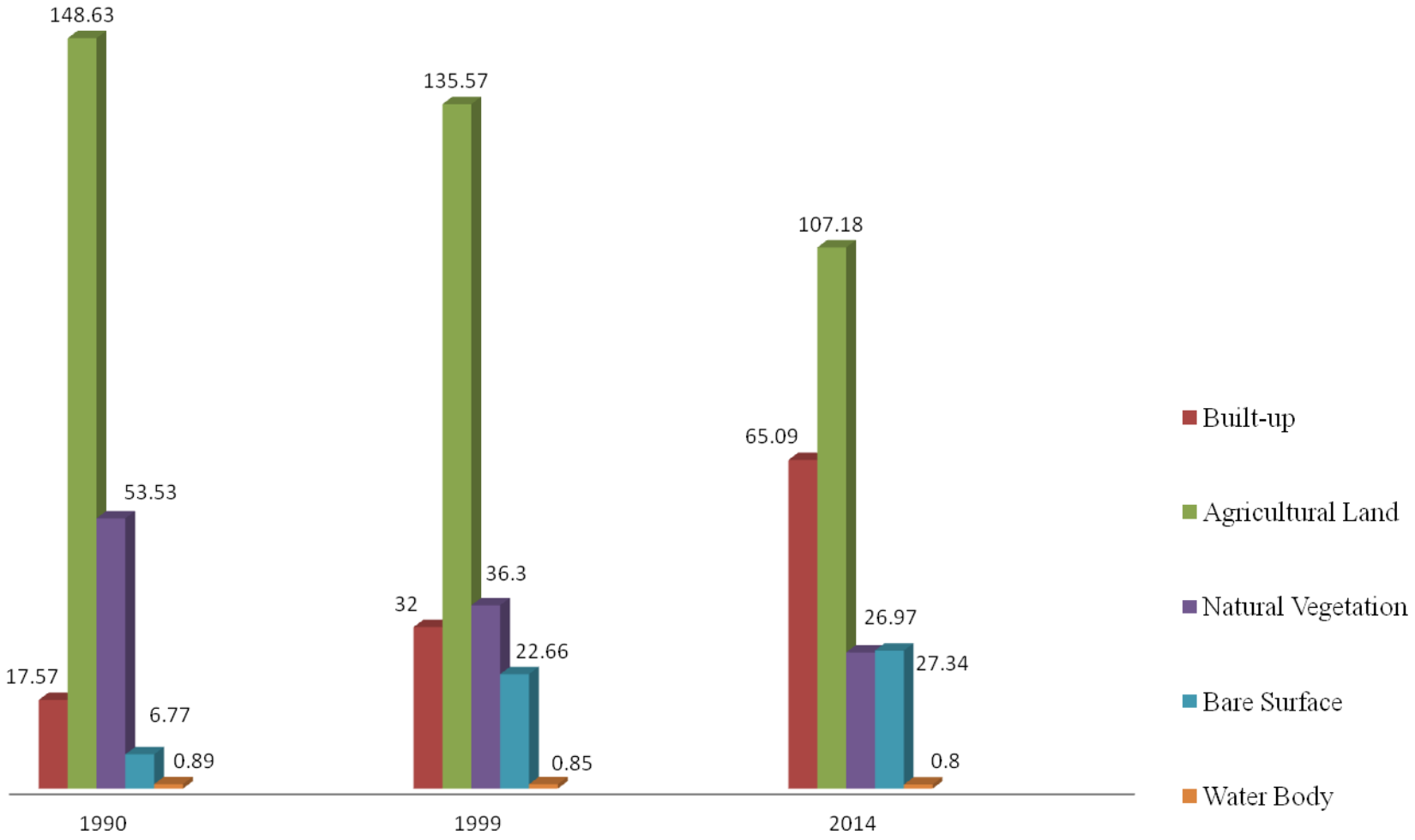
Agricultural Land has the highest coverage of the study area in 1990), this is not surprising as farming is one the major occupations in the study area in 1990. It decreased significantly

throughout the study period. This was majorly due to the rapid physical development (such as construction of road, buildings etc) and urban expansion which tend absorb more farmland to accommodate the growing population at the cost of the agricultural land.

