EFFECTS OF URBANIZATION ON LANDUSE/LANDCOVER CHANGES IN BIRNIN KEBBI, KEBBI STATE, NIGERIA.

BY

Aliyu Zailani ABUBAKAR
MSC/SCI/3315/2011-2012
(M.sc. REMOTE SENSING AND G.I.S)

BEING A THESIS SUBMITTED TO THE SCHOOL OF POST GRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE DEGREE IN REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM, DEPARTMENT OF GEOGRAPHY, A.B.U ZARIA

July 2015

DECLARATION

I solemnly declare that this work titled ‘’**EFFECTS OF URBANIZATION ON LANDUSE/LANDCOVER CHANGE IN BIRNIN KEBB, KEBBI STATE, NIGERIA**.’’ was written by me in the Department of Geography under the supervision of Dr B.A. SAWA and Dr D.N JEB. The information gleaned from literature has been duly acknowledged in the text and list of references provided. No part of this thesis has previously been presented for another degree or diplomat at any university.

ABUBAKAR, Aliyu Zailani ---------- ----------
(Msc/Sci/3315/2011-2012) Signature Date

CERTIFICATION

This thesis titled **"EFFECTS OF URBANIZATION ON LANDUSE/LANDCOVER CHANGES IN BIRNIN KEBBI, KEBBI STATE, NIGERIA"** by ABUBAKAR Aliyu Zailani meets the regulation governing the award of degree of Master of Science (M.Sc) in Remote Sensing and GIS, Ahmadu Bello University, and is approved for its contribution to knowledge and literacy presentation.

Dr. B.A SAWA	----------	----------
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Chairman (Supervisory Committee)	Signature	Date
Dr. D.N JEB	----------	----------
-		
(Member Supervisory Committee)	Signature	Date
Dr. I.J MUSA	----------	----------
-		
(Head of Department)	Signature	Date
Prof. A.Z HASSSAN	----------	----------
(Dean, School of Postgraduate Studies)	Signature	Date

DEDICATION

This project is dedicated to God and my loving, caring and industrious parent whose effort and sacrifice has made my dream of having this degree a reality. Words cannot adequately express my deep gratitude to you. I pray you will live long to reap the fruits of your labor.

ACKNOWLEDGEMENTS

All praise due to Allah, the Most Gracious and Most Merciful, for giving me the strength, health to complete my study. I am highly delighted for that to complete this thesis within this possible time though there are uncountable challenges encountered on the process.

Although this dissertation represents an individual work, it would not have been written without the sincere help and support from many people. It is a pleasure to express my gratitude to all those who made this thesis possible. Because of them, my graduate experience has become one that I will never forget and forever appreciate.

My deep gratitude is to my Thesis Supervisors, Dr. B.A Sawa and Dr. D.N Jeb whose proper guidance, patience, advice, support and supervision have assisted me in producing this work. May God bless you.

My heartfelt appreciation from the innermost core of my being goes to my parents Alhaji Abubakar S. Zailani and Hajiya Madinatu Aliyu, my brother Malam Mustapha Abubakar for their Love, caring, financial and moral support. God bless you all and grant you long life to eat the fruit of your labour.

This is my avenue to show appreciation to my wife Malama Maryam Aliyu Sambo and my daughter and son Fatimatul Zahrau Aliyu and Ahmad Aliyu for their word of encouragement, prayers and support, almighty God will bless you.

Special thanks and appreciation is extended to Mr Danboyi Joseph, Malam Abubakar Umar, Adewale Adebayo, Malam Auwal Abubakar, Mr Ifeanyi C, ,Mr Udoka Emenari, Malam Labbo Lawal and the entire staff of Department of Surveying and Geoinformatics of Waziri Umaru Federal Polytechnic Birnin kebbi for their support.

My sincere appreciation goes to my brothers and sisters Tanimu Abubakar, Umma Yero, Abdulkadir Abubakar, Saadu Abubakar, Ismail Abubakar, Adama Abubakar, Zainab Abubakar, Isah Abubakar, Aisha Abubakar, Maimunatu Abubakar, Usman Abubakar, Khadija Abubakar, Sulaiman Abubakar, Adam Abubakar, Ibrahim Abubakar, Amin Abubakar and our youngest Buhari Abubakar. God bless you all.

This acknowledgement will be incomplete if I fail to thank my friends, course mates, Ahmed Abba, Yusuf Suleman, Murtala Uba, Aminu Aiyu, Aminu Danraka, Isah Adamu, Abdullahi Jibrin, Salihu Zailani, Mukhtar Abdulkarim, Rirwan Dauda Paul Jobin, I thank you all.

Finally, I give glory to the owner of the entire universe for whom all wisdom, knowledge, understanding and mercy flow. Thanks for the sound health, wisdom and grace you gave me till this present moment.

Abstract:

This study therefore examined the integration of Remote Sensing and Geographic Information System (RS/GIS) for analyzing land use and land cover dynamics in BirninKebbi, the Kebbi State capital for the period 1986 to 2009. Land sat (TM) images of 1986, 1999 and Nigerian Sat-1image of 2009 were used. The study employed supervised digital image classification method using Erdas Imagine 9.2 and Arc GIS 9.3 software and classified the land use into built up area, riparian vegetation, bare lands, grassland, Agricultural land and water bodies. The images were made to pass through the processes of georeferencing, image enhancement, image resampling and classification. The results obtained shows that the built-up area has been increasing rapidly for the periods (1986-1999) by 547.3% .This is evident in the increased Land Consumption Rate (LCR) from 0.022 to 0.089 in 1986 and 1999 respectively and Land Absorption Coefficient (LAC) by 0.201 within the same period. While between 1999 to 2009 witnessed a drop in (LCR) at which the physical expansion of the was going on from 0.0089 in 1999 to 0.031 in 2009. This is evident in the drop observed Land Absorption Coefficient (LAC).The results also showed increase in the grass land while Agricultural land decreases, the water bodies were stable between 1986 and 2009. These results could help city planners and policy makers to attain and sustain future urban development. It is therefore recommended that encouragement should be given to people to build towards the outskirts, like Zauro, Ambursa etc through the provision of incentives and forces of attraction that is available at the city center in these areas to avoid the problem of overcrowdings.

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CHAPTER ONE: INTRODUCTION

1.6 Background to the Study

Studies have shown that there remains only few landscapes on the earth that still exist in their natural state. Due to anthropogenic activities, the earth's surface is being significantly altered and man's presence on the earth and his use of land has had a profound effect upon the natural environment, thus resulting into an observable pattern in the land use/land cover over time (Lambin, Geist and Lepers, 2003; Jiang, Yang,Nicholas, and Wang, 2004; Asthana and Asthana, 2005; Zubair, 2006; Long, Wu, Wang, and Dong, 2008).

Land cover as defined by Barnsley and Barr, (2000) is the physical materials on the surface of a given parcel of land (e.g. grass, concrete, tarmac, water), and land use is the human activity that takes place on, or makes use of that land (e.g. residential, commercial, industrial). Land use can consist of varied land covers, (i.e. a mosaic of biogeophysical materials found on the land surface). For instance, a single-family residential area consists of a pattern of land-cover materials (e.g. grass, pavement, shingled rooftops, trees, etc.). The aggregate of these surfaces and their prescribed designations (e.g. park) determines land-use (Anderson, Hardy, Roach and Wiremer, 1976).

Land is the most important natural resources on which all activities are based. Land use unlike geology, is seasonally dynamic and indeed is more changing. The increase in population and human activities are increasing the demand on the limited land and soil resources for agriculture, forest, pasture, urban and industrial land uses. Information on the rate and kind of changes in the use of land resources is essential for proper planning, management and to regularise the use of such resources. Knowledge about existing land use and landcover and its

trend of change is essential for various reasons. Landuse data are needed in the analysis of environmental processes and problems that must be understood if living conditions and standards are to be improved or maintained at current level. Changes in landuse can be due to urban expansion and the loss of agricultural land, changes in river regimes, the effects of shifting cultivation, the spread of erosion and desertification and so on. This, therefore, requires not only the identification of features but also the comparison of subsequent data in order to recognize when valid change has taken place.

According to Meyer (1995) Land use and land cover are distinct yet closely linked characteristic of the earth's surface. The use to which we put land could be grazing, agriculture, urban development, logging and mining among many others, while land cover categories could be cropland, forest, wetland, pasture, road among others.

Ademiluyi, *et al.*, (2008) said rapid urbanization/industrialization and large scale agriculture and major changes in human activities have been identified as the major causes of the dramatic changes in land cover and land use patterns globally. Urban centers in Nigeria are facing the problems of over-stretched infrastructures, environmental degradation, seasonal flooding, destruction of natural vegetation, all resulting from increase in population (Joel, 2006).

Accurate and timely information about land cover in urban areas is crucial for urban land management decision-making, ecosystem monitoring and urban planning. Although land cover changes can be monitored by traditional inventories and survey, satellite/aerial remote sensing

provides a cost-effective way in land cover change detection, as it can explicitly reveal spatial patterns of land cover change over a large geographic area in a recurrent and consistent way.

Though human beings have been modifying land to obtain food, shelter and other essentials of life for thousands of years, current rates, extents and intensities of such modifications are far greater than ever in history and continue undocumented. This has driven unprecedented changes in ecosystems and environmental processes at local and regional scales. Monitoring and mediating the negative consequences of land use changes while sustaining the production of essential resources has therefore become a major priority of researchers and policymakers around the world.

The movement of people from rural to urban cities in search of better livelihood lead to an expansion of urban areas and increase in social and economic activities along flood plains thus increasing the risk of urban dwellers and infrastructures to natural disasters such as floods (Akinbami, Akinwumi and Salami, 1996; Ishaya, Ifetimehin and Okafor, 2008 and Manandhar, 2010). Urban expansion is indicated by an increase in the population of people living in these areas. The result of such changes in the urban areas impact on the natural landscape, river morphology, drainage system and land use/land cover of the area increasing the frequency of water induced hazards (Manandhar, 2010).

Urbanization refers to the increase in the proportion of the population that lives in towns and cities. This usually results from the net movement of people from rural to urban areas or natural increase (the excess of births over deaths). However, the definition of what qualifies as urban center differs from one country to another depending on the criteria used. Urban population has

been growing more rapidly than rural population worldwide, particularly in developing countries (Lambin *et al*, 2003). Urbanization is one of the several anthropogenic activities that impact on land use/land cover.

The urban area where human beings live in is the symbol of human civilization, and it is an important place for humans to do their social activities. Urbanization is a significant characteristic of humans' modern lives. For a city, the level of urbanization can be used to estimate the level of development of economy, social, science and technology. Meanwhile, it is an important data to monitor the level of management and organization of a city.

Many things in reality have dual characters, so does urbanization. On the one hand, urbanization means the advanced industry, convenient transportation, and prosperous metropolitan area and so on. On the other hand, in the process of urbanization, the undesirable effects could not be avoided, such as the damage and pollution of natural environment. Because one of the most significant characteristics of urbanization is that the proportion of urban population to total population is increasing. One of the effects of expansion of population is the expansion of urban area, so the surrounding natural environment is destroyed, such as the deforestation.

Urban land expansion refers to the spreading out of a city and its suburbs towards non built-up areas at the periphery of an urban area; involving the conversion of other land uses into built-up land over time (Liu, Zhan & Deng, 2005). Urban land expansion is the most easily identifiable characteristic of urbanization process as it affects land cover/use at both regional and global scales.

In some instances, land use land cover change may result in environmental, social and economic impacts of greater damage than benefit to the area. . Land cover can be altered by forces other than anthropogenic. Natural events such as weather, flooding, fire, climate fluctuations, and

ecosystem dynamics may also initiate modifications upon land cover. There are also incidental impacts on land cover from other human activities such as forest and lakes damaged by acid rain from fossil fuel combustion and crops near cities damaged by tropospheric ozone resulting from automobile exhaust (Meyer, 1995).

1.7 Statement of the Research Problem

Land use / land cover are very dynamic in nature and have to be monitored at regular intervals for sustainable environmental development (Zubair, 2006). Population is a very important factor or agent of change in land-use in an area. For instance, as population increases, construction of dwellings increases, thus engendering conversion of cropland and forest land to settlements. These urban land-uses are of various types which could be for industrial, commercial, government, as well as transportation purposes.

With the creation of Kebbi State in 1991, Birnin Kebbi as the capital witnessed rapid growth and development. This was as the result of the change in its status from the hitherto local government council and emirate headquarters to that of the state capital. Although Kebbi State is largely rural, Birnin Kebbi is expected to witness rapid rate of urbanization because of its administrative and commercial functions.

Series of studies on urban activities and land use in Nigeria in the past few decades includes,

Adepoju, *et al.,* (2006) examined the land use/land cover changes in Lagos for two decades (1984-2002) due to the rapid urbanization. The land cover change map revealed that forest, low density residential and agricultural land uses were mostly threatened: most land allocated for these uses were legally or illegally converted to other land uses within and outside the metropolis. The urban/built up had 35.5% increases, bare soil nearly doubled its size with 96.3% increase from the initial area coverage in 1984. There was an increase of 1.6% in water

bodies which was attributed due to sensor difference or canalization projects in the study area. There was 57.8% decrease in the forest and agriculture land cover. The spatial growth or expansion in other land cover types had directly taken place on the agricultural land and forest as indicated by being the only land cover type with decrease in area coverage for the period under study.

