AN ASSESSMENT OF BUILT-UP EXPANSION IN USMANU DANFODIYO UNIVERSITY, SOKOTO

BY

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DECLARATION PAGE

I Musa Ibrahim Alhaji here by declare that this project is an independent work carried out by me

Signature…………………

Adm. No………………….   Date………………….

CERTIFICATION PAGE

This is to certify that this research work was carried out by Musa Ibrahim Alhaji and is here by submitted for assessment for the award of B.Sc. Degree in the department of Geography, Faculty of Social Sciences, Usmanu Danfodiyo University, Sokoto.

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DEDICATION

I dedicate this work to the glory of Allah (subhanahu wata'ala) and to the entire members of my family for their support and advice throughout the duration of my studies. Thanks.

TABLE OF CONTENT

CHAPTER THREE: RESULTS AND DISCUSSION

CHAPTER FOUR: SUMMARY, CONCLUSION AND RECOMMENDATIONS

ABSTRACT

This research project is an assessment of built-up expansion in Usmanu Danfodiyo University, Sokoto from 2007 to 2015. Data for this research project was collected from both primary and secondary sources. The primary source of data include field observation, interview and satellite imageries. While secondary data include relevant published materials such as textbooks, journal articles, dissertations, reports, and the internet. The method used is satellite image processing, image classification, overlay operations, vectorisation and digitizing. The study revealed that built-up expansion is more towards the north-east and eastern part of the study area and to some extent in the central part. From the result of analysis, it was discovered that in 2007, there are 208 structures covering 145,715 square meters. While in 2015, 50 structures were raised with an area of 92,328 square meters. The total built-up structures are 250 with a total area of 238,044 square meters. It is recommended that, the management should solicit for adequate funding in order to maintain and sustain the original master plan.

CHAPTER ONE

BACKGROUND TO THE STUDY

1.0   Introduction

Built-up means the built- up areas, while Expansion is a space through which anything is expanded (Advanced English Dictionary).

Built-up areas have been expanding throughout the world. Monitoring and prediction of the built-up is not only important for the economic development but also acts as sentinels of environmental decline important for ecologically sustainable development of a region. (ARER, 2003).

In the year 2000, urban areas occupied only about 2% - 3% of the earth's surface; However, they sheltered nearly half the world's population. The rapid expansion of urban areas, is dramatically changing the landscape of the urban-rural fringe, clearly highlighting the intensity of the ecological footprints of cities. The ecological footprint is defined as "the total area of productive land and water required continuously to produce all the resources consumed and to assimilate all the wastes produced, by a defined population, wherever on earth that land is located". Kitzes, etal (2007). The wealthy quarter of the world's population consume over three-quarters of world's resources, and of the total global resource depletion and pollution, contribution from cities is probably 70% or more. (RWWMEIA, 1996). For example, the per capital ecological footprint of North Americans is 4-5 ha/capita, which accounts for three times their fair share of the Earth's bounty. Similarly Japan's footprint is about 2.5 ha/capita and the Netherland's is 3.3 ha/capita, accounting for about eight and is times greater than the areas of total domestic territories respectively. Lenzen and Murray found Australian's ecological footprint to be about

13.6 ha/capita, if determined in terms of actual land use on all types of land. These footprints are associated with the provision of non-farm job opportunities, shifts to higher-valued farm enterprises (such as vegetables, fruits, or livestock) to meet the demands of urban consumers.

On the other hand, the provision of environmental services and landscape amenities place heavy demands on the ecological system in terms of resource extraction, disposal of waste, and discharge of pollutants. Urbanization is mostly taking up agricultural lands and it is estimated that one to two million hectares of cropland are being taken out of production every year in developing countries to meet the land demand for housing, industry, infrastructure, and recreation. The 20th century witnessed some of the most dramatic urban transformations in the history of earth's terrestrial environments. Lenzen, etal (2007).

