

**USMANU DANFODIYO UNIVERSITY, SOKOTO
(POSTGRADUATE SCHOOL)**

**EFFECTS OF URBANIZATION ON LAND USE AND LAND COVER
CHANGES IN ARGUNGU, KEBBI STATE, NIGERIA.**

**A Dissertation
Submitted to the
Postgraduate School**

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BY

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DEDICATION

This work is dedicated to my parent whose effort and sacrifice has made my dream of having this degree a reality. Words cannot adequately express my deep gratitude to them. I pray they will live long to reap the fruits of their labour.

CERTIFICATION

This Dissertation by Muhammad Ibrahim Musa (Admission number 13210305010) has met the requirement for the award of the degree of Master of Science (M.Sc) in Physics, Usmanu Danfodiyo University, and is approved for its contribution to knowledge.

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ABBRAVIATION

RS	-	Remote Sensing
ArcGIS	-	Architectural Reconnaissance Coverage Geographical Information System
GIS	-	Geographical Information System
LULC	-	Land Use Land Cover
GLCF	-	Global Land Cover Facilities
TM	-	Thematic Map
ETM	-	Enhance Thematic Map
ERDAS	-	Earth Resources Data Analysis System
μM	-	Micro Meter
UTM	-	Universal Transvers Mercator
WAS	-	World Geodetic System
Land sat	-	Land Satellite
BUK	-	Bayero University Kano
ASTAL	-	Advance Space Application Laboratory
GPS	-	Global Positioning System
UN	-	United Nation
AutoCAD	-	Computer Aided Drawing
EMS	-	Electromagnetic Spectrum
EM	-	Electromagnetic
EMR	-	Electromagnetic Radiation
NGVI	-	Normalized Differences Vegetation Index
ILU	-	Interferometric Land Use
MLC	-	Maximum Likelihood Classification
NPC	-	National Population Commission
NARSDA	-	National Space Research and Development Agency

ABSTRACT

Urban growth and expansion is among the major phenomena of study globally. This study examines the urban growth of Argungu, which is one of the largest towns in Kebbi State, This study examined the integration of Remote Sensing and Geographic Information System (RS/GIS) for analyzing land use and land cover dynamics in Argungu, for the period 1999 to 2016. Two satellite imageries (ETM+1999 and ETM+2016) and demographic data were used for the study. Supervised image classification techniques were applied to the two images and after the images were spectrally and spatially enhanced with ArcGIS 10.3. Google map, Historical map, and prior knowledge of the study area were used as referenced data for the classification. Five land use classes were also used for the study, i.e. vegetation, rock, bare surface, settlement and water body. The study obtained good result of some increased area and some decreased area results from both images data of the two different dates, that is 1999 image and 2016 image were compared as an input to produce the change detection results. The findings revealed that settlement and water increased by 21.25% and 10.26% between 1999 and 2016, while the vegetation cover, bare surface and rock were decreased by 10.00%,19.22% and 2.29% respectively. Both remote sensing and GIS techniques were fully demonstrated in this study and the research has provided (from the analysis) a supporting data and good information that could be used for decision making in urban planning and general environmental studies.

CHAPTER ONE

1.0 INTRODUCTION

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 bio geophysical 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 *et al.*, 1976).

Urban growth is a global phenomenon that is caused by human actions with current reduction of agricultural land (Lopez, et al. 2001), deforestation (Alphan, 2003), that reduces plants growth. This is as a result of population growth, cities expansion that results to the conversion of rural areas and agricultural lands to urban built up areas particularly in the developing countries of the world (UN-Habitat, 2003), it is clear evidence in China and other Asian countries. Nigeria is among the developing countries with rapid population and urbanization growth, and some cities like Argungu are experiencing this urban growth and expansion. Argungu is a commercial city in northern Nigeria with rapid urbanization which is associated with urban problems like, unemployment, and over population.

Urban expansion requires development of Land Use and Land Cover Change (Musa, 1994). Very high urbanization and towns expansion in most of developing

countries has been discovered as the major causes of land use and land cover (LU/LC) changes (Oyinloye and Adesina, 2006). As urbanisation is the major agent of land use and land cover (LU/LC) change detection of some important information that are needed in the process of monitoring cities using GIS and remote sensing application for analysis in the process of projecting the trends of future land use and land cover changes, and the causes of urbanizations in most of developing countries particularly in Africa. This is because of unawareness of data sources in government organizations and institutions of higher learning. There are serious limitations of remote sensing, and Geographical Information Systems (GIS), in developing countries particularly in the area of technical know-how on how to get a good data for GIS analysis which will be used for extracting meaningful information from the data, (Okpala, 1983, Adesina, 2005). However, according to Stren, (1994) there was a setback of economic resources in the academic institutions of higher learning particularly universities to conduct a research in remote sensing and Geographical Information Systems, (GIS). The second reason is political instabilities in some developing countries which hinder the successful development of Remote Sensing, GIS application and data sources as well as data collection, with main advantage of monitoring urban growth and the provision of thematic mapping so as to provide the bedrock of development with good information to policy makers, administrators which will be used for other development control, planning review of urban area. That is why the remote sensing (RS) and Geographical Information Systems (GIS) are needed. The data capture and analysis with the use of these powerful tools to achieve the objectives.

Data capture, analysis and evaluation will be used to provide thematic maps and graphs of the study area. The result will serve as useful information to policy makers and urban studies of both land use and land cover change (Geneletti, and Gorte, 2003). The use of land sat ETM+ of 1999 and land sat ETM+ of 2016 to assess the rate of changes in Argungu metropolis with the change detection discovered at eastern bypass of the study area and some other changes within the study period. Some supporting data apart from images used as reference guide as well as data capture and data collections, the result of unplanned growth in Argungu affect the spatial shape of the land use. This is because of the uncontrolled development and lack of information technology of data acquisition like Remote Sensing and GIS (Ikhuoria, 1995).

1.2 Statement of the Research Problem

The recent growing volume of urban areas in Argungu metropolis requires standard urban planning due to the high increase of unplanned growth is calling the attention of planning authorities than any other urban problems and is quite clear problems that affect the area within and outside the metropolitan city of Argungu.

Urbanization is usually associated with compounded environmental problems. The study area has this environmental problems which resulted into environmental degradation because of high urbanization that usually affects the natural ecosystem of conservation program of forest cover or game reserve that are usually converted into urban areas for residential and commercial purpose and

other urban infrastructures for what they said is urban development which on the other hand affects the natural environment which results into environmental degradation(United Nation Environmental Program, (UNEP). Available at <http://www.unep.org/>

The situation in Argungu and its environs is not different, 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 land use 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 land use and land cover research has been conducted in Argungu and Environs using Remote Sensing and GIS techniques.