Zubair, (2006) analyzed Landuse/Landcover change in Ilorin between 1972 and 2001, the result of the work shows a rapid growth in built-up land between 1972 and 1986 while the periods between 1986 and 2001 witnessed a reduction in this class. It was also observed that change by 2015 may likely follow the trend in 1986/2001.

Ishaya, Ifatimehin and Okafor, (2008) examined Urban expansion and loss of vegetation cover using remote sensing and GIS in Kaduna town, Northern Nigeria with the use of LandSat imageries of 1990 and 2000. The results showed that over the few decades, Kaduna town has been transforming due to population increase thereby, causing vegetation loss including expansion in built up area. Kaduna town springs its colonial origins with its development over the years due to the economic, educational and administrative role as a seat of government.

Eludoyin, Wokocha and Ayolagha, (2010) assessed the land use and land cover changes in Obio/Akpor in Rivers State between 1986 and 2000 using Remote Sensing and Geographic Information System. The study reveals that farmland, mangrove, primary forest and sparse vegetation reduced over time by 45.34%, 37.06%, 43.06% and 8.09% respectively while secondary forest, built up area and water increased by 5.88%, 74.55% and 3.43%, respectively. It was also projected that by 2020 farmland would be at 0.570 (57%) probability of changing to secondary forest and 0.154 (15.4%) of changing to built up area. Primary forest will be at 0.186 (18.6%) probability to change to built up area.

Bernerd, *et al.*, (2012) assessed Land use/Land cover (LULC) change in Makurdi, between 1991 –2006. The study revealed water body decreased from 21km² in 1991 to 17km²in 2006. The forest decreased from 133 km² in 1991 to 96km² in 2006. Similarly the areas of undergrowth/wetland and cultivated reduced 119km² (32%) and 19km²(14%) from 370km² and 138km² in 1991 to 251km² and 119km² in 2006 respectively. Conversely, the area of built-up land increased by 179km² (130%) from 138km² in 1991 to 317km² in 2006.

The situation in Birnin Kebbi and its environs is not different, though no effort has been made to document the landuse/landcover change in Birnin Kebbi and environs which has witnessed a remarkable expansion, growth and developmental activities. This has therefore resulted in increased land consumption, modification and alterations in the status of her landuse/land cover over time without any detailed and comprehensive attempt to evaluate its status. It is therefore necessary for a study such as this to be carried out in the area. To the best of the researcher's knowledge, no LULC research has been conducted in Birnin Kebbi and Environs using Remote Sensing and GIS. There is therefore, the need for this research to fill this gap.

The basic research questions for this research, therefore include

1 What are the land use-land cover classes in the study area?

2 What is the landuse- landcover pattern in the study area?

3 What is the Land Consumption Rate and Land Absorption Coefficient in the study area?

4 What is the effect of urbanization in the study area?

1.8 Aim and Objectives of the Study

The aim of this research is to examine the effect of urbanization on land use land cover changes in Birnin Kebbi, Kebbi State. The specific objectives are to:

i. map out Land use Land cover of 1986,1999 and 2009 using multispectral satellite imagery.
ii. analyse Land use Land cover changes from multitemporal data.
iii. determine land consumption rate and land absorption coefficient.
iv. determine the effect of Urbanization on Landuse/ Landcover

1.9 Scope of the Study

This study is limited to assessing the effect of urbanization on land use land cover changes in Birnin Kebbi and its environs between 1986-2009. The area was chosen based on the changes that have taken place in the area since it becomes a state capital. This research employed the use of Geographic Information System and Remote Sensing for the analysis of the data.

1.5 Justification of the Study

The growing population and increasing socio-economic activities create a pressure on landuse/land cover. This pressure results in unplanned and uncontrolled changes in Landuse/Landcover (LULC). The LULC alterations are generally caused by mismanagement of agricultural, urban, range and forest lands which lead to severe environmental problems such as landslides, floods etc.

Globally, land cover today is altered principally by direct human use: by agriculture and livestock raising, forest harvesting and management and urban and suburban construction and development.

Virtually, no attempt has been made at documenting the changes in landuse/cover change of Birnin Kebbi and its environs in the past using either conventional or digital remote sensing data and geographic information system.

Data on land use change are of importance to planners and decision markers in Birnin Kebbi in monitoring the consequences of land use change in the area. Such data are valuable for the management of resources, land use patterns and in modeling and predicting future changes. Information on land-use serves as a major input for any program on energy conservation, for monitoring environmental hazards and for the enhancement of equitable distribution of resources. Information on land-use change has also been found to be of great importance in the political administration of many countries (Zubair, 2006).

1.6 Organization of the Study

Complete presentation of the thesis includes five separate but connected chapters. Chapter one gives background information about the study, gaps of knowledge for the research, which further guides us to formulate the purpose of the study and central questions to be answered. It explains how the objectives can be achieved using remote sensing and geographic information system and subsequently justified the research work. Chapter two introduces the study in the context of existing literature on land use and Landcover and its effects. It also includes a review of several studies done in the areas along with important findings and Chapter three describes the biophysical characteristics of the study area, sources and methods in collection of primary and secondary data and more importantly the flow chart of the study. Chapter four presents the findings of the study derived upon analysis of all available data and discusses the major findings of the study with reference to existing knowledge, and relates them to the objectives, central questions and overall framework of the study. Finally, chapter five presents concluding remarks and implications of the major findings in addressing prevailing challenges in the target areas and also presents issues for further research.

CHAPTER TWO: CONCEPTUAL FRAME WORK AND LITERATURE REVIEW

2.1 INTRODUCTION

This chapter deals with conceptual frame work of the study and the review of literatures that are related to this research work. The concepts of landuse/landcover change were considered, literatures were reviewed under the following sub themes; pattern of landuse/landcover change and RS and GIS

2.2 CONCEPTUAL FRAME WORK

In order to clear any ambiguity in the usage of words in this research work, concept related to the research were defined.

2.2.1 Remote Sensing and Geographic Information System

Remote sensing is defined as the science of obtaining information about an object, area, or phenomenon through the analysis of data acquired by a device that is not in contact with the object, area, or phenomenon under investigation (Lillesand et al., 2004). Since the launch of Landsat-1 – the first Earth resource satellite in 1972, remote sensing has become an increasingly important tool for the inventory, monitoring, and management of earth resources. The increasing availability of information products generated from satellite imagery data has added greatly to our ability to understand the patterns and dynamics of the earth resource systems at all scales of inquiry.

A particularly important application of remote sensing is the generation of land use/ land-cover maps from satellite imagery. Compared to more traditional mapping approaches such as

terrestrial survey and basic aerial photo-interpretation, land-use mapping using satellite imagery has the advantages of low cost, large area coverage, repetitively, and computability (Franklin, 2001). Consequently, land-use information products obtained from satellite imagery such as land-use maps, data and GIS layers have become an essential tool in many operational programs involving land resource management.

Remote sensing can be defined as any process whereby information is gathered about an object, area or phenomenon without being in contact with it. Given this rather general definition, the term has come to be associated more specifically with the gauging of interactions between earth surface materials and electromagnetic energy. (Idrisi 32 Not dated).

Remote sensing is the science (and to some extent, art) of acquiring information about the Earth's surface without actually being in contact with it. This is done by sensing and recording reflected or emitted energy and processing, analyzing, and applying that information (Fundamentals of Remote Sensing, Not dated).

A Remote sensing device records response which is based on many characteristics of the land surface, including natural and artificial cover. An interpreter uses the element of tone, texture, pattern, shape, size, shadow, site and association to derive information about land cover (Fundermental of Remote Sensing, Not dated). In remote sensing, information transfer is accomplished by use of electromagnetic radiation (EMR). EMR is a form of energy that reveals its presence by the observable effects it produces when it strikes any matter. EMR is considered to span the spectrum of wavelengths from 10-100 mm to cosmic rays up to 1010 mm, the broadcast wavelengths, which extend from 0.30-15mm (Andy and Brain, 2004). The electro-magnetic radiation (EMR), which is reflected or emitted from an object, is the usual source of

Remote Sensing data. However, any medium, such as gravity or magnetic fields, can be used in remote sensing (Fundermentals of Remote Sensing, Not dated).

2.2.2 Land use/ Land cover

Land is a natural resources and also the main source of national wealth. It is used for a different purposes which include residential, industrial, agriculture, commercial, education etc.

According to Meyer (1995) every parcel of land on the Earth's surface is unique in the cover it possesses. Land use and land cover are distinct yet closely linked characteristics of the Earth's surface. The use to which we put land could be grazing, agriculture, urban development, logging, and mining among many others. While land cover categories could be cropland, forest, wetland, pasture, roads, urban areas and others. The term land cover originally referred to the kind and state of vegetation, such as forest or grass cover but it has broadened in subsequent usage to include other things such as human structures, soil type, biodiversity, surface and ground water (Meyer, 1995).

Landuse is the foundation of all forms of human activities, from it we obtain the food we eat, the shelter we need, the space to work and the room to relax (Briassoulis, 2000). Human need of land resources gives rise to land use which varies with the purposes it serves in terms of processing materials, provision of shelter, food production, recreation and so on.

Landuse and Landcover change studies have become key components for managing natural resources and monitoring environmental changes. Igbokwe (2010) opined that Landcover and Landuse information should form part of the environmental data, which are kept in the form of inventories/infrastructures in many advanced and emerging economies. Most Landuse change factors such as water flooding, air pollution, urban sprawl, soil erosion, deforestation, occur

without clear and logical planning which results in serious environmental degradation with notable consequences globally.

The land-use and land-cover pattern of a region is an outcome of natural and socio economic factors and their utilization by man in time and space. Land-use and land-cover change has become a central component in current strategies in managing natural resources and monitoring environmental changes. Urban expansion has increased the exploitation of natural resources and has changed land use and land cover patterns. Rapid urbanization, therefore, brings opportunities for new urban developments, however, it also has brought serious losses of arable land, forest land and water bodies. Land cover change is a major concern of global environmental change.

Land cover can be altered by forces other than anthropogenic. Natural events such as weather, flooding, fire, climate fluctuations, and ecosystem dynamics may also initiate modifications upon land cover. Globally, land cover today is altered principally by direct human use: by agriculture and livestock raising, forest harvesting management and urban and suburban construction and development. There are also incidental impacts on land cover from other human activities such as forest and lakes damaged by acid rain from fossil fuel combustion and crops near cities damaged by tropospheric ozone resulting from automobile exhaust (Meyer, 1995).

Hence, in order to use land optimally, it is not only necessary to have the information on existing land use land cover but also the capability to monitor the dynamics of land use resulting from both changing demands of increasing population and forces of nature acting to shape the landscape.

2.2.3 Effects of Landuse/landcover change

One of the foremost problems associated with industrialization and civilization is the urbanization and the consequent ills and fallouts. This is because industrialization and civilization are pull factor for the rural-urban migrants as well as cross-national migrants. In recent times most Nigerian cities especially Ibadan, Lagos and Kano have experienced tremendous planned and unplanned growth due to population explosion, which led to congestion, environmental degradation and urban socio-spatial upheavals. Planners and other urban gatekeepers manage urban space and residents for purpose of efficient functioning and performance of urban systems. They however require the understanding of change process in urban land use and the interactions with the change agents in order to discharge their functions in urban space (Oluseyi 2006).

Urbanization has a great impact on climate. By covering with buildings, roads and other impervious surfaces, urban areas generally have a higher solar radiation absorption, and a greater thermal capacity and conductivity, so that heat is stored during the day and released by night. Therefore, urban areas tend to experience a relatively higher temperature compared with the surrounding rural areas. This thermal difference, in conjunction with waste heat released from urban houses, transportation and industry, contribute to the development of urban heat (Dami, *et al*., 2011).

2.2.4 Change Detection

Change detection is the process of identifying differences in the state of an object or phenomenon by observing it at different times (Singh, 1989). Change detection is an important process in monitoring and managing natural resources and urban development because it provides quantitative analysis of the spatial distribution of the population of interest.

Macleod and Congation (1998) listed four aspects of change detection which are important when monitoring natural resources:

i. Detecting the changes that have occurred
ii. Identifying the nature of the change
iii. Measuring the area extent of the change
iv. Assessing the spatial pattern of the change

The basis of using remote sensing data for change detection is that changes in land cover result in changes in radiance values which can be remotely sensed. Techniques to perform change detection with satellite imagery have become numerous as a result of increasing versatility in manipulating digital data and increasing computer power.

Change detection according to Singh (1989) and Mejabi (2008) is the concept of identifying contrasts or discrepancies in the state of an object or phenomenon by observing it at different times. This involves the ability to quantify temporal alteration and transformation using multi-temporal data sets. In general, change detection involves the application of multi-temporal data sets to quantitatively analyse the temporal effects of the phenomenon.