1.1   Statement of Research Problem

Urban environment is one of the most dynamic systems on earth and rapid urbanization has been a major development in most parts of the world. The effects of urban concentration become noticed in the 19th century with the alarming rate of urban population, and this trend continues. (De Sherbinin etal, 2002) noted that several decades of accelerating urban growth have exerted profound environmental socio-economic impacts felt in every parts of the world. The continuously growing population culminates in overcrowding resulting in pressure on the land and, consequently, becomes a burden to limited civic cycle amenities forcing the "middle class" as well as the builders to move to outlying suburbs, a phenomenon called urban growth or sprawl.

The European Environment Agency (2006) likened urban sprawl to unplanned, incremental urban development, characterized by low-density mix of land uses on the urban fringe. It is the

physical pattern of low –density expansion of large urban areas mainly in to the surrounding agricultural areas. Burak and Karen (2008) identified three phases of urban growth and develop scenarios to evaluate the impact of urban growth on several environmental indicators: land use, air quality, and demand for water and energy.

Unchecked and unmanaged urban growth has been attributed to lack of adoption of efficient and effective urban planning tools, sustainable development is often proposed. UN-Habitat (2008) presented global report on planning sustainable cities, which reveals that developed countries have adopted some innovative approaches in recent decades for achieving a sustainable urban environment. Among such approaches are strategic spatial planning, use of spatial planning to integrate public sector functions, new land regularization and management approaches. However, contrary is the case in developing countries where older forms of master planning still persist. This approach fails to accommodate the ways of life of the majority of the inhabitants in rapidly growing and largely poor and informal cities. It has not been flexible to planning spatial structures of the cities which have enhanced the unbridled expansion of cities as well as laxity of monitoring and evaluation of urban plans. This have over time often directly contributed to social and spatial marginalization. Likewise in some areas they could not even follow the guide line provided by the master plan, which in return may result to so many environmental problems, such as flooding, pollution, climate change and land degradation all of which can be happen as a result of building on where it is not supposed to be for example on a drainage line, refuse dump places and in a shelter belt or forest reserves.

Usmanu Danfodiyo University Sokoto is one of the oldest tertiary Institution in the northern region, since it was founded in 1975, it is always increasing both in terms of the student population and staff strength which necessitate the expansion of buildings.

11

In considering the research problem of the study area, there is the poor implementation process of the original master plan in the University where only 52% of the building structures are implemented which corresponded or tally to the original master plan (Zayyanu 2015), this occurred as a result of insufficient funding of capital project and also the increase in population which could linked to increase in number of the student's enrolment. This common phenomena lead to the deviation of some structures from their original locations due to lack of funds to compensate settlers of some surrounding villages within the study area. However, insufficient fund also made it difficult to construct buildings far away from academic core area as these buildings cannot be link to amenities like water and electricity supply. Among the deviation areas are old Faculty of Management Sciences now Mathematics Department, Mini Market, and Faculty of Education among others.

It is in view of the foregoing that, the research work will be conducted to assess the extent of built-up expansion in the area using remote sensing and GIS application as a tool.

1.2 Aims and Objectives

The aim of this study is to assess the built up expansion in Usmanu Danfodiyo University Sokoto for sustainable development.

The specific objectives in this study include;

1. To determine the trend and direction of built-up expansion in the permanent site of Usmanu Danfodiyo University, Sokoto

 2. To identify the deviation of built-up in relation to the original master plan

1.3 Research Question

It is believed that the expansion of the University could be linked to socio-economic determinant of the management, students, employees, as well as the people living (settlers) within the campus. It is in view of these that the study seek to find answers to the following research questions;

1. How does the built up expansion contributes to the overall development of the University?

2. To what extent did the built-up expansion conformed with the master plan?

3. What is the direction of built up expansion?

1.4 Justification of the Study

Remote sensing is a means of non-contact data capture and GIS is a tool for data management. The integration of both systems provides effective and efficient tool for urban planning and management. For instance, Shupeng, etal (2000) integrated remote sensing and GIS application in analysis of urban growth in china. They emphasized the early application of remote sensing to environmental monitoring and resources investigation and its achievements in china since the early 1970s.