Natural Vegetation which occupied 23.54% of the study area in 1990 also witnessed decreasing trend throughout the study period. Logically, as built – up areas increases, agricultural land decreases so also natural forest. It is a chain reaction; as population grows , more surrounding land which is basically agricultural land are absorbed for urban land uses such as constructions of building and roads; farmers tend to open up new forest land for agricultural activities (encroachment for agricultural and urban landuses) as well as the accompanying population pressure on forest resources and biodiversity.

Bare Surface which was noticeable in 1990 rose significantly between 1990 and 2014, this could also be attributed to the facts that the process of cultivation involves the clearing of natural vegetation; abandonment of farmlands (and agricultural activities) for white collar jobs and the huge financial benefits attached to selling land for urban land use rather than agricultural purposes. Water body is the smallest of all the classes throughout the study years and equally reduced within the same period. Population growth is the major culprit but the low change rate could be due to the presence of boreholes and water wells in almost all households in the study area, which effectively reduce the growing population's pressure on water bodies.

Figure 4.2: Bar chart of Land use types and area extent (Sq km)



Source: Author's Analysis, 2014

4.3 EXTENT AND RATE OF URBAN GROWTH

The extent of urban growth in the study area is presented in kilometer square and percentage as shown in the tables 4.2

Table 4.2: Extent of Urban growth between 1990 and 2014

EXTENT OF URBAN GROWTH									
	1990	**1999**	**2014**	**(1990 – 1999)**		**(1999-2014)**		**1990-2014**	
Land use	**(km²)**	**(km²)**	**km²**	km²	%	km²	%	km²	%
Built-up	17.57	32.00	65.09	14.42	82.09%	33.09	103.42%	47.52	270.40%

Source: Author' Analysis, 2014

Table 4.2 above shows the urban growth extent in the study area between 1990 and 2014. It is evidenced from above that urban built-up witnessed the highest change over the study period compared to other land uses, it increased from 14.42km² (82.09%) between 1990 and 1999 to 33.09km² (103.42%) between 1999 and 2014, resulting in 47.52km² (270.40%) as the overall urban growth between 1990 - 2014. This significant rapid urban growth could be associated with the sitting of Local Government Headquarters and Federal and military institution in the study area which consequently lead to rapid physical development (such roads, buildings, industries, etc); locating of new and upgrading of existing social amenities; industrial and commercial developments; and population influx. This result corresponds with the findings of Oyinloye (2013) which revealed that there is a direct relationship between rapid urban growth and factors such as creation of states and local governments; and sitting of universities, polytechnics, colleges of education, commercial centres, industrial centres, tourism resorts and population influx in Nigeria. Also, Francis *et al* (2013) identified which revealed that urban growth is the outcome of the social, economic and political developments which in turn lead to urban

expansion and growth of large cities. We can deduce that urban growth in the study area is the consequence of either few or all of political, commercial, industrial, social, physical development, improved socioeconomic indices and population influx.

The rate of change in urban growth within the study year is tabulated in square kilometers and percentage is shown in table 4.3.

Table 4.3: Rate of Change in Urban growth between 1990 – 2014

RATE OF CHANGE									
	1990	**1999**	**2014**	**Annual Rate of change (1990 – 1999)**		**Annual Rate of change (1999 - 2014)**		**Total Annual Rate of change (1990 - 2014)**	
Landuse	**(km²)**	**(km²)**	**(km²)**	**(km²)**	**%**	**km²**	**%**	**km²**	**%**
Built-up	17.57	32.00	65.09	1.60	9.12%	2.21	6.89%	1.98	11.27%

Source: Author' Analysis, 2014

As shown in the table above, the annual rate of urban growth was significant throughout the study period. The study area witnessed change rates of 1.60km² (9.12%) between 1990 – 1999 and 2.21km² (6.89%) between 1999 – 2014. The entire study period (1990 to 2014) recorded a commendable annual urban change rate of 1.98km² (11.27%), this result coincides with the negative change rate of agricultural land and natural vegetation. Agricultural land decreases with an annual change rate of -1.45km² (-0.98%) between 1990 and 1999; and -1.89km² (-0.87%) between 1999 and 2014. Natural vegetation change rate was -1.91 km² (-3.58%) between 1990 – 1999 and -0.62 km² (-1.71%) between 1999 – 2014. The total loss in annual rate between 1990 – 2014 was -1.73km² (-1.16%) for agricultural land and -1.11 km² (-2.07%) for natural vegetation. This implies that as built – up is gaining coverage from agricultural land and natural vegetation.