2.2.5 Concept of Urbanization

The urbanization process can be said to be transformation of landscapes, characterized by rural life styles into urban landscapes and determines lateral and structural changes that result into a new landscape patterns. According to Rimal (2011) urbanization is an increased system modernization process, which modifies the socio-economic activities and revolutionizes the landuse pattern in accordance with time frame. Also, Modica etal, (2012) define urbanization as a complex diffusion process, that result into dramatic spreading and variously affecting rural landscape at varying spatial scales.

The rate of urbanization is the increase in proportion of urban population overtime, calculated as the rate of growth of urban population minus that of the total population. Urban population can grow either at faster rate or slow than the total population. Urbanization is a settlement change process from rural to an urban experience as towns and cities grew bigger more and more people came to them mostly from rural areas in search of jobs opportunities and other forms of prosperity. Most of the cities experience growth in population through migration than natural increase, the movement of people into urban centers, is an objective anticipation and desire to have a better life as towns and cities are places where needs, ideas, ambition and aspiration of humanity mostly realized (Satterthwaite 2005).

2.2.6 Challenges of Urbanization

The most fundamental source of potential confusion in the study of urbanization and city growth is the measurement of urban itself. What defines an urban area? Unfortunately, there is no unique answer. Despite the fact that the world is becoming more and more urban in nature,

the definition of urban itself remains rather fleeting, changing over time and space (Frey & Zimmer, 2001).

Because the United Nation (UN) is forced to rely on national statistical agencies for their data, the definition of what constitutes an urban area varies from one country to another and this obviously makes cross country comparisons problematic. Some countries define their urban population as those people living within certain administrative boundaries—such as in administrative centers (as in El Salvador), municipality councils (as in Iraq), or in places having a municipality or a municipal corporation, a town committee, or a cantonment board (as in Bangladesh or Pakistan). Other countries prefer to classify their urban population using either population size or population density as the primary consideration. But the line between urban and rural is to a certain extent arbitrary and culturally bound and so not surprisingly, it differs between countries. In Nigeria, all local government headquarters are classified as urban centers.

2.2.7 Urbanization and Sustainable Urban Development in Nigeria

Urbanization is a transformative process from rural to an urban experience. The level of urbanization of country determines its level of development and economic growth in most cases (UNFPA, 2007). Therefore it can be easily concluded that urbanization is inevitable as it is part of an old recent human population history.

According to the UN (2010) report on state of Africa cities report observes that Urbanization has been associated with improved human development, bring incomes and better living standard. But rapid urbanization can be said to be a curse as well as blessing, unless strong and

immediate and decisive policy action is taken, the phenomena could be burden from opportunity to a region.

The case study of evolution, urban centers in Nigerian Savannah could discover some evolved processes which have profound effect on contemporary urban life. By focusing on the achievements of urbanization it becomes obvious that the evolved processes generate a rather spectrum, starting from dynamic town expansion based on high construction activities and its structural as well as functional development leading towards a spatial divergence of centrality, continuing with strong economic display and increased social living standard (Balzerek H, 2003).

2.2.8 Urbanization in Birnin Kebbi

Several drivers of urbanization are responsible for the fast growth of the city which has exerted great influence on population growth, employment structure, physical expansion and development of the town. Birnin Kebbi has now become center of trade and commerce, serving the whole sub-region of far North West zone including the neighboring Niger and Benin Republics. The local economy has attracted, and is still attracting migrants, from within and outside the country. This trend is manifested in the rapid population increase, physical growth and development of the town induced by the change in its status.

2.3 REVIEW OF RELATED LITERATURE

Arvind and Nathawat (2006) carried out a study on land use land cover mapping of Panchkula, Ambala and Yamunanger districts, Hangana State in India. They observed that the heterogeneous climate and physiographic conditions in these districts have resulted in the development of different land use land cover in these districts. Digital analysis of satellite data indicates that majority of areas in

these districts. are used for agricultural purpose. The hilly regions exhibit fair development of reserved forests. It is inferred that land use land cover pattern in the area are generally controlled by agro – climatic conditions, ground water potential and a host of other factors.

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

Oluseyi, (2006) performed urban land use change analysis of metropolitan city of Ibadan within the periods of 1972, and 2003 and discovered that the land use types that are subject to major changes are vegetal covers and sprawl development. Developments in Ibadan are similitude of the building types in the tradition core and the transition zones. It was also obvious that the city was growing at such an alarming rate using up all the green and other forms of soft landscape in the city.

Dami, *et al.*, (2011) used remote sensing and GIS techniques to examine the trends in landuse changes in Maiduguri urban area between 1961 and 2002 and the implications of these in environmental management. The study revealed among others that trend in land use changes trend in the city showed that Maiduguri grew at a fast rate.

Zubair, (2006) analyzed Landuse/Landcover change in Ilorin between 1972 and 2001, the result of the work shows a rapid growth in built-up land between 1972 and 1986 while the periods between 1986 and 2001 witnessed a reduction in this class. It was also observed that

change by 2015 may likely follow the trend in 1986/2001.Many projects were embarked upon after creation of the state and falls within the oil boom era of 1970s. But reduction between 1986-2001 attributed of what the researcher called austerity measures known as SAP introduced into the country at the period to restore the country economy.

The Land cover changes along the lower reaches of river Gongola, northeast Nigeria was assessed by Tukur et al, (2002) using 1976 Landsat MSS and SPOT-XS 1994 data. Supervised classification was adopted using maximum likelihood technique and the study revealed that, between 1976 and 1994, the LU and LC such as bare surfaces, cultivated and grazed fields, wood and shrub vegetations were on the increase, while marshy areas and storm channel had reduced.

Van der meer *et al*, (2002) used Landsat ETM+ images combined with fieldwork and ground truthing to estimate the acreage infested with Imperata Cylindrica and Stiga in the moist savanna of Nigeria. The spectral signatures of Imperata and other LC types assisted in the classification of the LU/LC types in the area. ERS SAR and Landsat ETM images were used by Okhimamhe, (2002) in which maximum likelihood classification (MLC), Normalized differences vegetation indices (NDVI) and Interferometric Land Use (ILU) techniques were adopted, and the study showed that ILU and NDVI images could be used to measure the accuracy of the MLC for woody vegetation cover.

Ekpenyong (2008) used the GIS database to model the land use/cover change between 1984 and 2003 for Akwa Ibom State. The result showed that some urban centres had expanded into

farmlands/fallow lands and the surrounding secondary forest. Within that period, mangrove forest had reduced by 50 per cent. Other forest covers in the area also changed, threatening food security and climate among others.

While examining the process of land use conversion and rate in common and public lands in South-Eastern Nigeria between 1972 and 2001, Bisong (2007) showed that deforestation was higher in publicly controlled lands than in communal lands. Agricultural land use characteristics, such as farm types and the nature of croplands/fallows, correlated strongly and significantly with deforestation rates. Similarly, Idoko, Bisong, Bisong and Okon (2008) analyzed satellite imageries of 1987 and 2004 for the Federal Capital Territory, Abuja for land use change. The imageries were characterized into five classes using maximum likelihood algorithm.

The classes were vegetation, built-up, rock outcrop, water body and farm land. The two classified imageries were compared to identify any changes. Also, a spatio-temporal change in land use type was obtained in quantitative terms. The analysis revealed that vegetation cover reduced by 85.22 per cent between 1987 and 2004. Again, the built-up area increased by 21.99 per cent and farm land increased by 0.14 per cent.

Abbas (2009) did an overview of Land cover changes in Nigeria, 1975-2005 using Landsat data of 1975 and SPOT XS data of 2005. The author's work was limited in that he used two dates at such a long period of thirty-five years.

Ujoh *eta*l (2011) analyzed urban expansion and vegetal cover loss in and around Abuja with the use of Landsat imageries between 1987 to 2006. The study revealed that while built-up area increased, vegetation cover decreased at an alarming rate. Using population figures of the study area for 1987, 2001 and 2006, the Land Consumption Rate (LCR) and Land Absorption Coefficient (LAC) were determined. Increasing population and expansion in the Federal Capital City (FCC) resulted in land degradation including loss of vegetal cover, indiscriminate waste disposal, contamination of surface water.

CHAPTER THREE: STUDY AREA AND METHODOLOGY

3.1 INTRODUCTION

This chapter looks into the general background of the study area as it relates to immediate environment. It also considers the methodology adopted for the study. The procedure adopted in this research work forms the basis for deriving statistics of land use dynamics.

3.2 THE STUDY AREA

3.2.1 Location

Birnin Kebbi, the study area, is the capital of Kebbi State. It is located in the north-western part of Nigeria. It lies between latitudes $12^{o}\ 15^{1}$ N to $12^{o}\ 35^{1}$ N; and Longitudes $4^{o}\ 01^{1}$E to $4^{o}\ 38^{1}$ E . It is bounded to the north east by Argungu LGA, to the south by Kalgo LGA, to the east by Gwandu LGA, to the west by Arewa Dandi LGA.(See fig 3.1)

3.2.2 Relief and Drainage

Relief in the state is generally gently rolling to undulating. Further northwest of the study area, there are however, outcrops and steep cliffs of limestone, reaching 15m in height in the town and up to 30m just outside. In general, elevations throughout the state are mostly less than 300m (Birnin Kebbi Master Plan1980-2000).

The landscape of Birnin Kebbi is dominated by extensive flood plains. The Rima and the Shella rivers are located in the north and south east of the town respectively. Both rivers have broad flood plains. The Rima river system has major tributeries like Gawon, Zamfara and Gubinka. These tributeries rise in the Basement Complex region of Sokoto State and flow westward to join the Rima (Birnin Kebbi Master Plan1980-2000).

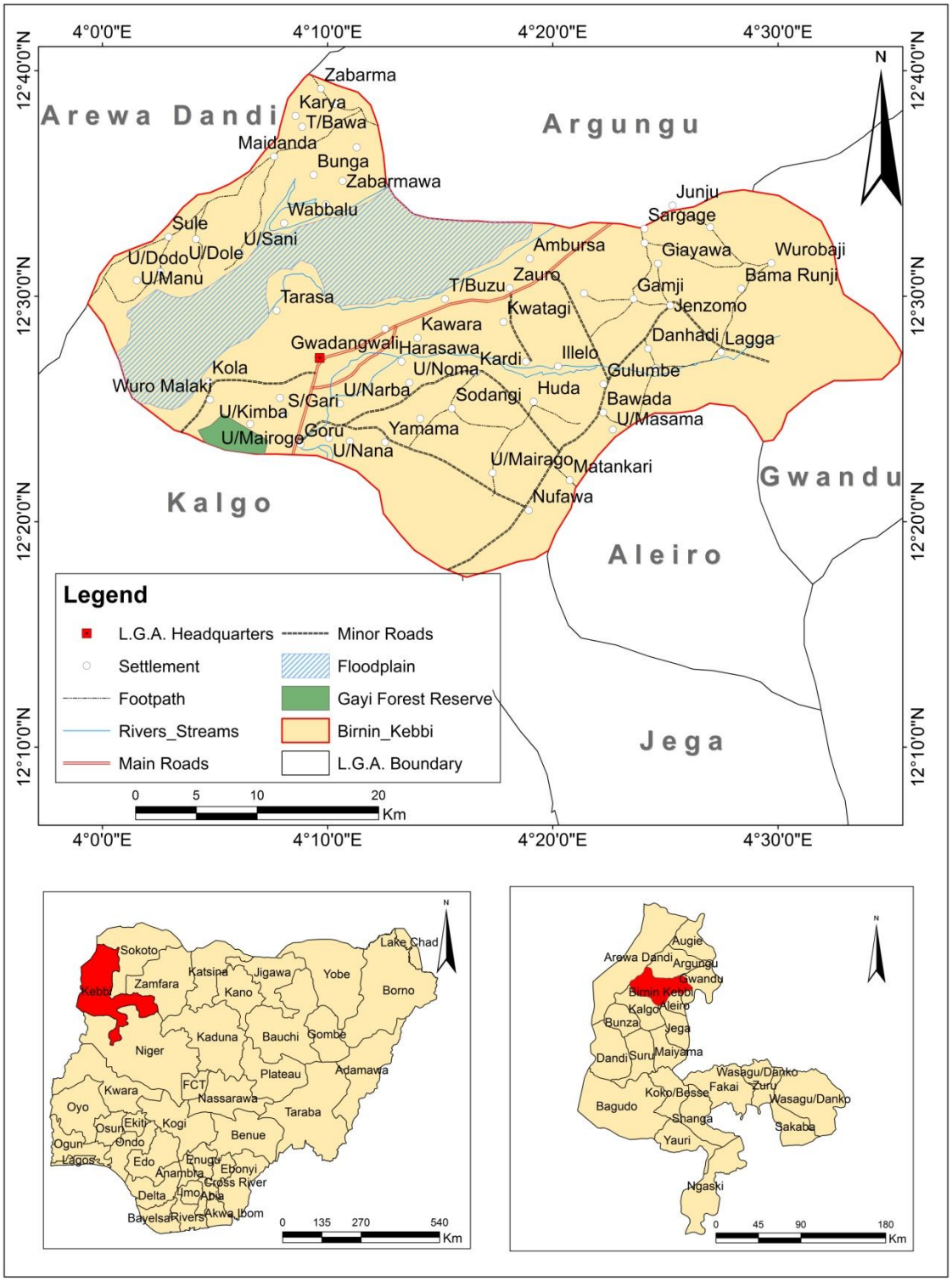

Fig 3.1: Birnin Kebbi

SOURCES: Adopted and Modified from Administrative map of Kebbi State

3.2.3 Climate

Although, there are no weather element recording stations that exist in Birnin Kebbi, the town falls within the Theison polygon whose recording stations is situated at Sokoto (Danboyi 2006). Kebbi State enjoys a Tropical Continental type of climate characterized by distinct wet and dry seasons. This is largely controlled by two air masses, namely Tropical Maritime and Tropical Continental, blowing from Atlantic and the Sahara Desert respectively. These air masses determine the two dominant seasons wet and dry.