However, this study focus on the assessment of built-up expansion in Usmanu Danfodiyo University Sokoto. Therefore, this study tend to incorporate an integrated approach of Geographic Information System (GIS) and Remote Sensing (RS) techniques. Similar studies conducted in the study area which did not explore the use of these spatial technology includes; An Apraisal of the Usmanu Dan Fodiyo University Sokoto Master Plan from 1980 to 2004 by Zayyanu (2005), Growth and Expansion of Dandima Area by Zainaf (2005), Land Use Pattern

and Soil Characteristic in Villages Around Usmanu Danfodiyo University Sokoto by Bara'atu (2008).

1.5 Scope of the Study

The scope of the study covers Usmanu Danfodiyo University Sokoto, comprising all Faculties, Libraries, Lecture Halls, Research Centers, V.C Complex, V.C Quarters, and Students Hostel as well as surrounding settlements.

The study emphasizes on built-up expansion in Usmanu Danfodiyo University Sokoto from 2007 to 2015.

1.6 Significance of Study

The output data analysis of this research work will aid the school management, government and stake holders in the following ways;

1. Aid decision making processes and implementation strategies for rapid development of infrastructures, facilities, and intensive expansion of built-up land.

2. To identify the location of newly built faculties, Departments, Lecture halls, research centers and Library among others facilities in line with the institution master plan.

3.To make futures predictions on the growth and development of the Usmanu Danfodiyo University Sokoto.

Other students and researchers will benefit immensely from these studies since it provide the data and information regarding to the impact of the expansion of the University.

1.7   Study Area

Usmanu Danfodiyo University Sokoto (UDUS) formerly University of Sokoto, is one of the initial twelve federal Universities in Nigeria founded in 1975. It is in the ancient city of Sokoto. The school is named after Usmanu Dan Fodio, the founder of the Sokoto Caliphate. It currently has ten Faculties (Agriculture, Arts, Education, Law, Management Sciences, Social Sciences, Medical College, and Veterinary Sciences. In addition, it has a Postgraduate School and four research centers (Centre for Islamic Studies, Centre for Hausa Studies, Centre for Energy Research, Centre for Environmental Studies and Centre for Peace Studies). Its Students come from across Nigeria and West Africa.

1.7.1   Geographical Location

Usmanu Danfodiyo University Sokoto is located between latitudes $13^{\cdot} 07^{I} 41.094^{II}$N and longitudes $5^{\cdot}1^{I}54.055^{II}$E respectively. The Usmanu Danfodiyo University Sokoto lies to the north west part of Sokoto State and share its borders with 'Yar Kanta village to the north, Sokoto rima-river to the south, Makera and Gidan yaro villages to the West, and Sokoto-Gwadabawa-Ilela Border Road to the East, all of which are fall in Wamakko Local Government in Sokoto, Sokoto State.

1.7.2   Physical Characteristics

The topography of the study area is dominated by the famous dissects plain and provides the rich alluvial soil fit for a variety of crop cultivation in the area. There are also isolated hills and mountain ranges scattered all over the area.

During the cold season; the climate is dominated by hamatten wind blowing sahara dust over the land. The dust dims sunlight, thereby lowering temperatures significantly and also leading to the inconvenience of dust everywhere in the area. While in the hot season however, the maximum daytime temperatures are generally under 40˙C (104.0˙f) in most of the year.

In terms of Vegetation, Usmanu Danfodiyo University falls within the Savanna zone. This is an open tse-tse fly-free grassland suitable for cultivation of grain crops and animal husbandry. Sokoto Caliphate: (phD. Thesis) A S. A.B.U Zaria.

1.7.3   Climate

Usmanu Danfodiyo University Sokoto is in the dry sahel surrounded by sandy savannah and isolated hills. With an annual average temperature of 28.3˙C (82.9˙f), it is one of the hottest area in the world. The warmest months are February to April, where daytime temperatures can exceed 45˙C (113.0˙F). The highest recorded temperature is 47.2˙C (117.0˙f), which is also the highest recorded temperature in Nigeria. The rainy season is from June to October, during which showers are daily occurrence. The showers rarely last long and are far cry from the regular torrential showers known in many tropical regions. From late October to February, during the cold season, the climate is dominated by the harmattan wind blowing sahara dust over the land. A Brief History and Geography of Sokoto State, Retrieved (2007) by Abubakar S.