1.3 Aim and Objectives of the Study

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

- i. Map out Land use and Land cover between 1999 and 2016 using multispectral satellite imagery.
- ii. Analyze Land use and Land cover changes from multi temporal data.
- iii. Determine the population changes within the study period

1.4 Justification of the Study

Adequate information on the effect of urbanization on land use and land cover of Argungu is of vital importance, because it would not only allow proper planning of the land but also serve as a guide to policy makers in lands application and utilization

1.5 Scope and Limitation

The scope of this study employed the use of satellite imagery data of 1999 and 2016 and is limited to the use of GIS and remote sensing techniques.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Theoretical Fundamentals

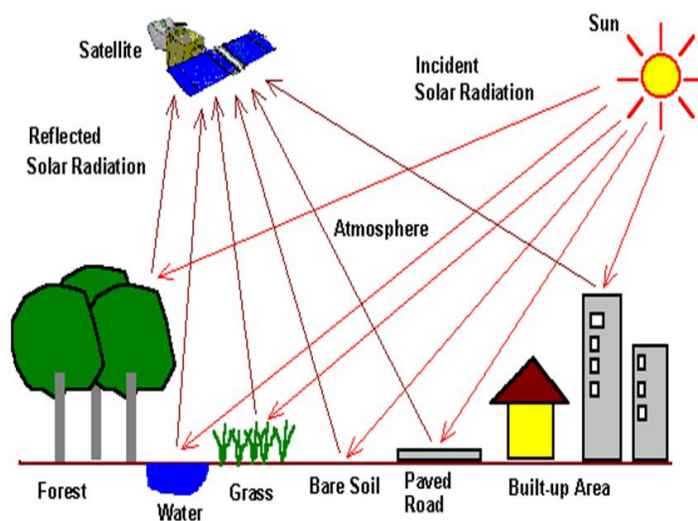
2.1.1 Remote Sensing

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. 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 (Meyer, 1995). 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 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

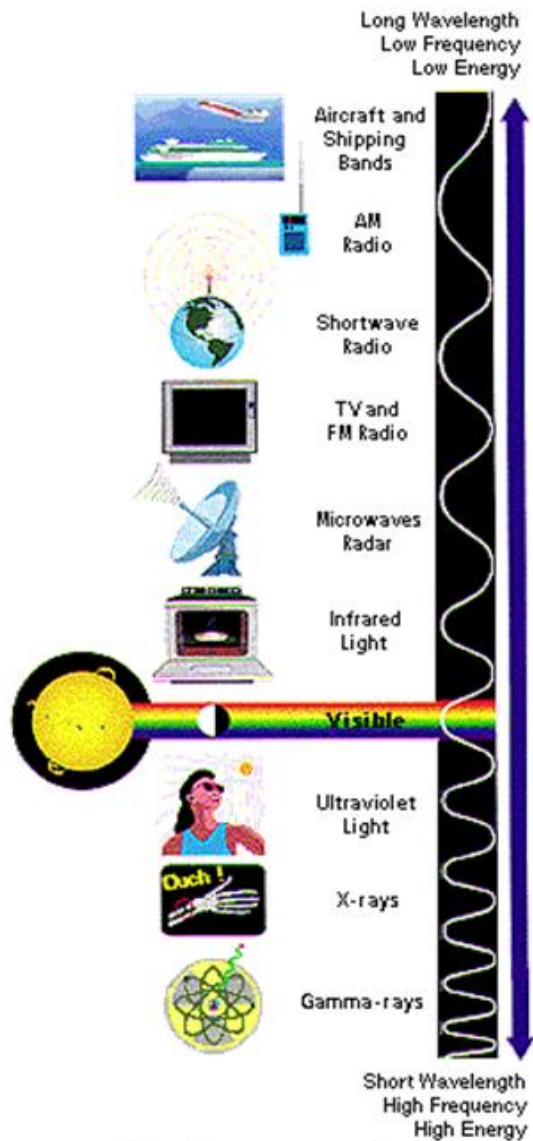
sensing and recording reflected or emitted energy and processing, analyzing, and applying that information (Fundamentals of Remote Sensing, Not dated).

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 (Fundamental 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 (Miller and Small, 2003). 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 (Fundamentals of Remote Sensing, Not dated).



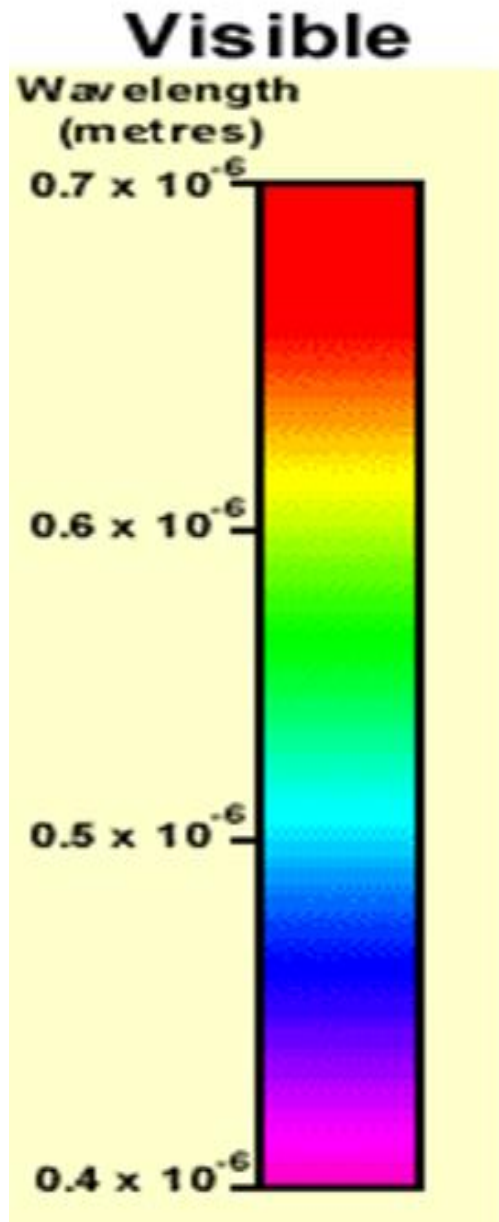
Fig; 2.0 Remote Sensing Process.