The wet season lasts from April to October in the south and May to September in the north; while the dry season lasts for the remaining period of the year. Mean annual rainfall is about 800mm in the north and 1000mm in the south.

In Birnin Kebbi and environs, the highest mean daily temperature are recorded at the peak of the dry season just before the onset of the rains in April while the lowest are recorded at the peak of the harmattan periods. The mean temperature during the hot season is 37^0C while it could be as low as 8^0C during the cold harmattan period (December-February).

Relative humidity is much higher in the southern areas than in the north where Birnin Kebbi is located. It is also higher during the wet season than the dry season all over the country. Whatever the season, relative humidity is generally lower in the afternoon than in the morning. This is because the capacity of the air to hold moisture increases during the day with increase in the air temperature (Birnin Kebbi Master Plan 1980-2000).

3.2.4 Geology

The geological characteristics of Birnin Kebbi include thick and vast sequences of sedimentary deposits of the Sokoto basin, which underlie about 50% of the area. The rest is being underlain by the Precambrian basement complex rocks.

The Sokoto basin is part of an elongated sedimentary basin underlying most of northwestern Nigeria and part of eastern Niger republic. The Kebbi basin constitutes approximately 10% of the regional geological basin with its focal point in Niger republic. The sequence ranges in age from cretaceous to quaternary and is composed mostly of interbedded sand, clays some limestone; all laid on an uneven floor of basement complex. The beds dip gently towards the northwest. Alluvium of quaternary age underlies the lowlands of the river and its attributes (Birnin Kebbi Master Plan 1980-2000).

3.2.5 Soils and Vegetation

Wetland and savannah soils have developed throughout Kebbi state. The principal soils within the Birnin Kebbi region are the vertisols. These are heavy, cracking clayed soils with more than 35% clay have shrinking and swelling properties. The soils are high in minerals but have problems associated with spillage, poor drainage, flood and erosion.

The entire Kebbi State falls within the northern Guinea savannah zone, characterized by heterogeneous mixture of vegetation, heavily disturbed by human influence and few trees of medium height which naturally provide habitat for a variety of wild life. Small holder and grazing agriculture activities are common in this zone. The perennial grasses and herbs of the savannah provide a large and easily obtainable source of food for herbivore wild life (Birnin Kebbi Master Plan 1980-2000).

Low acacia trees and shrubs with grasses, however, dominate the vegetative cover of Birnin Kebbi. Most of the trees have been felled to give way to agricultural and urban development although some cropies of neem trees could be indiscriminately found within the town.

3.2.6 Population and People

The population of Birnin Kebbi has increased from 47,682 in 1984 to 63,147 in 1991 to 74,027 in 1996, and 268,620 in 2006 (NPC, 2009). Multiple ethnic groups, major among who are Kabawas, Fulanis, Zabarmawas Dakarkaris, largely inhabit Birnin Kebbi.However, the diversity of the ethnic composition within the metropolis has greatly multiplied, especially with the present status as a state capital. Such ethnic diversities in the capital include the Dakarkaris, Kambaris, Gungawas, Dandawas, and more recently Yorubas, Igbos, Urhobos, etc.

3.2.7 Economic Activities of Birnin Kebbi

Economically, it is important to point out that opportunities facing the people of Birnin Kebbi have been determined principally by its economic base (Danboyi 2006). Performance of the town's economy in the last twenty three years (23) years(1991 to 2014) has exerted great influence on population growth, employment structure, physical expansion and development of the town.Birnin Kebbi is thus now serving triple functions as the state capital and Local Government Headquarters as well as the seat of Gwandu Emirate. Owing to these functions, it has now become center of trade and commerce, serving the whole sub-region of far North West zone including the neighboring Niger and Benin Republics. The local economy has attracted, and is still attracting migrants, from within and outside the country. This trend is manifested in

the rapid population increase, physical growth and development of the town induced by the change in its status.

Birnin Kebbi is sandwiched between two fertile fadama lands; the Shella and Rima rivers fadama. Shella river fadama is situated approximately 3km south east of the town and averages about 1.5km width. The area extends continuously in an easterly direction before turning due south into the permanent water of Shella river. The Rima river fadama situated North West of the town, which runs southerly and finally empties into the river Niger. The Rima river valley consists of the largest fadama land in Kebbi state made up of 525,000 hectares out of which about 142,000 hectares remain after the flood as dry season pools of stagnant water. The two expance of Fadama lands (Rima and Shella) thus provide important area of high value agricultural soils for planting of floating rice as well as other crops in the retreating floodwaters (Birnin Kebbi Master Plan 1980-2000).

3.4 METHODOLGY

3.3.1 Reconnaissance Survey

An initial visit to the area was conducted to afford the researcher the opportunity to familiarize himself with the environment. This had also assisted in planning the field work.

3.3.2 Tools and Equipments Used

i. Computer hardware and related accessories like mouse, printer etc
ii. ArcGIS 9.3 Software: This was used basically for digitizing the base map
iii. ERDAS IMAGINE 9.2 : This was used for sub-setting images, development of Landuse landcover classes and subsequently for change detection analysis of the study
iv. Microsoft word: This was used for presentation of the research.
v. Hand held GPS (Germin): For taking coordinates of places and groundthruthing

3.3.3 Types of Data Used

Types of data used include:

i. Topographic Map: This map was used to delineate the study area and extract settlements information in the study area. It was obtained from Kebbi State Ministry of Lands and Town planning.
ii. Administrative Map: This was used for delineating the study area and subsequently for sub-setting the satellite images of the study area. It was also obtained from Kebbi State Ministry of Lands and Town planning.

iii Satellite Images: LandSat TM of 1986, 1999 and Nigeria Sat-1 of 2009 were obtained. These images were used to generate the land use and land cover information within the study area between 1986-2009. They are obtained from National Center for Remote Sensing, Jos.

iv Population data: Population data for 1984, 1996 and 2006 were used. All were obtained from National Population Commission, Kebbi State.

3.3.4 Sources of Data Used

The sources of data used includes both primary and secondary sources

3.3.6.2 Primary Sources

The primary data used for this study include three sets of satellite imageries, field observation, and information from residents and key informants. The three sets of satellite imageries of Birnin Kebbi used include 1986, 1999 and 2009.These are: LandSat Multispectral Scanner (TM) 1986, 1999 and Nigeria-Sat 1. All these satellite imageries were obtained from National Centre for Remote Sensing Jos, Nigeria.

3.3.4.2 Secondary Sources

Secondary data used for this study include; Birnin Kebbi base map, Population figures of 1991 and 2006 obtained from Kebbi State ministry of Land, Housing and Town Planning and National Population Commision respectively. Other secondary information sources were sourced from relevant dissertations, journal articles, research papers, textbooks and internet. Table 3.1 presents the data used and their sources.

Table 3.1 Data Acquired and Source

S/N	Types of data required	Year	Resolution	Source
1. 2. 3.	Landsat image Landsat image Nigeria Sat-1	1986 1999 2009	30m ™ 30m ™ 32m	National Centre For Remote Sensing, Jos.
4	Administrative Map of Birnin Kebbi	1999	1:250,000	Kebbi State Ministry of Lands and Town Planning.
5	Population Data	1984,1991, 2006		National Population Commision

3.3.7 Data Processing

Landsat TM imagery of 1986 with 30m spatial resolution; Landsat TM captured in 1999 whose spatial resolution was 30m; and Nigeriasat-1 image of 2009 with 32m resolution were used for the study. The portion of interest (Birnin Kebbi and its environs) was subsetted from each of the larger scenes using ERDAS IMAGINE 9.2 software.

3.3.5.1 Image Pre Processing

Preprocessing functions involve those operations that are normally required prior to the main data analysis and extraction of information, and are generally grouped as radiometric or geometric corrections. Radiometric corrections include correcting the data for sensor irregularities and unwanted sensor or atmospheric noise, and converting the data so they

accurately represent the reflected or emitted radiation measured by the sensor. Geometric corrections include correcting for geometric distortions due to sensor-Earth geometry variations, and conversion of the data to real world coordinates (e.g. latitude and longitude) on the Earth's surface.

Since the data used were ortho-rectified, there was no need for geometric and radiometric correction to be performed on them. However, the data sets were geo-referenced or geo-coded that is registered to a geographic coordinate system (UTM Zone 31).

3.3.5.2. Image Resampling

This is the mathematical technique used to create a new version of the image with a different width and/or height in pixels. Increasing the size of an image is called upsampling; reducing its size is called downsampling. Resampling Methods includes

i. Nearest Neighbor
ii. Bilinear
iii. Bicubic

The nearest neighbor resampling method was used to resample the 2009 imagery to 30m resolution in order to bring all the datasets to a common resolution and projections. This was necessary in order to make it possible for overlay and other operations to be carried out.

3.3.5.3 Layer Stacking

During layer stacking, the Universal Traverse Mercator (UTM) system with WGS84 as a datum was assigned as a preference as far as projection is concerned. All four five bands of TM and ETM+, excluding the thermal band, were considered for Layers stacking. The nature of these different bands had to be considered to make a decision as to which three band combination

would be most helpful for classification and visual interpretation. The Band 4 reflective infrared wavelength (0.76-0.90 μm) is absorbed by water (appearing dark) and reflected by vegetation (appearing bright), while mid-infrared bands 5 (1.55-1.75 μm) and 7 (2.08-2.35 μm) contrast well, revealing differences in types and conditions of vegetation and soil (McHugh, 2006)

3.3.6 Image Classification and Analysis

The overall objective of image classification is to automatically categorize all pixels in an image into land cover classes or themes. Normally, multispectral data are used to perform the classification, and the spectral pattern present within the data for each pixel is used as numerical basis for categorization. There are two types of classification:

i. Supervised classification
ii. Unsupervised classification

The unsupervised approach attempts spectral grouping that may have an unclear meaning from the user's point of view. Having established these, the analyst then tries to associate an information class with each group. The unsupervised approach is often referred to as clustering and results in statistics that are for spectral, statistical clusters (Fundamentals of Remote Sensing, Not dated).

In the supervised approach to classification, the image analyst supervises the pixel categorization process by specifying to the computer algorithm; numerical descriptors of the various land cover types present in the scene. There is a consistent logic to all of the supervised classification routines in almost all image processing softwares. In addition, there is a basic sequence of operations that must be followed no matter which of the supervised classifiers is used. In this study the following sequence of operations were used.

1. Defining of the Training Sites.

2. Extraction of Signatures

3. Classification of the Image.(Duda and Cantry, 2002).

Supervised classification technique using maximum likelihood algorithm is the most commonly and widely used method for land cover classification (Jia and Richards, 2006). This classifier is based on Bayesian probability theory. Maximum Likelihood Classification is a statistical decision criterion to assist in the classification of overlapping signatures; pixels are assigned to the class of highest probability. The Maximum Likelihood classifier is considered to give more accurate results than Minimum distance classification however it is much slower due to extra computations. It was found that the Maximum likelihood method gave the best results and both Minimum distance and Mahalanobis distance methods overestimated agriculture land and suburban areas (Ahmadi and Hames, 2009).

A supervised classification was performed on false colour composites (bands 4, 3 and 2) into the following land use and land cover classes; Agricultural land, Built-up area, Natural Forest, Water body and Bare surfaces(see Table 3.2). Information collected during the field surveys was combined with the digital topographic map which was developed for the city and used to assess the accuracy of the classification.