The area's lifeline for growing crops is the floodplains of the Sokoto-Rima River System, which are covered with alluvial soil. For the rest, the general dryness of the area allows for few crops, millet perhaps being the most abundant, complemented by maize, rice, and other cereals and beans. Apart from tomatoes, few vegetables grow in the area. The low variety of foodstuffs, available has resulted in the relatively dull local cuisine.

Rain starts late and end early with mean annual rainfall ranging between 500mm and 1300mm there are two major seasons in the area, namely wet and dry. The dry season starts from October, and lasts up to April in some times it may extend to May or June in other times. The wet season on the other hand begins in most of the time in May and lasts up to September or October. The harmattan, dry, cold and fairly dust wind is experience in the area between November and February. Heat is more severe in the area in March and April. But the weather in the area is always cold in the morning and hot in the afternoons, save in peak harmattern period. Abubakar S. (2007).

The topography of the area is dominated by famous Hausa plain of northern Nigeria. The vast fadama land of the Sokoto-Rima River Systems dissects the plain and provides the rich alluvial soil fit for a variety of crops cultivation in the area.

1.7.4   Population

Usmanu Danfodiyo University, Sokoto. As at 2012 it had a total population of 17,969 undergraduate students, 2155 postgraduate students, 1248 sub-degree students and 1336 pre-degree students, giving a total students population of 22,708. The University at present runs about 155 post graduate programmes (49 PhD, 26 MPhil, 65 Masters' programmes and 15 post graduate diploma programmes). End of Tenure Report (2014).

The staff strength of the University rose from 48 (academic, technical and administrative) in 1977 to 942 academic staff on various appointments (full-time, sabbatical, contract or visiting) and about 2000 others (administrative and technical) in 2012. End of Tenure Report (2014). Usmanu Danfodiyo University, Sokoto indeed, is one of the most cosmopolitan campuses in the country, drawing its staff and students from across the country and neighboring countries. In

addition, international scholars from African as well as other part of the world either on full-time appointment or short visits through the University's wide range of linkages and collaborations with institutions around the world also form part of the available staff in the University

Students constitute a major part of the University system and therefore, students' enrolment is quite important in the sustainability of any institution. Statistics shows the details on students distribution, students staff ratio, graduation rate and classes of degree obtained by graduates of the University between 2005/06 and 2013/14 sessions. It is clear that the population of students in the University for the period improved from 13:1 to 8:1, which indicates a significant increase in the number of staff when compared to students enrolment.

In the same vein, every state of the Federation and the capital Territory is represented in the student population of UDUS while international students constitute 1.13% of the entire students body.

In terms of staff population also statistics shows that, at present, there is total of 1113 academic staff on various appointments in the University compared to 760 in 2010 to 2011 session giving an increase of 31.7%. Similarly, the strength of other categories of non-academic staff increased in order to meet up with the academic and administrative support services in the University due to enormous expansion in academic programmes, infrastructure and facilities. End of Tenure Report (2014).

1.8   Material and Methods

This section provide details of the step by step approaches for the research project. It tend to discuss the data collected, processing and method of analysis.

An integrated approach of remote sensing (RS) and geographic information system (GIS) techniques as well as statistical methods are used to assess the built-up land expansion patterns in the area.

1.8.1   Materials and Softwares

Among the materials and software to be use in this study, include the following;

1. Microsoft word

2. Microsoft excel

3. ArcGis 9.3

4. Ilwis 3.6

5. Satellite imageries

6. Global Positioning Systems (GPS)

7. Lap Top

1.8.2   Types and Source of Data

For the purpose of this research, two types of data were used. These are primary and secondary data. Primary data includes, field observation, structured questionnaire, and interview were used, while the secondary data was collected from relevant published materials such as textbooks, journal articles, dissertations, satellite imageries, maps, reports and the internet

The characteristics of some of the data to be used in this study are indicated in table 1.