The Electromagnetic Spectrum (EMS) is the entire range of EM waves in order of increasing frequency and decreasing wavelength. The most useful region of electromagnetic spectrum in remote sensing is VISIBLE REGIONS. The diagram below shows the electromagnetic spectrum and the most useful regions in remote sensing.



The electromagnetic spectrum categorizes solar radiation from the longest to the shortest wavelengths.

Fig; 2.1a EMS Spectrum



Fig; 2.1b Regions of EMS IN RS

2.1.2 Geographical Information Systems (GIS)

Geographical Information systems can be defined as powerful tools with combination of some data, hardware, software with analysis processes and human skills (Adesina, 2005). GIS is capable of processing different sets of data that involves raster and vector formats as sets of data programmes that are able to store, analyse and visualise in spatial components (Gatrell and Loytonen, 1998). GIS was developed in the year 1960 in Canada by a Canadian scientist Roger T. for the application of environmental studies using spatial data (ERDAS, 2003). It progressed in to further developments in the year 1972 when image interpretation of satellite data related with other geographical features as the beginning of digital image processing and image classifications.

Geographical Information Systems (GIS), are needed in developing countries particularly Nigeria with a new information technology that start to rise for the last 5-10 years. The application of GIS in some urban planning Agency and some planning ministries with basic computer applications and CAD known as computer aided drawing, the new technology integrate data analysis from remote sensing and GIS techniques,(Gatrell and Loytones, 1998).

ArcGIS is special software or tool designed to perform special task involving Geographical Information Systems (GIS).it is produced by ESRI, ArcGIS Desktop has four separate applications

- ArcMap
- ArcCatalog

- ArcScene
- ArcGlobe

2.1.3 Land Use Land Cover

Land is natural resources and also the main source of national wealth. It is used for 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).

Land use 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 Long *et. al.*, (2008). 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, and recreation and so on.

Land use and land cover change studies have become key components for managing natural resources and monitoring environmental changes. Igbokwe

(2010) suggests that Land use and Land cover information should form part of the environmental data, which are kept in the form of inventories/infrastructures in many advanced and emerging economies. Most Land use 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 rising, 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.

2.1.4 Effects of Land Use Land Cover 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. (Oluseyi 2006).

Urbanization 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. 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).

2.1.5 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.

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 analyze the temporal effects of the phenomenon.

2.1.6 Image Classification

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 images processing software's. 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.

Supervised classification technique using maximum likelihood algorithm is the most commonly and widely used method for land cover classification (Jia and Richards, 2006). 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 Likelihood 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 color 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 3.3).

2.1.7 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 *et. al*, (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).

2.1.8 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.

2.1.9 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, 2003).

2.1.10 Urbanization in Argungu

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. Argungu 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.

2.1.11 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 (Argungu Master Plan1980-2010).

The landscape of Argungu 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 Matan fada 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 Matan fada river (Argungu Master Plan 1980-2010).

2.1.12 Climate

Although, there are no weather element recording stations that exist in Argungu, the 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 Argungu and its 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°C while it could be as low as 8°C during the cold harmattan period (December-February).

Relative humidity is much higher in the southern areas than in the north where Argungu 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 (Argungu Master Plan 1980-2010).

2.1.13 Geology

The geological characteristics of Argungu 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 (Kebbi Master Plan 1980-2010).

2.1.14 Soils and Vegetation

Wetland and savannah soils have developed throughout Kebbi state. The principal soils within the Argungu 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 (Argungu Master Plan 1980-2010).

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

2.1.15 Economic Activities of Argungu

Economically, it is important to point out that opportunities facing the people of Argungu 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 2016) has exerted great influence on population growth, employment structure, physical expansion and development of the town. Argungu 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.

The town of Argungu which has been hosting fishing and cultural festival is located North-East of Kebbi State at a distance of about 58 km along the bank of River Rima or Gulbin Kebbi. Argungu is the Headquarters of both Argungu Emirate and Argungu Local Government Area. The population of Argungu Local Government area was estimated to be 195,484 (NPC, 2006). Argungu is an undulating highly drained region blessed with numerous rivers, streams, Lakes, ponds and pools. The most important rivers are the River Rima and the Gulbin Kebbi. The region has a very good flood-plain of an average of five kilometers wide. From the foregoing, it is not surprising that Argungu has become an area where intensive fishing and cultivation of Millet, corn, cassava, beans, groundnuts, maize as well as rice cultivation takes place. Consequently, there is a high population concentration in the Argungu region.

Argungu Local Government Area comes entirely within the Sudan/Sahel Savannah, climatic and vegetational zone. It experiences three dominant seasons. The wet season (damuna) extends from June to September. Starting from August, the numerous streams, lakes and ponds, notably the Gulbin Kebbi overflow their banks. The cool season (dari) extends from October to January and is usually characterized by a relatively long spell of dryness and dust (Harmattan) from the Sahara. The hot season (bazara) starts from February and lasts until May. This period is marked by intensive heat with temperature of over 90°C.

2.2 Review of Related Literature

Arvind and Nathawat (2006) carried out a study on land use and land cover mapping of Panchkula, Ambala and Yamunanger districts, Haryana State in India. They observed that the heterogeneous climate and physiographic conditions in these districts have resulted in the development of different land use and 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 and 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 land use 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 Land use and Land cover 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 Singh (1989) 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 area of land 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 in which maximum likelihood classification (MLC), Normalized differences vegetation index (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 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, Bisong (2007) 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, settlement, rock, water body and bare surface. 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 *et al.*, (2011) analyzed urban expansion and vegetal cover loss in and around Abuja with the use of Landsat imageries from 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

3.0 MATERIALS AND METHOD

3.1 Materials

- i. ArcGIS 10.2 Software: This used basically for digitizing the base map
- ii. ERDAS IMAGINE 9.2: This also used for sub-setting images, development of Land use land cover classes and subsequently for change detection analysis of the research
- iii. Hand held GPS (Version; German): For taking coordinates of places and ground thruthing
- iv. Computer hardware and related software (Microsoft word, excel, and PowerPoint)

3.2 Methods

3.2.1 Data Collection

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 1999 and 2016 were obtained. These images were used to generate the land use and land cover information within

the study area from 1999-2016. They are obtained from Advance space Application laboratory, kano.

- iv. Population data: Population data for 1999 and 2016 were used. All were obtained from National Population Commission, Kebbi State.

3.2.2 Data Classification

The sources of data used includes both primary and secondary sources

3.2.2.1 Primary Data

The primary data used for this study include three sets of satellite imageries, field observation, and information from residents and key informants. The two sets of satellite imageries of Argungu used include 1999 and 2016. These are: LandSat Multispectral Scanner (TM) of 1999-2016. All these satellite imageries were obtained from Advance Space Application laboratory, B.U.K, Kano (ASTAL) Nigeria.