Table 3.2 Classification Scheme

CODE	LANDUSE/LANDCOVER	DESCRIPTION
1	Agricultural land	Lands used for farming (plantation, cropland orchard)
2	Built-up land	Lands used for residential, industrial, commercial, etc.
3	Grassland/Natural forest	Lands covered with natural vegetation (any plant species)
4	Water body	Rivers, Lakes Streams, reservoirs
5	Bare surfaces	Lands devoid of vegetation, exposed soil
6	Riperian Vegetation	Is a distinct forest community occurring on the banks of rivers

SOURCES: Adopted from Anderson *etal* 1976

3.3.6.1 Accuracy Assessment

Remote sensing data accuracy assessment concerns two main aspects: positional accuracy and thematic accuracy. Positional accuracy refers to the accuracy of a geometrically rectified image, while thematic accuracy refers to the accuracy of classification. The best way for checking the result of classification is to check everything in each class which can be realized in Erdas Imagine by the function of accuracy assessment. An accuracy assessment can be done by determining a confusion matrix. This finds the relationships between the mapped class label and

that observed on the ground or reference data for a sample of cases at specific locations. The overall accuracy can be determined by dividing the number of correctly classified pixels by the total number of reference pixels. Overall accuracy is considered as the most suitable method for calculating accuracy assessment. The Kappa coefficient of agreement can be used to improve the overall accuracy. It expresses the proportionate reduction in error generated by a classifier compared with the error of a completely random classification (Ahmadi and Hames, 2009).

In the error matrices, the producer's accuracy refers to the ratio which is calculated by the number of correct classified pixels in one class dividing the total number of referenced pixels of this class; the user's accuracy refers to the ratio which is calculated by the number of correct classified pixels in one class dividing the total number of classified pixels in this class; the overall classification accuracy is calculated by the number of correct classified pixels dividing the total number of classified pixels; the kappa coefficient is often used for estimating the accuracy of the classification (Bakr *et al.,* 2010). The accuracy statistics for classification on three years are shown in table , the accuracy of year 1986, 1999 and 2009 was 87.86%, 85.71% and 80.15% respectively. Therefore, the classified maps from supervised classification were acceptable and used in the next stages.

The Kappa values such as: 0.80 (i.e., 80%) represents strong agreement; 0.40 and 0.80 (i.e., 40–80%) represent moderate agreement; and a value below 0.40 (i.e., 40%) represent poor agreement (Congalton and Ross, 1999). The conditional Kappa values in table 3.3,3.4 and 3.5 shows that water bodies, forest, urban/built-up, Agricultural land, riparian vegetation and bare soil land cover have strong agreement with the classification.

3.3.7 Data Analysis

The comparison of the landuse/landcover statistics assisted in identifying the percentage change, trend and rate of change between 1986 and 2009.

To characterize the landuse/landcover change of Birnin Kebbi in 1986, 1999 and 2009, Calculation of the area in Hectares of the resulting landuse/land cover types for each study year and subsequently comparing the results. In achieving this, the first task was to develop a table showing the area in kilometers and the percentage change for each year (1986 and 2009) measured against each landuse/land cover type.

Percentage change, to determine the trend of change, it can then be calculated by dividing observed change by sum of changes multiplied by 100 as shown in table 4.2

$$\text{(trend) percentage change} = \frac{\text{observed change}}{\text{Base year}} \times 100$$

To determine the landuse/landcover change between 1986 and 1999 as well as 1999 and 2009 in Hectares and percentage change:

The change in Hectares = the Area of former year minus Area of later year.

Land Consumption Rate (LCR*)* is a measure of progressive spatial urbanization of a study area and Land Absorption Coefficient (*LAC)* is a measure of change of urban land by each unit increase in urban population.

The Land consumption rate is given below;

L.C.R = A/P

where

A = areal extent of the city in hectares

P = population

Land Absorption Coefficient is determined using the formula:

L.A.C = A2 – A1/P2-P1

where

A1 and A2 are the areal extents (in hectares) for the early and later years respectively, and P1 and P2 are population figure for the early and later years respectively (Yeates and Garner, 1976)

To determine the population of the selected years under study, the exponential method of population projection has been used which was recommended by National Population Commission due to its high variance.

$p_t = p_o e^{rn}$ Where p_o = Previous/ base year population, in this case 1984, 1996 and 2006 were used.

p_t = population of the present year, in this case 1986, 1999 and 2009 were used.

e=exponential n = number of the year interval.

r = growth rate of the state, in this case 3.2% was used.

3.3.7.1 Change Detection/ Overlay Operation

An important aspect of change detection is to determine what is actually changing to what i.e. which land use class is changing to the other. This information will reveal both the desirable and undesirable changes and classes that are "relatively" stable overtime. This information will also serve as a vital tool in management decisions. This process involves a pixel to pixel comparison of the study year images through overlay.

The images generated from this analysis were then overlaid, so as to obtain a visual representation of the area/extent of changes that occurred in the period for each of the land cover classes. In overlay operations, the exact location the amount of changes was determined.

In terms of location of change, the emphasis is on built-up land. Figure 4.4 shows this change between 1986 and 1999.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 INTRODUCTION

The objective of this study forms the basis of all the analysis carried out in this chapter. The results are presented inform of maps, and statistical tables. They include the static, change and rate of change of the LULC.

4.2 LAND USE LAND COVER CLASSES

Figures 4.1 to 4.3 present the LULC of the study area during the study period. The static land use land cover distribution for each study year as derived from the imageries is presented in Table 4.1. This characterizes the landuse and landcover class of Birnin Kebbi over twenty three years in Hectares and percentage.

Table 4.1 Static Land use Land Cover of Birnin Kebbi (1986,1999 and 2009)

Landuse/Landcover	**1986**		**1999**		**2009**	
	Ha	%	Ha	%	Ha	%
Riperian Vegetation	15488.10	12.38	7996.95	6.39	15027.70	12.02
Bare surface	35428.05	28.33	43814.70	35.03	38943.63	31.14
Grassland/ Forest	23902.56	19.11	26198.64	20.95	25756.70	20.60
Agricultural Land	48536.19	39.81	35985.69	28.77	35329.32	28.25
Built-up	1136.61	0.91	7315.92	5.85	9303.39	7.44
Water body	571.32	0.46	3750.93	2.10	702.09	0.56
Total	125062.83	100	125062.83	100	125062.83	100

Source: Author's GIS Analysis 2014

The figures presented in table 4.1 represent the static area of each land use land cover category for each study year. Built-up in 1986 occupies the least class with just 0.91% of the total land area. This may not be unconnected to the fact that the town (Birnin Kebbi) was made the state capital in 1991, the image was acquired before the creation of the state in 1986.

On the other hand, Agricultural Land occupies the highest portion with 39.81% in 1986 and decreased to 28.77% and 28.25% in 1999 and 2009 respectively. Bare surface occupied 28.33% of the total area in 1986 was increased to 35.03% in 1999 and drastically reduced to 31.14%. The study further revealed that water body had the lowest proportion occupied 0.46% in 1986, 3% in 1999 and 0.56% in 2009. Apart from this, the time of the year in which the area was imaged which happens to fall within the onset of hamattan could also be a major contributing factor to the observed classification, contributing to the high percentage of bare surface and the low percentage of water body. The spatial growth or expansion in other land cover types is directly taken place on the agricultural land as indicated by been the only land cover type with decrease in area coverage for the period under study. The figures 4.1, 4.2, and 4.3 are the Landuse/Landcover maps derived from the satellite imageries of 1984, 1999 and 2009 respectively that showed different landuse classes of the study area as they appeared in these years.

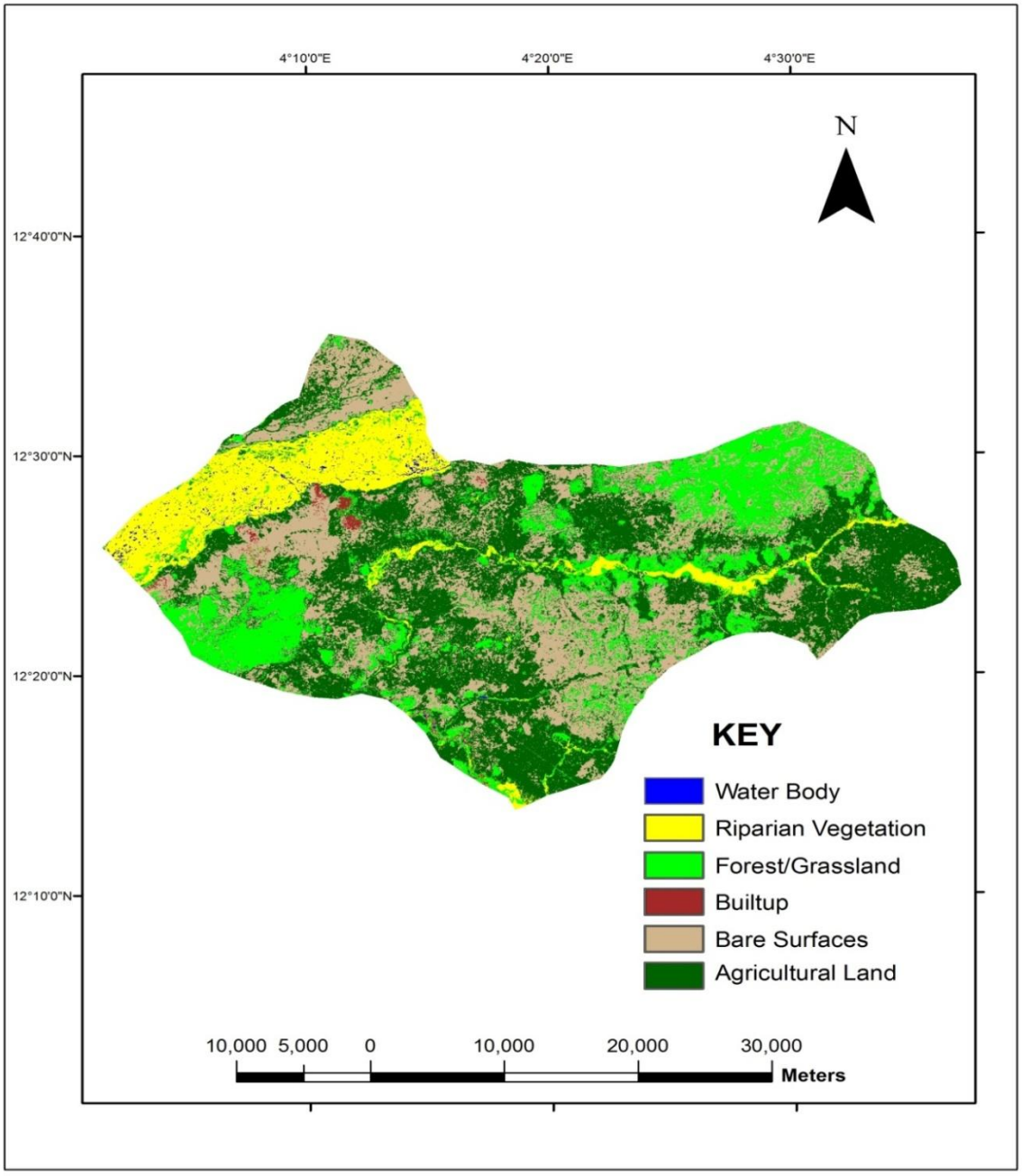

Fig 4.1:Landuse/Landcover Map of Birnin Kebbi in 1986

Sources: Author's GIS Analysis 2014

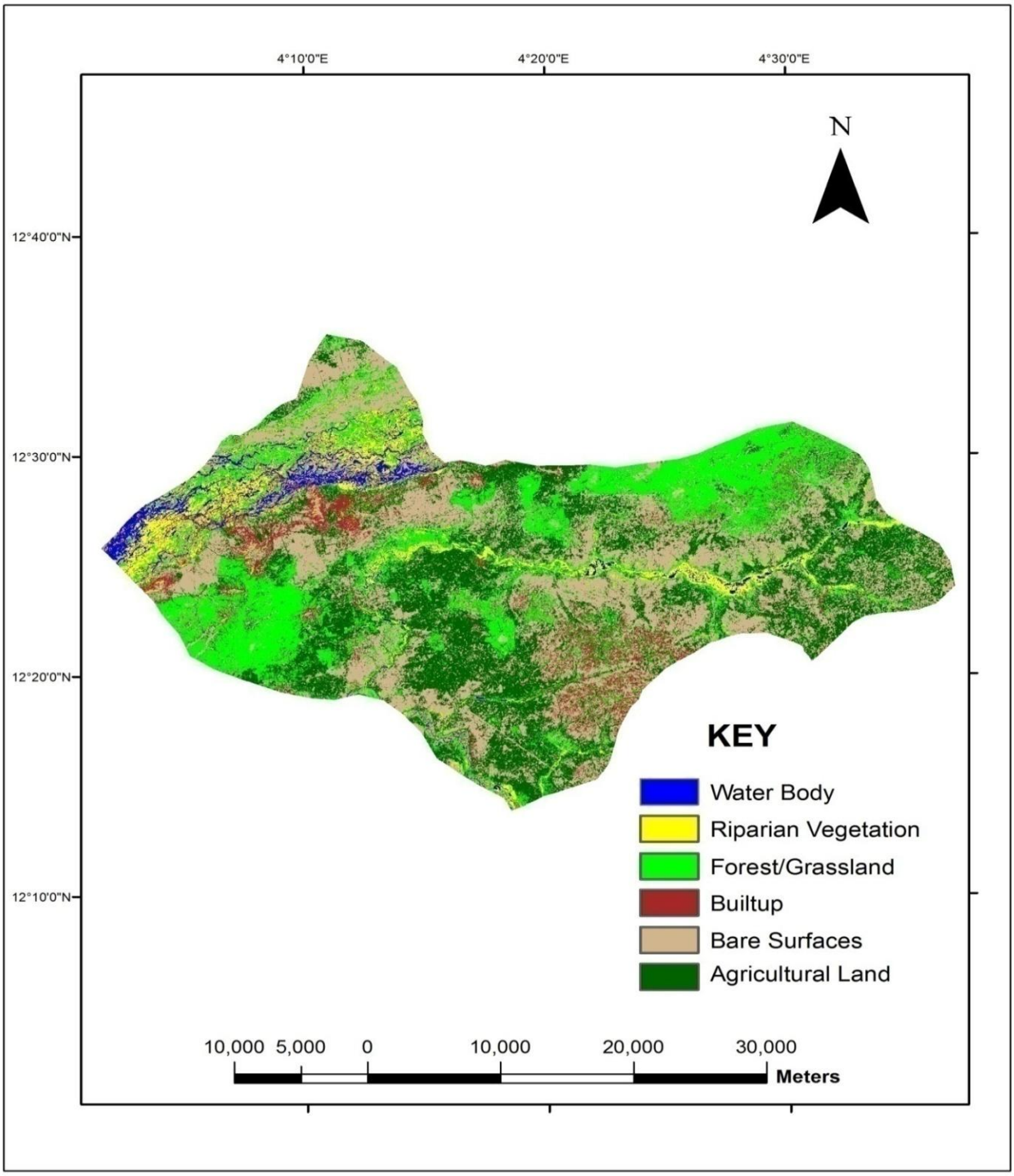

Fig 4.2: Landuse/Landcover Map of Birnin Kebbi in 1999

Source: Author's GIS Analysis, 2014.