Table1. Data types and sources

S/N	Data	Resolution	Scale	Year	Sources
1	Landsat	30m	N/A	2000 and 2012	NARSDA
2	Topographic Map of Sokoto sheet 10 NE/NW	N/A	1:50,000	1969	Survey Department, Sokoto
3	Administrative Map of Nigeria	N/A	1:25,000	N/A	OSGOF
4	Spot 5	10m	N/A	2012	RECTAS

Source: Author Field Work.

1.8.3 Method of Data Analysis

The data obtained will be analyzed and presented in Maps, simple percentages, and tables. Satellite image processing will include classification to obtain land use land cover, digitizing, overlay analysis, and vectorisation. Responses and views obtained from the interview will be tabulated for easy reference.

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┌─────────────────────────────────────────────┐
│   Data Acquisition (Satellite Images/Maps)  │
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│  Data Enhancement, Processing and Registration │
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│  Classification/Digitizing/Satellite Images/Map) │
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  │Built-up│─│Roads │─│Open Space│─│Vegetation │─│ Settlement │
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                  │ Ground Truthing│
                  └───────────────┘
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                  │ Final Maps Production │
                  └───────────────────────┘
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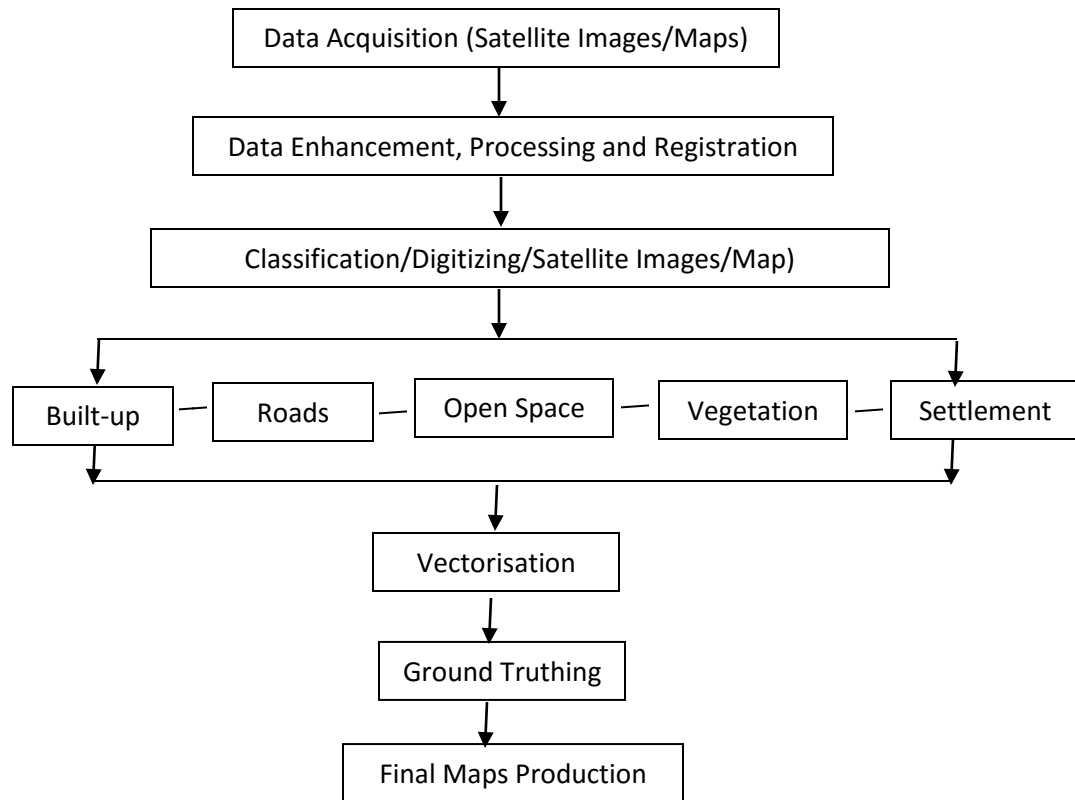
Fig. 1: Work Flow Diagram

Some of the method of data analysis such as Image Processing, Image Classification, overlay operations, vectorisation, and digitizing are discussed in brief as follows;

- **Image Processing** this is the processing of images using mathematical operations by using any form of signal processing for which the input is an image, such as photograph or video frame; the output of image processing may be either an image or a set of characteristics or parameters related to the image. Most image-processing techniques involve treating the image as a two-dimensional signal and applying standard signal-processing techniques to it. Joseph P. (2002).