3.2.2.2 Secondary Data

Secondary data used for this study include; Argungu base map, Population figures of 1999 to 2016 obtained from Kebbi State ministry of Land, Housing and Town Planning and National Population Commission 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 to be required	Year	Resolution	Source
1.	Landsat image	1999	30m TM	National Centre For
2.	Landsat image	2016	32m TM	Remote Sensing and GIS, Jos
3.	Administrative Map of Argungu.	1999-2016		Kebbi State Ministry of Lands and Town Planning
4.	Population Data	1999-2016		National Population Commission

3.2.3 Data Processing

Landsat imagery of 1999 and 2016 with 30m TM spatial resolutions; are used for the study. The portion of interest (Argungu and its environs) is subsetting from each of the larger scenes using ArcGIS 10.3 software.

3.2.4 Image Preprocessing

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 Auto-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).

3.2.5 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 up-sampling; reducing its size is called down-sampling. 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.

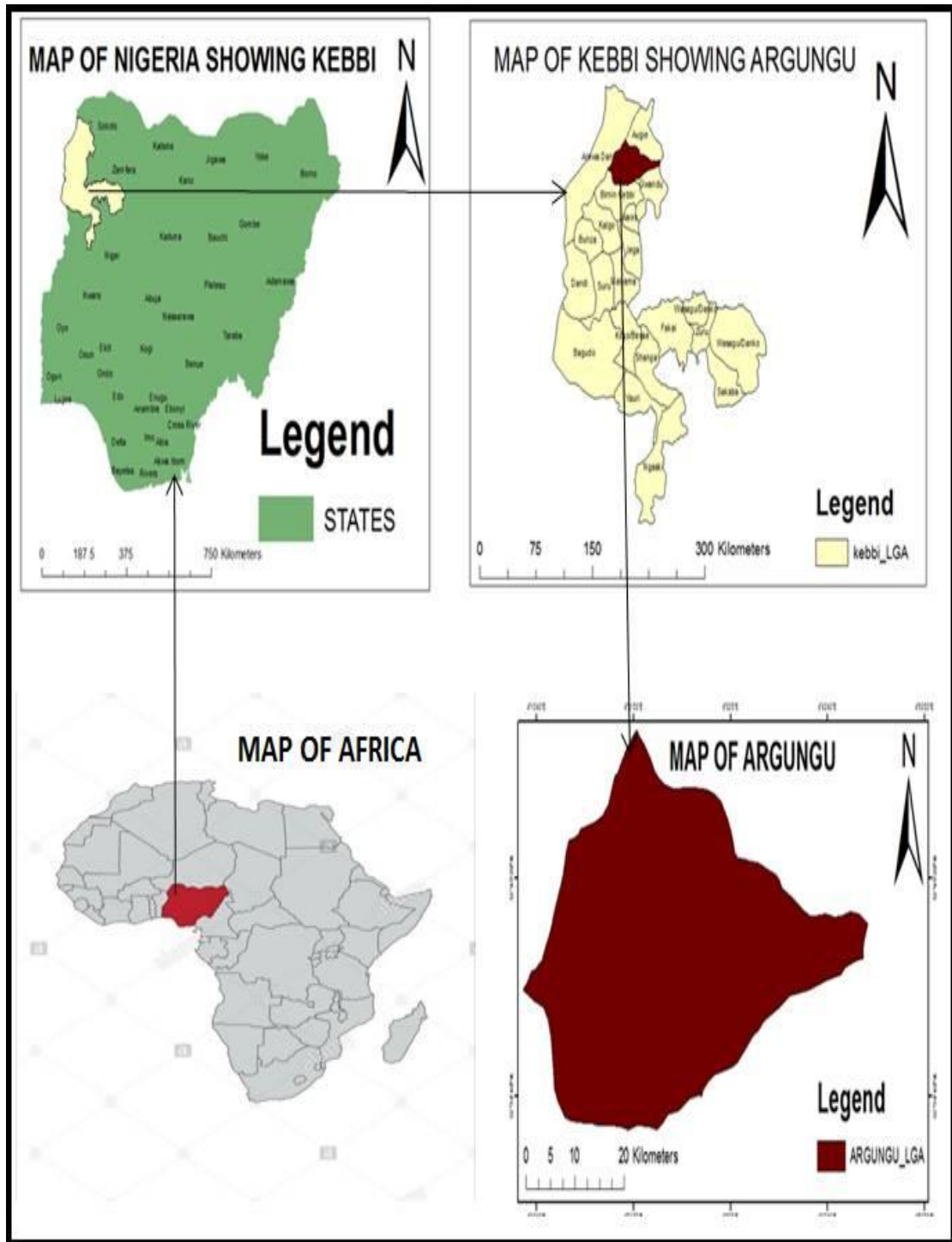
3.2.6 Layer Stacking

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)

3.2.8 Study Area

Argungu is located between latitude $12^{\circ} 30'33''\text{N}$ to $12^{\circ} 40'54''\text{N}$ and longitude $4^{\circ} 20'54''\text{E}$ to $4^{\circ} 30'54''\text{E}$ covering an area of 428 KM^2 and elevation of 241 meters above sea level. It is bounded by Yabo Local Government area of Sokoto state to the North-East, in the South by Gwandu and Birnin Kebbi Local Government areas, while to the North-West by Augie and Arewa Local Government areas respectively.