4.4 SPATIAL LOSS OF AGRICULTURAL LAND TO URBAN EXPANSION

Figure 4.3 shows the spatial loss of agricultural land to urban expansion in the study area between 1990 and 2014. The statistical analysis presented in square kilometers and percentages are tabulated in table 4.4.

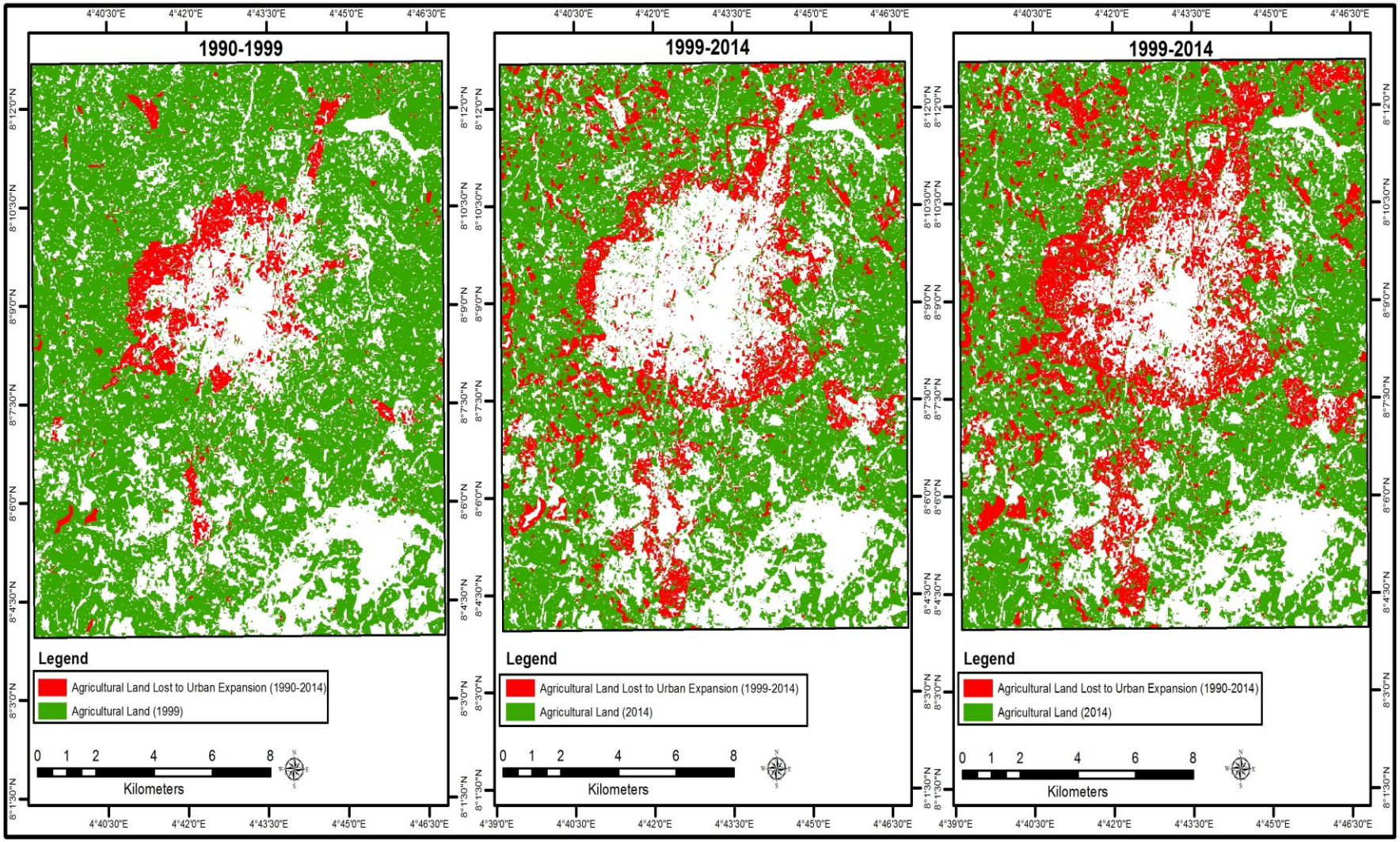


Figure 4.3: Spatial loss of Agricultural land lost to urban expansion
Source: Author's Analysis, 2014

Figure 4.4 shows the agricultural land of 1999 and 2014 with the area loss to urban expansion between 1990 and 1999; 1999 and 2014; and 1990 and 2014. The rapid growth of built – up area on agricultural land which indicates the process of urban expansion is discernible on the images, thus clearly displaying the spatial loss of agricultural land to urban expansion over the study period.

Table 4.4: Spatial loss of agricultural land to Urban Expansion

Spatial loss of Agricultural Land Lost to Urban Expansion (Built-up)											
Spatial Loss						**Annual Rate of Conversion**					
1990-1999		1999-2014		1990-2014		1990-1999		1999-2014		1990-2014	
(km²)	%	(km²)	%	(km²)	%	(km²)	%	(km²)	%	(km²)	%
13.92	6.12%	31.27	13.75%	43.50	19.13%	1.55	0.68	2.08	0.92	1.81	0.80

Source: Author's Analysis 2014

Table 4.5 shows the extent, percentage and annual rate of conversion of agricultural land to urban expansion. As shown, within the period 1990-1999, about 13.92km² (6.12%) of agricultural land area was converted to urban expansion (built up) at an annual conversion rate of 1.55 km² (0.68%), while the period 1999-2014, witnessed 43.50km² (19.13%) of agricultural land converted at an annual conversion rate of 1.81km² (0.80%). The implication is that urban expansion is mostly at the expense of agricultural land, thus as urban built –up increases, agricultural land decreases. This result concur with the findings of Etim and Dukiya (2013), Olawale et al (2011), and Njungbwen and Njungbwen (2011) where loss in agricultural land were attributed to urban expansion. Also Shalaby (2012) in his work on assessment of urban sprawl impact on the agricultural land in the Nile Delta region of Egypt identified urban