- **Image Classification** refers to the task of extracting information classes from a multiband raster image. The resulting raster from image classification can be used to create thematic maps. There are two types of classification depending on the interaction between the analyst and the computer during the classification, these are;

(a)- Supervised and (b)- Unsupervised. With the ArcGis spatial Analyst extension, there is a full suite of tools in the multivariate toolset to perform supervised and unsupervised classification. ECS (2007).

- **Digitizing** is the representation of an object, image, sound, document or a signal (usually an analog signal) by a discrete set of its points or samples. The result is call digital presentation or, more specifically, a digital image, for the object, and digital form, for the signal. Strictly speaking, digitizing means simply capturing an analog signal in digital form for a document the term means to trace the document image or capture the "corners" where the lines end or change direction. Mc (2000).

  Mc Quail identifies the process of digitization has immense significance to the computing ideals as it "allows information of all kinds in all formats to be carried with the some efficiency and also intermingled".

- **Vectorisation** this may refer to (parallel computing), converting a computer program from a scalar implementation to a vectorized program. While in computer graphics including image processing vectorizationn or image tracing is the creation of vector from raster graphics. Wikipedia.

- **Overlay Operation**, overlay is a GIS operation in which layers with a common, registered map base are joined on the basis of their occupation of space.

  The overlay function creates composite maps by combining diverse data sets. The overlay function can perform simple operations such as laying a road map over a map of local wetlands, or more sophisticated operation such as multiplying and adding map attribute of different value to determine averages and co-occurrences. Keith C. (1997).
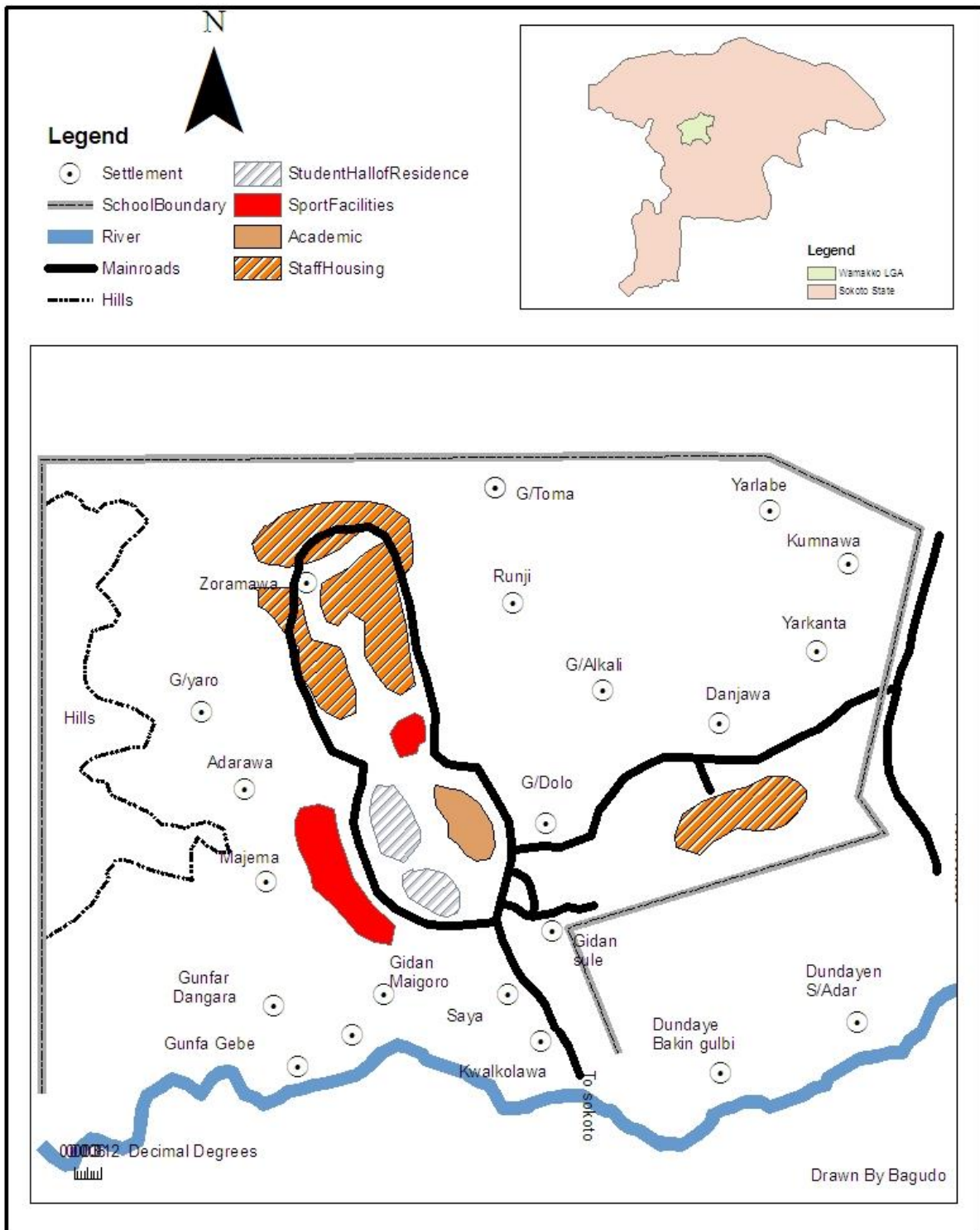
Source: GIS Lab, Department of Geography UDUS.