MAP OF NIGERIA SHOWING THE STUDY AREA

Fig; 3.1a Study Area

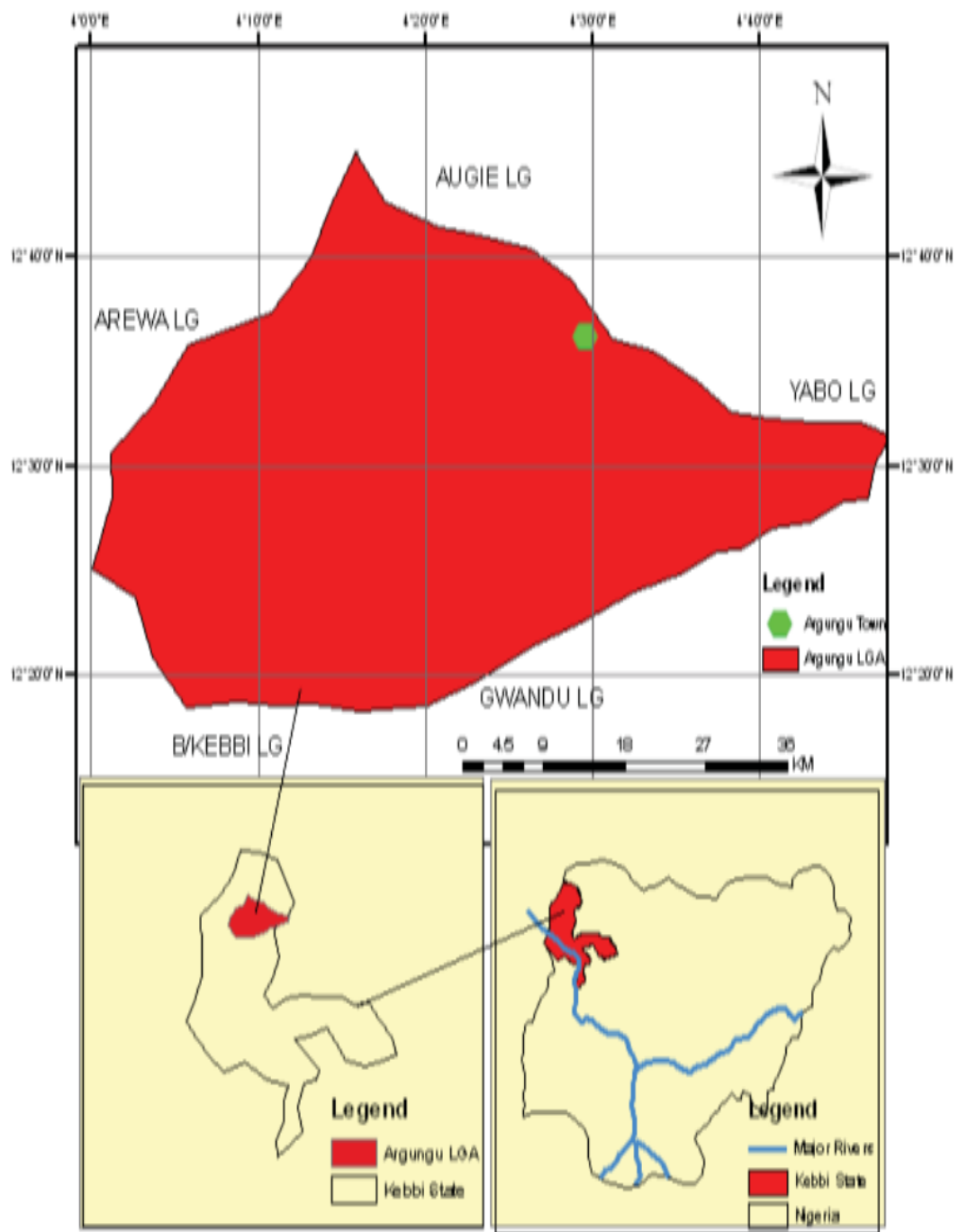
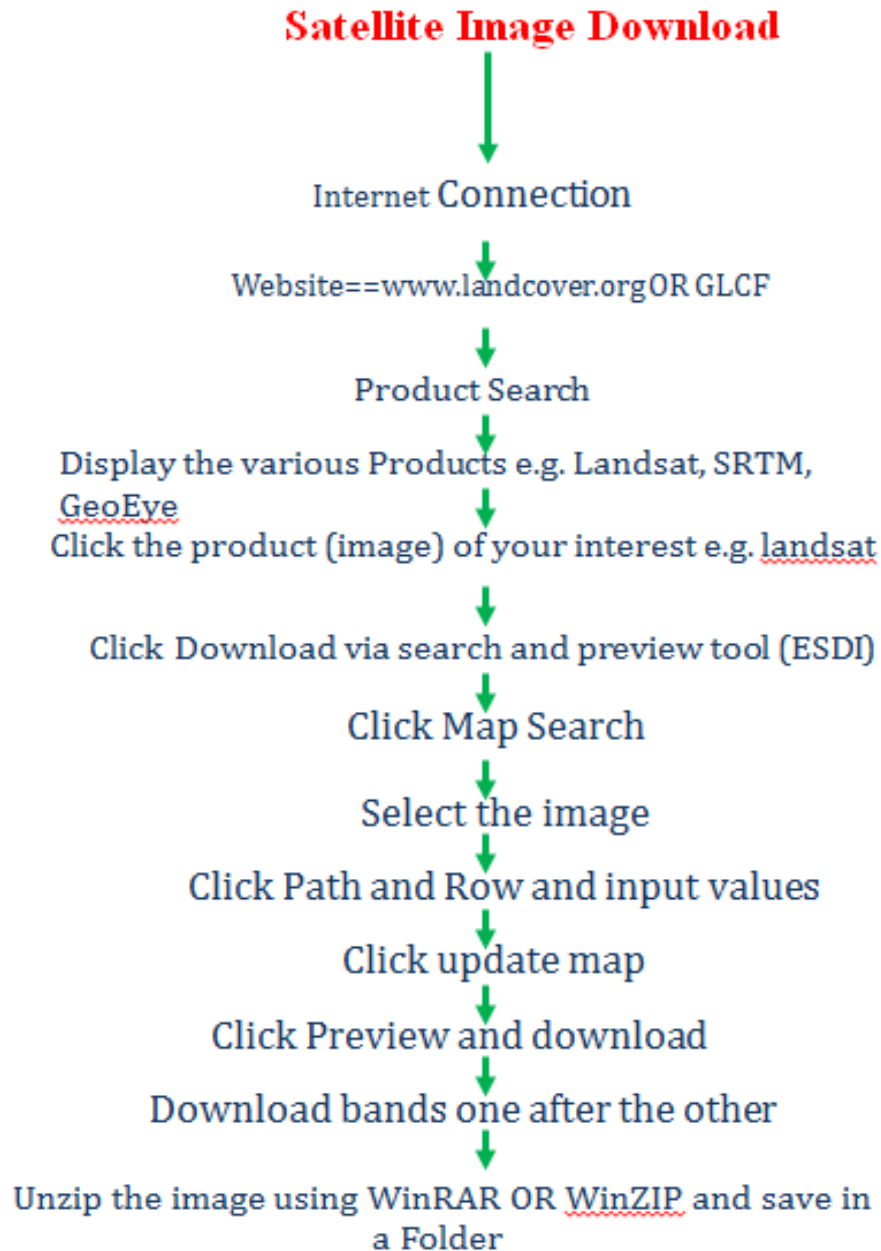