expansion as the factor responsible for the loss of 1960 km^2 (77.3 %) of agricultural land between 1984 and 2006. We can therefore deduce from the data that urban expansion take place on and at the expense of agricultural land.

In summary, from the tables 4.1, 4.2, 4.3, and 4.4, it is clear that there was no category of land use that was actually stable during the study period. It can also be deduced that the lost suffered by agricultural land and in extension natural vegetation were gained by built – up in the study area. Because while the former shown negative changes, the latter maintained positive changes throughout the study period. In other words, agricultural lands have been significantly converted to built – up land.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 INTRODUCTION

This chapter describes the summary of the major findings of this study, conclusion derived from the findings and recommendations for effective management and reducing the impact of urban expansion particularly on agricultural land in the study area and the state at large.

5.2 SUMMARY OF THE MAJOR FINDINGS

This research provide insight on the impact of urban expansion of agricultural land in Offa Local Government Area using Remote Sensing and GIS. Attempt was made to capture as accurate as possible the five major land uses types in the study area as they change through time. The study used Remote Sensing and GIS as an analytical tool with satellite images used for mapping and quantifying the land use types, rate and extent of urban growth, spatial loss and conversion of agricultural land to other land use and urban expansion within the study period.

As shown from the classified land use classes, land use types had changed significantly over the period of more than two decades (1990 – 2014). The statistics indicated that the growth rate of built up area occupied the largest share among land use categories especially at the expense of agricultural land. It shows a rapid decline in agricultural land between 1999 and 2014 while the period between 1990 and 1999 witnessed relatively slow decline. The lost agricultural land between these periods was converted to urban land use (built up and bare surfaces).