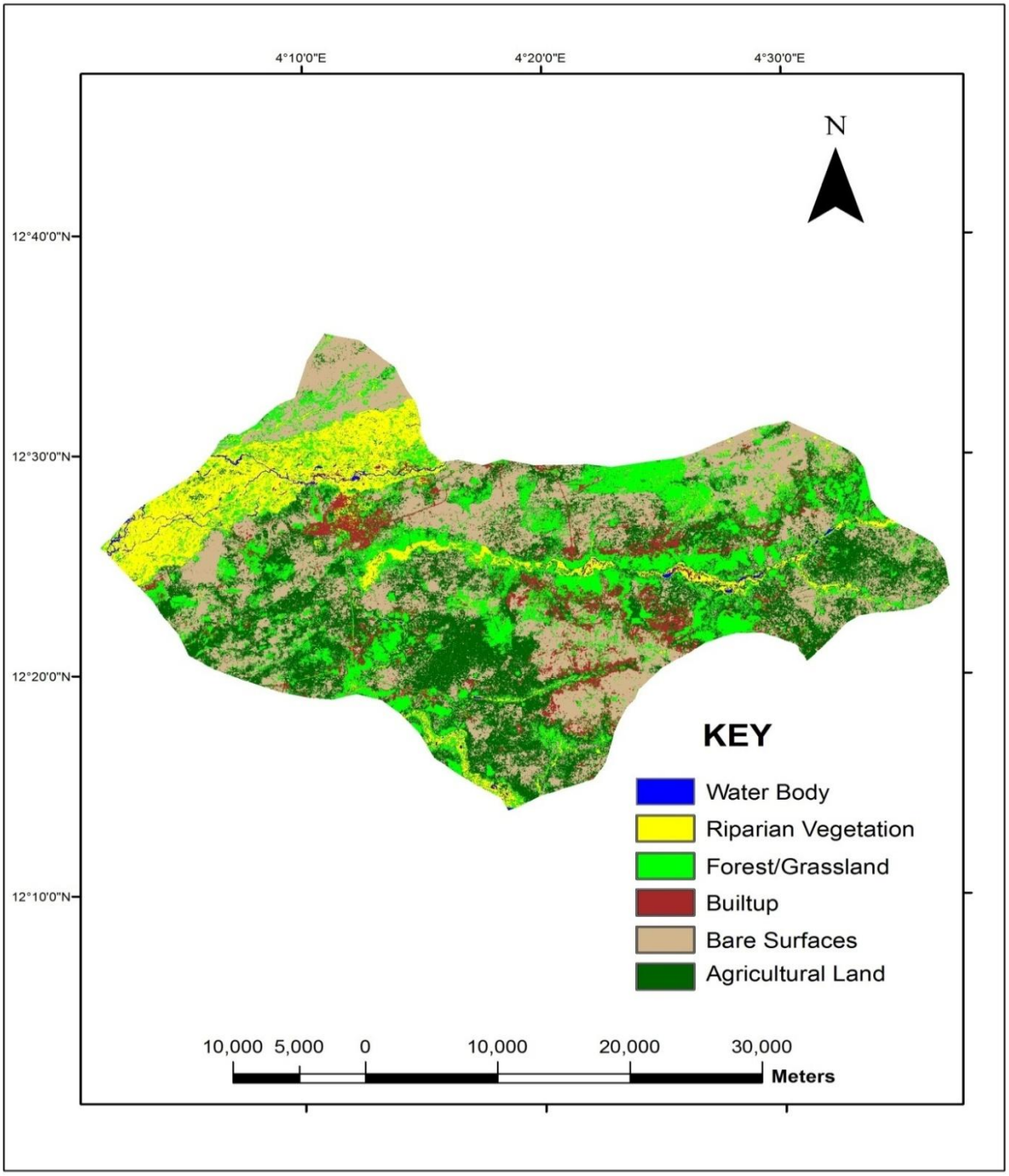

Fig 4.3: Landuse/Landcover Map of Birnin Kebbi in 2009

Source: Author's GIS Analysis, 2014.

4.3 LANDUSE/LANDCOVER CHANGE

The landuse/landcover change is presented in Hectares and percentage as shown in the tables 4.2 below:

Table 4.2 Landuse/Landcover Change (1986-2008)

Landuse/Landcover	**1986**	**1999**	**2009**	**1999-1986**		**2009-1999**		**2009-1986**	
	Ha	Ha	Ha	Ha	Perc	Ha	Perc	Ha	Perc
Riperian Vegetation	15488.10	7996.95	15027.70	-7491.15	-48.4	7330.75	91.7	-460.4	-2.9
Bare surface	35428.05	43814.70	38943.63	8386.65	23.8	-4871.07	-11.1	3515.5	10
Grassland/ forest	23902.56	26198.64	25756.70	2296.08	9.6	-441.94	-1.7	1854.1	7.8
Agricultural land	48536.19	35985.69	35329.32	-12550.5	-0.3	-656.37	-1.8	-13206.8	-27
Built-up	1136.61	7315.92	9303.39	6179.31	543.7	1987.47	27	8166.78	718
Water body	571.32	3750.93	702.09	3179.61	556.7	-3048.84	-81	130.77	22

Source: Author's GIS Analysis, 2014.

Table 4.2. depicts an analysis up to year 2009 revealing a drastic change in the normal course of urbanization. The yearly records revealed that the built-up areas increased rapidly by 543.7 per cent between 1986 and 1999, while between 1999 and 2009 shows a gradual increased in built up by 27 percent. The study also revealed that the year 1999 has shown a remarkable growth of

built up areas in town by 7315.92 hectares against 1136.61 hectares in 1986. This could be due to the fact that a lot of projects have been embarked after the creation of the state in 1992. As indicated in the table 4.3, built up land increased by 41.82%, this may not be unconnected to the fact that many projects were embarked upon after the creation of Kebbi State and Birnin Kebbi as a state capital and this attracted a lot of people to the area thus contributing to the physical expansion of the city as evident in the increased land consumption rate from 0.022 to 0.089 and land absorption coefficient by 0.201 between 1986 and 1999 as in table 4. 5 Many of these projects include the Army barracks and Police Barracks at Badariya, Aleiru Housing Estate at Gwadangwaje, Gesse Housing Estate, Rima River Basin Authority quaters, Permanent site of Waziri Umaru Federal Polytechnic, among many others which all encouraged migration into the city.

4.4 LAND USE LAND COVER CHANGE: RATE

The rate at which each land use type is changing per year is tabulated in Hectares and percentage as in table 4.3:

Table 4.3 Comparison of Areas and Rates of Changes in LULC Classes of Birnin Kebbi between 1986 and 2009.

Landuse/Landcover	**1986-1999**	**1999-2009**	**1986-2009**	**Rate of Change Per year (1986-1999)**		**Rate of Change Per year (1999-2009)**		**Rate of Change Per year (1986-2009)**	
	Ha	Ha	Ha	Ha	%	Ha	%	Ha	%
Riperian Vegetation	-7491.15	7330.75	-460.4	-576.24	-3.72	733.08	9.17	-20.02	-0.13

Bare surface	8386.65	-4871.07	3515.5	645.13	1.83	-487.11	-1.11	152.85	0.43
Grassland/ forest	2296.08	-441.94	1854.1	176.62	0.74	-44.19	-0.17	80.61	0.34
Agricultural Land	-12250.5	-656.37	-13206.8	-965.42	-0.02	-65.64	-0.18	-574.21	-1.18
Built-up	6179.31	1987.47	8166.78	475.33	41.82	198.75	2.70	355.08	31.22
Water body	3179.61	-3048.84	130.77	244.59	42.82	-304.88	-8.10	5.69	0.99

Source: Author's GIS Analysis, 2014.

From table 4.3, the results showed that the area of all the LULC classes have undergone change, but with differing magnitude and rates. Bare surface has increased during the first period of the study by annual rate of 1.83% and decline was revealed during the second period at annual rate of -1.11%. Despite the periodic variations in change of bare surface, the overall rate of change during the whole period of analysis (1986-2009) is found to be an increase of 0.43 per annum. However, the Grassland/ Forest land was observed during the first period (1986-1999) to cover 176.62 with an annual increase rate of 0.74%. It however, decreased to 44.19% during the second period with an estimated rate of decline of 0.17% per year and despite this the overall rate of change revealed an increase of 0.34% per annum.

Furthermore, Agricultural land has maintained a continuous pattern of change. Both first (1986-1999) and second period (1999-2009) of the study showed a decline of -0.02% and -0.18% rate of change per annum respectively. And the overall change was estimated to -1.18% per annum.

The study further revealed that water body which had 0.46% in 1986, increased to 2.1% in 1999 and subsequently declined to 0.56% in 2009.The increased in 1999 could be attributed to the heavy rainfall recorded in the year and there by causes floodings in the state capital.

The period between 1999 and 2009 witnessed a drop in the rate at which the physical expansion of the city was going as against 1986 and 1999. For instance, the built-up land only increased by 2.7% as against the 41.82% increase between 1986 and 1999.

Also, farming seems to be practiced moderately, occupying 38.81% of the total classes in 1986 and reduces to 28.77% and 28.25% in 1999 and 2009 respectively. This may be due to the fact that the city is just moving away from the rather traditional setting where farming seems to form the basis for living to administrative center/ state capital.

Figures 4.4 to 4.7 depict the overlay map to show the location of built up area changes between the years of study.

4.5 EFFECTS OF URBANIZATION ON LANDUSE/LANDCOVER IN BIRNIN KEBBI

In a more general sense, urbanization is the concentration of population due to the process of movement and redistribution (Satterthwaite 2005). Here movement and redistribution refers to the spatial location and relocation of human population, resources, and industries in a landscape. Broadly speaking, urbanization in the BirninKebbi was the output of two major processes – economic growth and city growth. Growth of city and economy was brought about by the change in the status of the town, rapid expansion of overall population, and the high level of agricultural productivity. Urbanization, the conversion of other types of land to uses associated with growth of populations and economy, is a main type of land use and land cover change in

human history. It has a great impact on climate. By covering with buildings, roads and other impervious surfaces, urban areas generally have higher solar radiation absorption, and a greater thermal capacity and conductivity, so that heat is stored during the day and released by night. Therefore, urban areas tend to experience a relatively higher temperature compared with the surrounding rural areas (Weng, Q. 1999). Urbanization is a result of a rapid population increase caused by mass immigration from rural areas to urban areas in Birnin Kebbi. Together with this, unplanned and thus uncontrolled urbanization (development of urban and rural area) results in the destruction of green areas.