Fig 3.1b Map of Nigeria Showing the Study Area (Argungu)

3.3 Data Acquisition



3.3.1 Image Frame Work

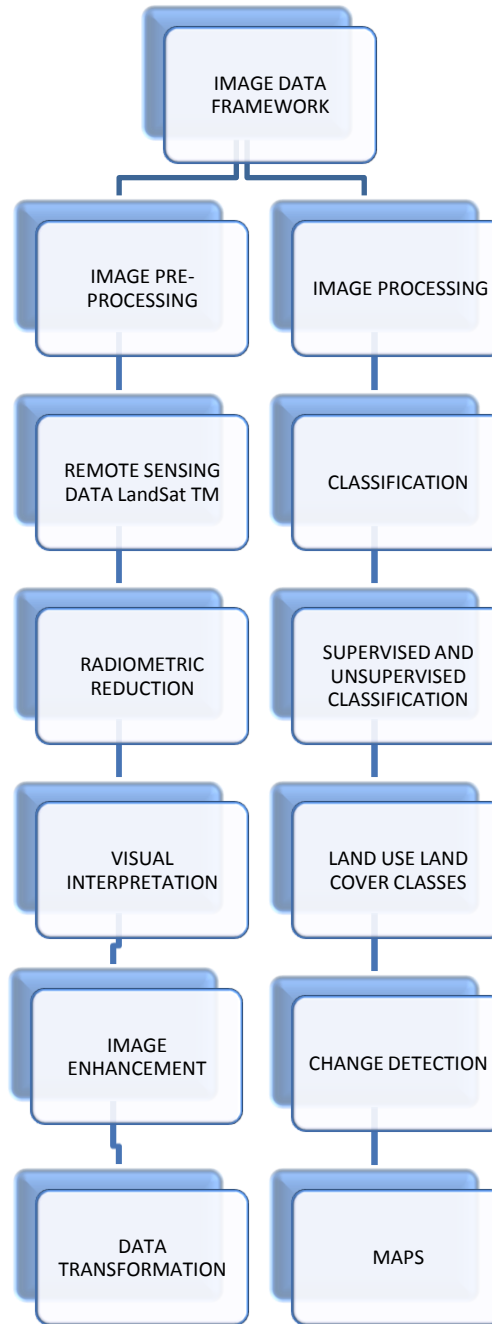


Table 3.2: Classification Scheme

Code	Land use Land cover	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	Riparian Vegetation	Is a distinct forest community occurring on the banks of rivers

3.4 Data Analysis

The comparison of the land use land cover has assist in identifying the percentage change, trend and rate of change from 1999 to 2016

To characterize the land use land cover change of Argungu in 1999 and 2016, Calculation of the area in Hectares of the resulting land use 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 hectares and the percentage change for each year (1999 -2016) will be measured against each land use 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

$$\text{(Trend) percentage change} = \frac{\text{Observed Change}}{\text{Base Year}} \times 100 \dots\dots\dots 1$$

To determine the land use land cover change between 1999 and 2016 in Hectares and percentage change:

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

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.

$$P_t = P_0 e^{rn} \dots\dots\dots 2$$

Where p_0 = Previous/ base year population, in this case 1999 and 2016 were used.

P_t = population of the present year, in this case 1999 and 2016 were used.

e =exponential, n = number of the year interval.

r = growth rate of the state, (3.2% expected rate)

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Land Use Land Cover Classes

Figures 4.1 and 4.2 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 land use land cover class of Argungu over fifteen years in Hectares and percentage.

Table 4.1 Static Land use Land Cover of Argungu (1999 and 2016)

Land use Land cover	1999		2016	
Class	Area/Ha	%	Area/Ha	%
Vegetation	22139.024699	17.17	5670.09	7.17
Bare surface	48520.180515	37.63	26321.5808	18.41
Water	13835.278685	10.73	34811.3696	20.99
Rock	10585.986767	8.21	1192.77	5.92
Settlement	33859.684834	26.26	60973.3376	47.51
Total	128940.1555	100	128969.148	100

The results presented in table 4.1 represent the static area of each land use land cover category for each study year. Bare surface occupied the highest portion with 37.63% of the total area in 1999 and later was reduced to 18.41% in 2016. Settlement occupies the second highest portion with 26.26% in 1999 and increased to 47.51% in 2016. Vegetation in 1999 occupies 17.17% of the total land area, which later Decreased by 7.17% in 2016. In which rock have the lowest percentage of 8.21% in 1999 while in 2016 reduced to 5.92%, the image was acquired after the creation of the state in 1991.

On the other hand, the study further revealed that water body had increased from 10.73% in 1999, to 20.99% in 2016. Apart from this, the figures 4.1, 4.2 are the Land use Land cover maps derived from the satellite imageries of 1999 and 2016 respectively that showed different land use classes of the study area as they appeared in these years.