Agricultural land which has the highest coverage with 148.63 km² (65.36%) in 1990, 135.57 km² (59.62%) in 1999 and 107.18 km² (47.14%) witnessed decreasing trend throughout the study period (1990 – 2014). It changed by -41.45 km² (-27.89%) with an annual change rate of -1.73km² (-1.16%) and lost 1.81 km^2 (0.80%) to urban expansion within the same period. Natural vegetation also reduced gradually over the study period from 23.54%, 15.97% and 11.86% in 1990, 1999 and 2014 respectively. This gradual reduction of agricultural land and natural forest can be attributed to the constant conquest by built – up land and bare surfaces.

The built-up area expanded from 17.5km² in 1990 to 32.00km² and 65.09km² in 1999 and 2014, the extent of the change within the same period was 14.42km² (82.09%), 33.09km² (103.42%) and 47.52km² (270.40%). It also expanded at an annual rate of 1.60km² (9.12%) between 1990 and 1999; 2.21km² (6.89%) between 1999 and 2014; and 1.98km² (11.27%) within the study period (1990 – 2014). This gradual expansion was at the expense of agricultural land and is also attributed to the creation of a local government area, sitting of federal and military institutions, rapid physical, commercial development of the study area as well as the significant rise in socioeconomic indices and population growth.

The GIS based analysis of urban expansion over the demographic change and land use modifications has also indicated that urban growth has basically taken place haphazardly on agricultural land because it is the suitable available land. This means land use has been changing from predominantly agricultural uses to non-agricultural uses, such that provision of residential and recreational space, transportation facilities, and industrial space is clearly dictated by the urbanization phenomenon.

5.3 CONCLUSION

This research work showcases the ability of GIS and Remote Sensing in analyzing spatial-temporal dynamics of urban growth. Offa Local Government Area has emerged from being predominantly rural area three decades ago to a city with an appreciable urbanization level. The result has shown that the area has lost quite significant portion of its agricultural land to urban expansion. Built – up has gained 28.63% of the total coverage over the study period. Therefore, there is a need to an understanding of structural urban dynamics in order to have absolute foundation for the formulating sound and effective urban policies. Such policies must be contemporary to turn potential crises into opportunities as failure maybe too devastating. Hence, the challenge is the sustainability of agricultural land (and in extension agricultural activities) in the face of very rapid declining agricultural land and urbanization. This feat can be achieved via the integration of agricultural landscapes into urban land use planning systems and as crucial part of urban development since urban growth and expansion is inevitable.

5.4 RECOMMENDATIONS.

The result of this work has shown that there had been remarkable reduction in agricultural land and a resulting increase in urban built up. In fact, the area has lost about 43.59% km² of its prime agricultural land to urban expansion in less than three decades. In view of the rate of development that is going on at present and the likely ones in the future with due consideration of the conversion rate of agricultural land to urban built up, the following are therefore recommended;

a) Population influx has been attributed as one of the major causes of urban expansion in the study area especially from the surrounding rural areas. Hence adequate social amenities should be incorporated into rural planning framework to improve living conditions in the rural areas so that the rate of emigration will be reduced and thereby checking the expansion of the city on agricultural land.

b) There is need to control urban spreading to agriculture land as this will have serious repercussion on food production. Although urban expansion cannot be stopped, with proper management and planning it can be directed in a desirable and sustainable way.

c) Remote Sensing and GIS techniques should be incorporated as a monitoring system which will enable planners and decision makers to adequately plan and control urban expansion effectively in a spatiotemporal dimension.

d) Proactive measure should be taken by all stakeholders the study area towards a better understanding of the changing pattern of landuse of the area so as to be better equipped in order to manage various environmental challenges that might be associated with urban expansion.

e) Impact of population growth and urban expansion on agricultural land is a continual phenomenon; this research is therefore not an end to the issue of loss of agricultural land to urban expansion. Therefore that further studies into spatiotemporal pattern of urban expansion, the resulting environmental effects is recommended.

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