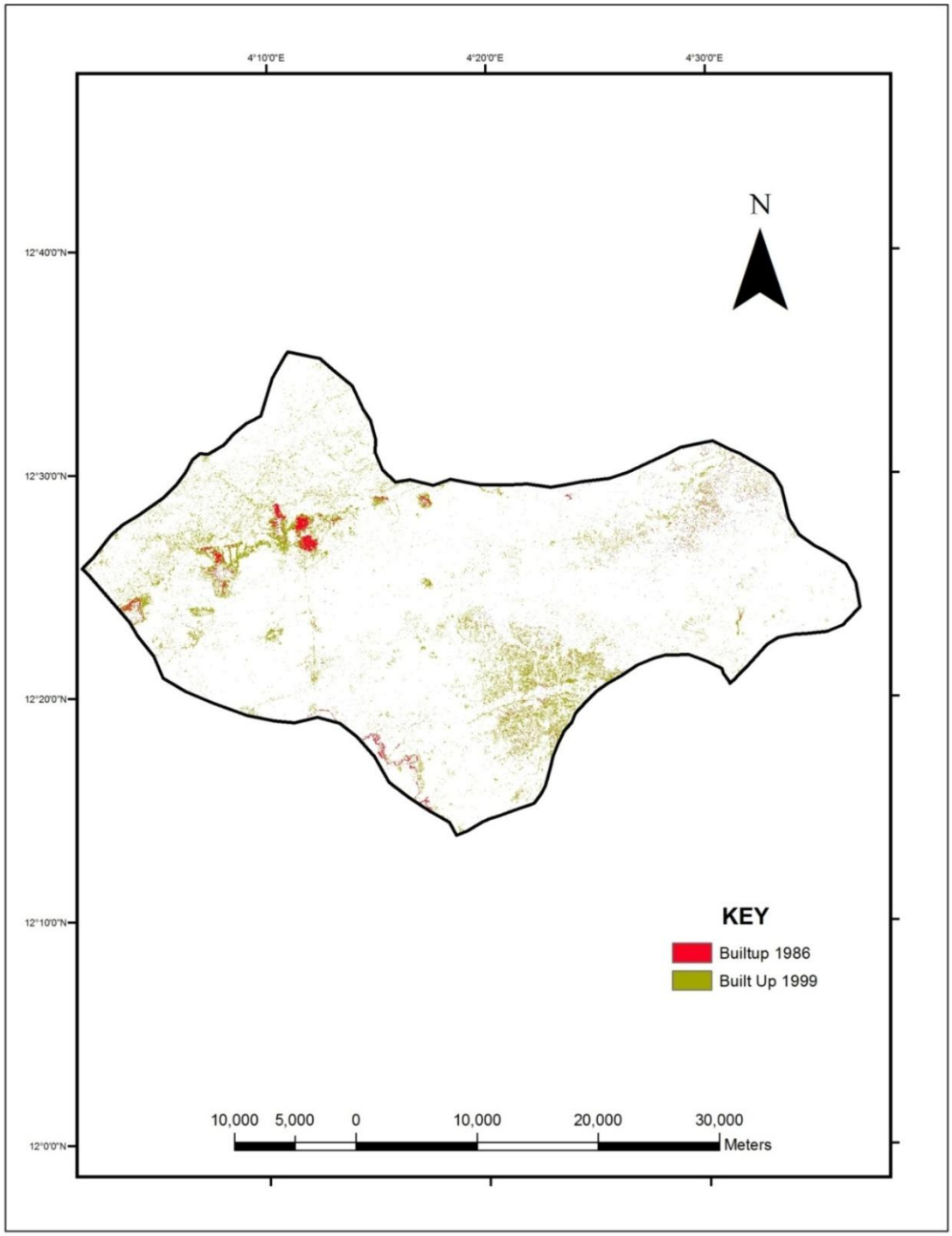

Fig4.4 Overlay of Built up Land to show the location of change in1986/1999

Sources: Author's GIS Analysis 2014

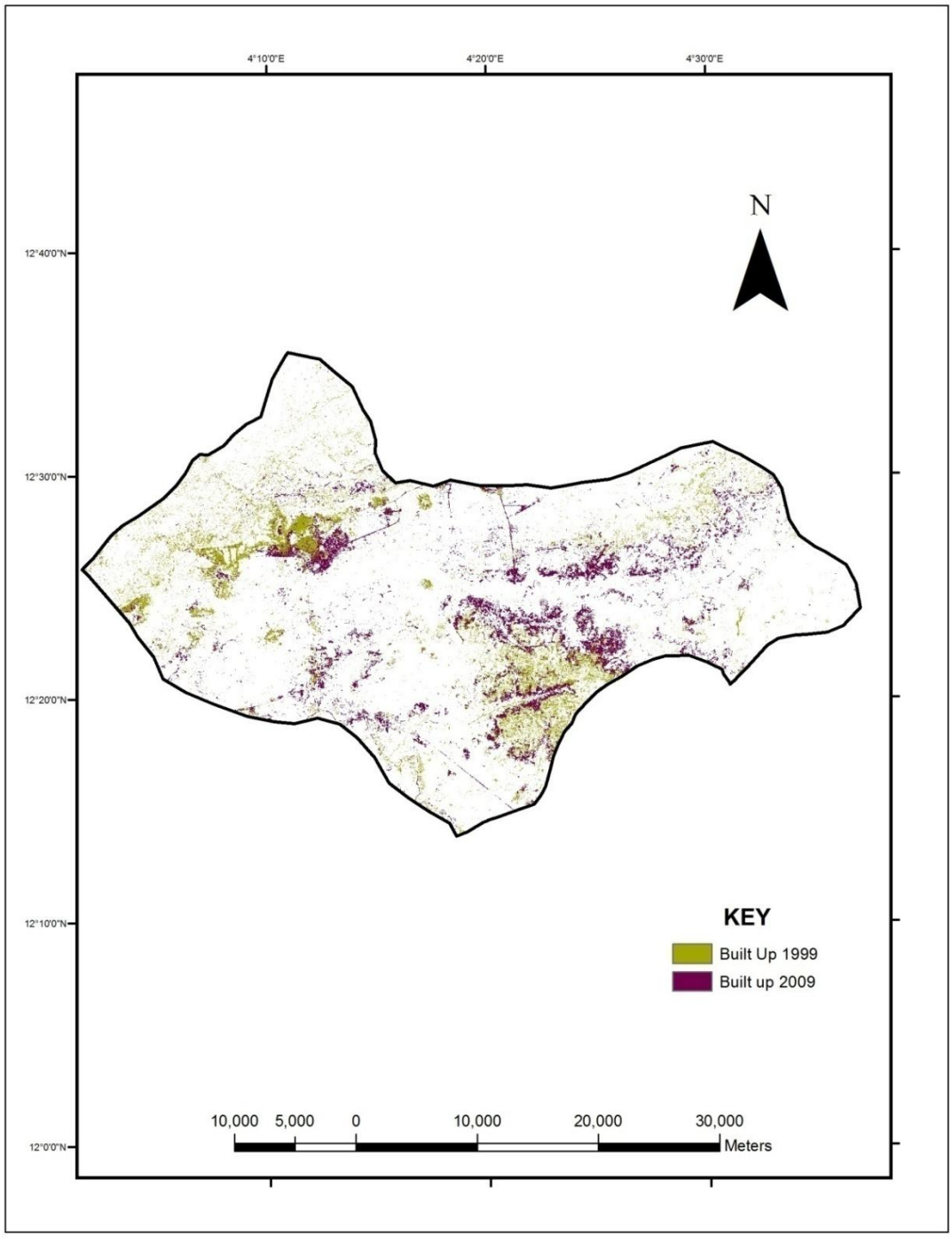

Fig 4.5 Overlay of Built up Land to show the location of change in1999/2009

Sources: Author's GIS Analysis 2014

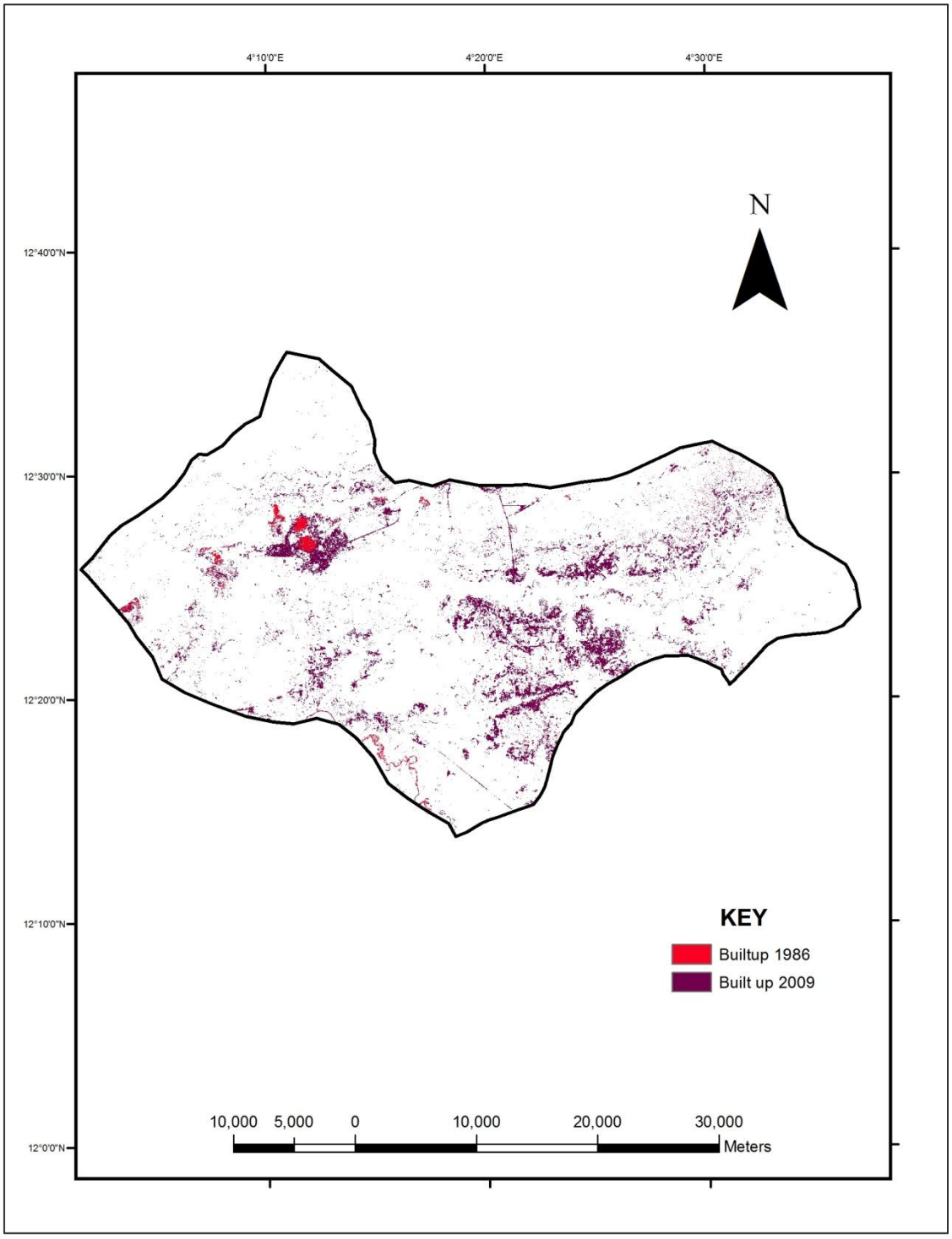

Fig4.6 Overlay of Built up Land to show the location of change in1986/2009

Sources: GIS Analysis 2014

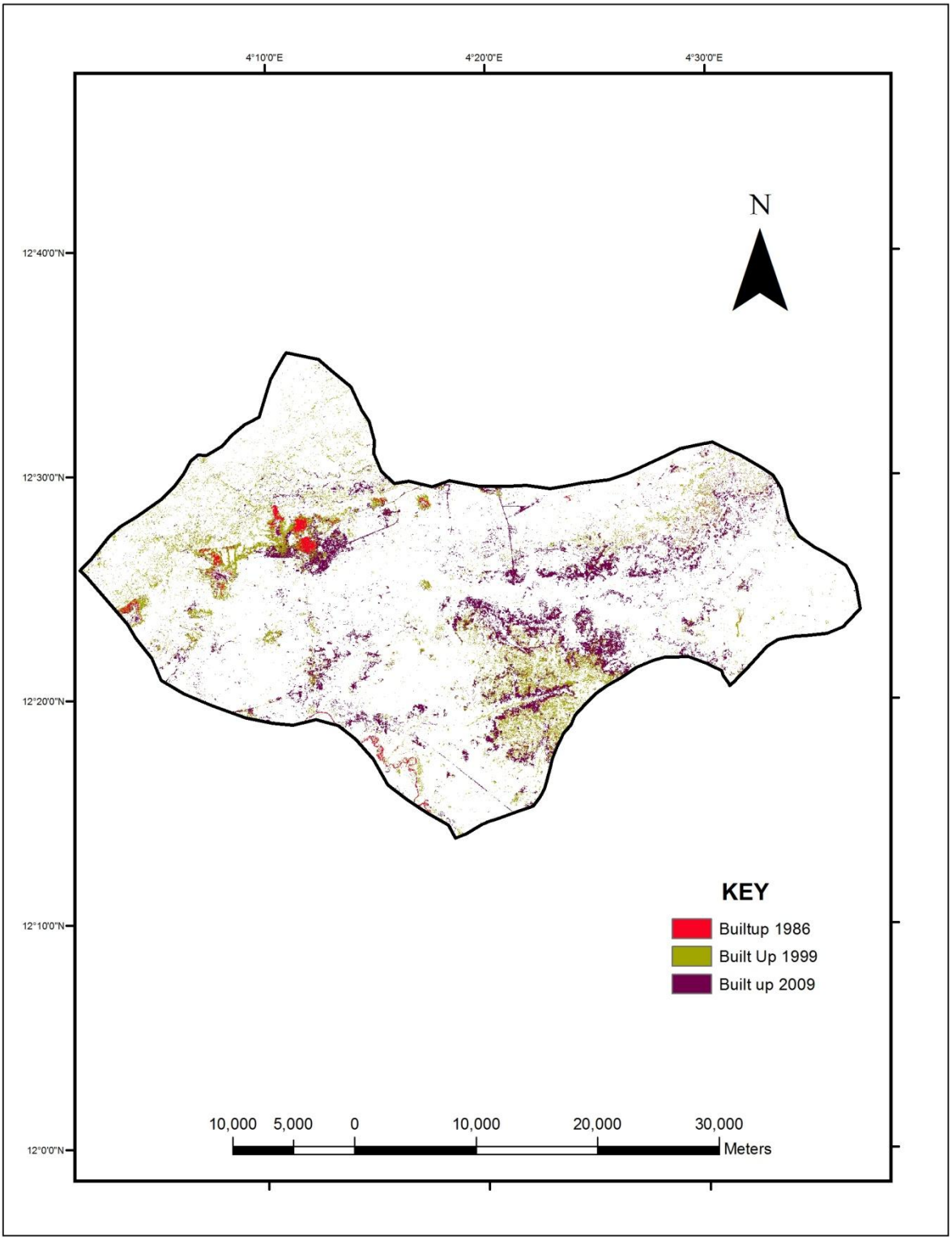

Fig4.7 Overlay of Built up Land to show the location of change in1986/1999/2009

Sources: Author's GIS Analysis 2014

4.6 LAND CONSUMPTION RATE AND ABSORPTION COEFFICIENT

Land Consumption Rate (LCR*)* is a measure of progressive spatial urbanization of a study area and Land Absorption Coefficient (*LAC)* is a measure of change of urban land by each unit increase in urban population. The LCR of the study area between 1986 and 2009 are presented in Table 4.5

4.6.1 Population of Birnin Kebbi 1986-2009

It should be noted here that the closest year population available to each study year were used in generating both the Land Consumption Rates and the Land Absorption Coefficients as given in table on population.

Table 4.4. Population figure of Birnin Kebbi in 1986,1999 and 2009.

year	**population figure**	**source**
1986	50,833	Projected
1999	81,485	Projected
2009	295,685	Projected

The period between 1999 and 2009 witnessed a drop in LCR at which the physical expansion of the city was going as against the 1986 and 1999 period. For instance, the built-up land only increased by 2.7% as against the 41.82% increase between 1986 and 1999. This is also evident in the drop observed in the land absorption coefficient from 0.201 between 1986 and 1999. Indeed, this may be due to the fact that, the people lack zeal to come back home to build, they prefer

to build in cities like Abuja, Kaduna, sokoto etc where there are more social amenities than they are in Birnin Kebbi.

4.6.2 Land Consumption Rate and Land Absorption Coefficient Figures

The land Consumption Rate and Land Absorption Coefficient of the study area is presented in the table 4.5

Table 4.5 Land Consumption Rate and Absorption Coefficient of Birnin Kebbi (1986-2009)

year	Land consumption rate	year	Land absorption coefficient
1986	0.022	1986/99	0.201
1999	0.089	1999/09	0.009
2009	0.031		

The creation of Kebbi State and Birnin Kebbi as a state capital has attracted a lot of people to the area thus contributing to the physical expansion of the city as evident in the increased land consumption rate from 0.022 to 0.089 and land absorption coefficient by 0.201 between 1986 and 1999 as in table 4. 5 Many of these projects include the Army barracks and Police Barracks at Badariya, Aleiru Housing Estate at Gwadangwaje, Gesse Housing Estate, Rima River Basin Authority quaters, Permanent site of Waziri Umaru Federal Polytechnic, among many others which all encouraged migration into the city.

The period between 1999 and 2009 witnessed a drop in LCR at which the physical expansion of the city was going as against the 1986 and 1999 period. For instance, the built-up land only increased by 2.7% as against the 41.82% increase between 1986 and 1999.

This is also evident in the drop observed in the land absorption coefficient from 0.201 between 1986 and 1999 to 0.009 between 1999 and 2009.

The overlay of build up lands of 1986, 1999 and 2009 on the remaining landuse/landcover class in the study is shown in fig 4.8 which identified the actual location and magnitude of change occurred. This was limited to the built-up land because the focus of this study is to monitor growth in settlement within the area of study.

Table 4.6 Accuracy Results for Classified Landsat Image of 1986 From Pixel Based Image Analysis

Class Name	**Producer's Accuracy (%)**	**User's Accuracy (%)**	**Kappa Statistic**
Agricultural land	90.20	59.47	0.78
Built up	100.00	100.00	1.00
Grassland/Natural forest	90.00	74.45	0.72
Water body	100.00	100.00	1.00
Bare Surface	98.33	96.92	0.97
Riperian Vegetation	96.30	89.63	0.89

Overall Classification Accuracy is 87.86% Overall Kappa is 0.8601

Source: Author's GIS Analysis 2014

Table 4.7 Accuracy Results for Classified Landsat Image of 1999 From Pixel Based Image Analysis

Class Name	Producer's Accuracy (%)	User's Accuracy (%)	Kappa Statistic
Agricultural land	92.22	100.00	0.98