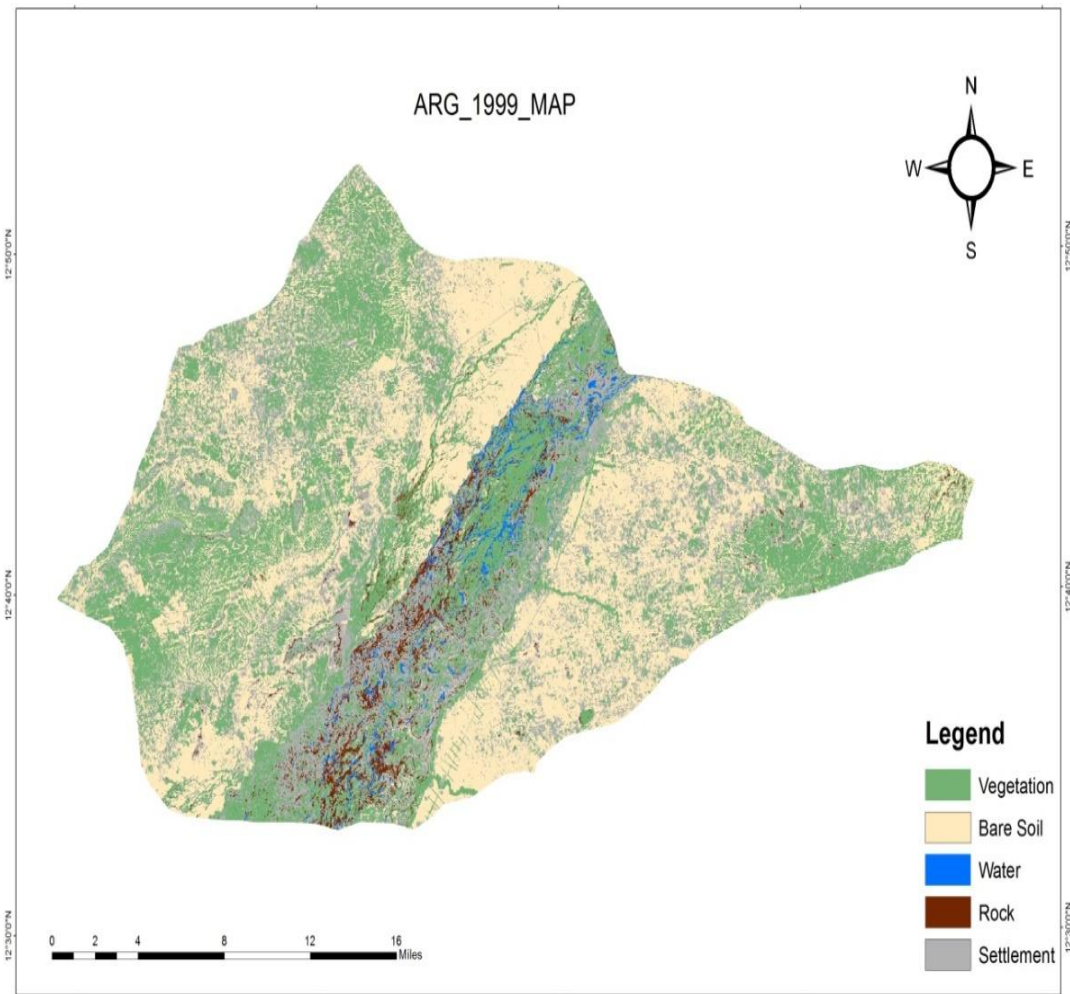


Fig 4.1: Land use Land cover Map of Argungu in 1999

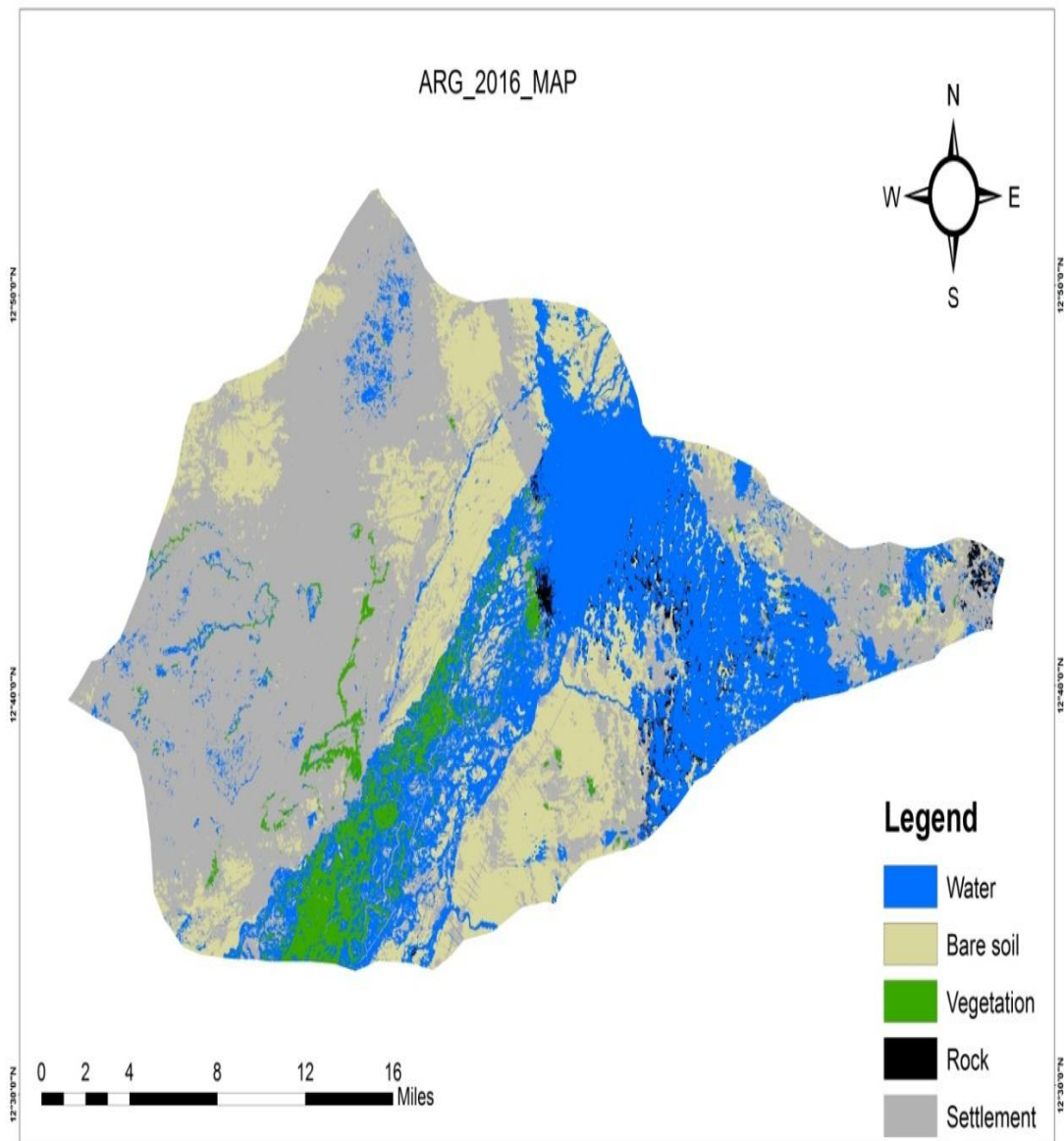


Fig 4.2: Land use Land cover Map of Argungu in 2016

4.2 Land Use Land Cover Change

The land use land cover change is presented in Hectares and percentage as shown in the tables 4.2 and 4.3 below: The results show that the static lands cover distribution for each study year that was derived from supervised classification with output classified maps was successfully presented in the classes table below.

Table 4.2 Comparison of Areas in LULC Classes of Argungu from 1999 to 2016

Land Use Land Cover	1999		2016	
Class	Area/Ha	Area/%	Area/Ha	Area/%
Vegetation	41,484.93	17.17	5,670.09	7.17
Bare Soil	48,529.22	37.63	26,321.58	18.41
Water	1,562.59	10.73	34,811.37	20.99
Rock	3,521.42	8.21	1,192.77	5.92
Settlement	3,3841.99	26.26	60,973.34	47.51
Total	128940.15	100	128969.15	100

Table 4.3 Rates of Changes in LULC Classes of Argungu between 1999 and 2016.