Built up	75.00	87.50	0.87
Grassland/Natural forest	93.48	65.00	0.62
Water body	64.29	100.00	1.00
Bare Surface	88.98	83.33	0.75
Riperian Vegetation	91.67	91.67	0.91

Overall Classification Accuracy is 85.71% Overall Kappa is 0.8262

Source: Author's GIS Analysis 2014

Table 4.8 Accuracy Results for Classified Nigeria Sat 1 of 2009 From Pixel Based Image Analysis

Class Name	Producer's Accuracy (%)	User's Accuracy (%)	Kappa Statistic
Agricultural land	63.00	73.75	0.69
Built up	100.00	83.33	0.83
Grassland/Natural forest	75.00	81.82	0.78

Water body	16.67	100.00	1.00
Bare Surface	91.32	90.54	0.88
Riperian Vegetation	83.33	83.33	0.81

Overall Classification Accuracy is 80.15% Overall Kappa is 0.7564

Source: Author's GIS Analysis 2014

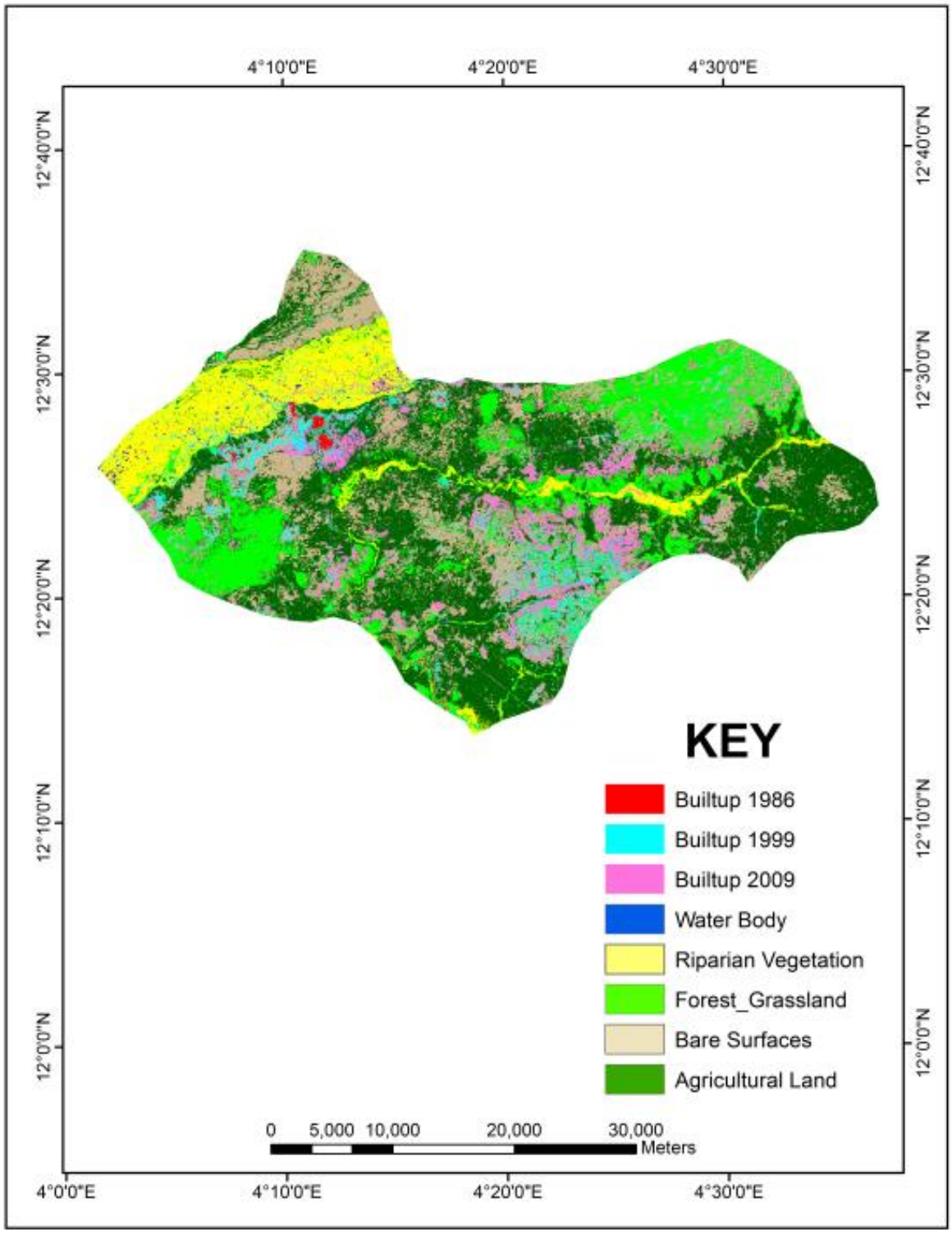

Fig4.8 Overlay of Built up Land 1986/1999/2009 on other Landuse/Landcovers

Sources: Author's GIS Analysis 2014

CHAPTER FIVE SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Introduction

This chapter looks into the summary of the research and the conclusion of the work together with the recommendations for further investigation of the effects of urbanization on the land use land cover of the area.

5.2 Summary

Attempt was made to capture as accurate as possible six land use land cover classes as they changed through time. The six classes were distinctly produced for each study year but with more emphasis on built-up land as it is a combination of anthropogenic activities that make up this class; and indeed, it is one that affects the other classes. In achieving this, Land Consumption Rate and Land Absorption Coefficient were used in the research work. The result of the work shows a rapid growth in built-up land between 1986 and 1999 while the periods between 1999 and 2009 witnessed a reduction in this class due to the fact that government now concentrate on other prominent towns of the state (Aliero, Dakingari Arugungu and Kalgo, Jega) to make them lively like the state capital in order to avoid influx of neighboring citizens to the capital.

5.3 Conclusion

Results of this study indicate that, supervised classification provided satisfactory results in terms of distinguishing urban areas, bare land, grassland, Water body, riparian vegetation and agricultural lands. The main change observed for the time period of 1986 to 2009 was the decrease of agricultural areas due to urbanization from 39% to 28%. The creation of Kebbi State

and Birnin Kebbi as a state capital has attracted a lot of people to the area thus contributing to the physical expansion of the city.

Built up area is increasing in the study area at the rate of 31.2% between 1986 to 2009 while agricultural land is decreasing at the rate of -1.18 within same period of the study. This there for showed that Urbanization has increased the socio-economic status of the people though it have negative impact on agriculture.

5.4 Recommendations

The trend, pattern and rate of landuse/landcover change of Birnin Kebbi revealed that; there is a possibility of overcrowding in the near future, It is therefore suggested that encouragement should be given to people to build towards the outskirts, like Zauro, Ambursa etc through the provision of incentives and forces of attraction that are available at the city center in these areas to avoid the problem of overcrowdings.

From the research, it revealed that a lot still need to be done in adoption of an appropriate urban planning and zoning with impact studies and scenarios, in order to protect agricultural lands from urbanization encroachment hence this research may be adopted and used as a source for planning and management in Birnin Kebbi.

There is the need for implementation of immigration policies to control the level of illegal immigration in Nigeria by National Immigration Service (NIS).

The efforts put in place by Kebbi State Enviromental protection agency KESEPA to save guard and protect the environment should be maintained as it is greatly assisting the state capital from excessive logging thereby making it more secured from this phemomenon.

Seminars and conferences should be organized locally to showcase the usefulness of studies such as this one and results and findings should be adopted as instruments for subsequent development and monitoring of activities within the study area.

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