Land use land cover	Change Detection		Result
Class	Ha	%	
Vegetation	-35814.84	-10.00	Decrease
Bare Surface	-22207.64	-19.22	Decrease
Water	33248.78	10.26	Increase
Rock	-2328.65	-2.29	Decrease
Settlement	27131.35	21.25	Increase

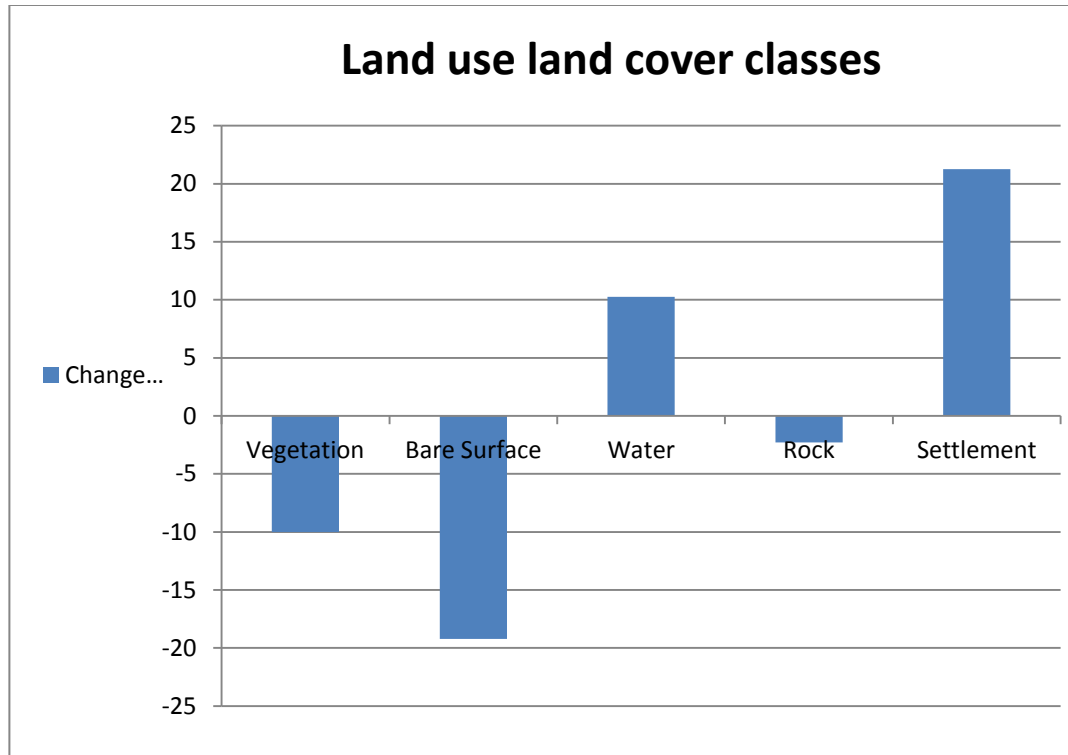


Figure 4.3: Percentage Change in the Land Cover Class. Result for 1999-2016

As can be seen from Table 4.3 and the charts results in figure 4.3 the vegetation, bare surface and rock has decreased by -10.00%, -19.22% and -2.29 % respectively. This is mainly due to the population growth and two major reasons that lead to the deforestation in the study area namely rapid urbanization accomplished with increased built-up areas and road infrastructure in the study area and extraction of fire wood for cooking. Decrease in vegetation cover was also as a result of fire wood collection for cooking and bush burning or land clearing during the periods of this study.

The rapid urbanization taken place in the area can be attributed to the commercial activities that are taken place leading to the massive relocation of people from

other places to Argungu and newly construction activities are taken place from private, commercial, and public buildings. As observed in table 4.3 Settlement and water increased by 21.25% and 10.26% which is the cause of urbanization activities that include estate developments. This is clearly indicated in figure 4.3.

4.3 Population of Argungu

It should be noted here that the projected population of Argungu in 1999 is 114,000 peoples which later massively increased by 273,000 by end of 2016, due to urbanization in the area; Table 4.4 shows the projected population figures of Argungu between 1999 and 2016

Table 4.4 Projected Population Figure of Argungu between 1999 and 2016.

Year	Population figure	Percentage %	Source
1999	114,000	29.45	Projected
2016	273,000	70.54	Projected

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

The study has examined the effect of urbanization on land use and land cover changes in Argungu with the use of remote sensing and GIS techniques as powerful tools to extract meaningful information. Two different date multispectral satellite imagery has been map out between 1999 and 2016. Results of this study indicate that, supervised classification provided satisfactory result for the effect of urbanization in Argungu. The main change observed for the period between 1999 and 2016 was the decrease in vegetation, bare surface and rock due to urbanization by 10.00%, 19.22% and 2.29% respectively, and increase in Settlement and water body by 21.25% and 10.26. From the results obtained from table 4.2 and 4.3 above, the analysis of change detection was made and was very successfully with remote sensing and GIS techniques.

5.2 Conclusion

After the study the following major findings can be concluded as follows:

- I. Urbanization has direct effect on the land use and land cover changes in Argungu base on the map results of 1999 and 2016.
- II. The Land use and Land cover changes has shown that the bare surface, vegetation, rock, settlement and water body has significant changes in which the settlement and water body increases by 21.25% and 10.26%,

while vegetation, bare surface and rock decreases by 10.00%, 19.22% and 2.29% respectively.

- III. The human population has increased by 70.54% (159,000) from 1999 to 2016.

5.3 Recommendations

- I. The trend, pattern and rate of land use land cover change of Argungu revealed that; there is a possibility of overcrowding in the near future, It is therefore recommended that encouragement should be given to people to build towards the outskirts of the city 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.
- II. 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. Current satellite imagery of 2017/2018 should be utilized for further research work in the study area.
- III. 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.
- IV. This study has made special recommendations to the physical planning authority to improve their planning activities at both technical and management level. These include:

- a) The local planning authority in the study area should improve their monitoring activities at the local government level in relation to the rates of changes that were detected in this study.
- b) The immigration agency should improve their policies in relation to the population growth in the study area.
- c) City planners should use the remote sensing data with good spatial resolution to improve their planning for development.
- d) The study has provided a different date data within the study period to decision makers for further implementations and future planning of the growing city to prevent

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