Fig. 2: Map of the Study Area.

CHAPTER TWO

LITERATURES REVIEW

2.0   Introduction

In this chapter related literatures on built-up expansion are to be discussed. In general term built-up expansion refers to the processes in which area is being expanding over the land surface of the World (Wikipedia).

In the year 2000, urban areas occupied only about 2% - 3% of the earth's surface; however, they sheltered nearly half of the world's population. The rapid expansion of urban areas, is dramatically changing the landscape of the urban-rural fringe, clearly highlighting the intensity of the ecological footprints of cities. Lambin and Lepers (2003).

2.1   The Implication of Built-up Expansion on Ecological Footprints

The ecological footprint is defined as "the total area of productive land and water required continuously to produce all the resources consumed and to assimilate all the wastes produced, by a defined population, wherever on the earth that land is located". The wealthy quarter of the world's population consume over three-quarters of world's resources, and of the total global resource depletion and pollution, contribution from cities is probably 70% or more. For example, the per capital ecological footprint of North Americans is 4-5 ha/capita, which accounts three times their fair share of the Earth's bounty. Similarly Japan's footprint is about 2.5 ha/capita and the Netherland's is 3.3 ha/capita, accounting for about eight and is times greater than the areas of total domestic territories respectively. Lenzen and Murray found Australian's ecological footprint to be about 13.6 ha/capita, if determined in terms of actual land use on all types of land.

These footprints are associated with the provision of non-farm job opportunities, shifts to higher-valued farm enterprises (such as vegetables, fruits, or livestock) to meet the demands of urban consumers. Wintle and J.M (2005).

2.2   The Effect of Built-up Expansion on Agriculture

The provision of environmental services and landscape amenities place heavy demands on the ecological system in terms of resource extraction, disposal of waste, and discharge of pollutants due to built-up expansion is mostly taking up agricultural lands and it is estimated that one to two million hectares of cropland are being taken out of production in every developing countries to meet the land demand for housing, industry, infrastructure, and recreation. The 20th century witnessed some of the most dramatic urban transformations in the history of earth's terrestrial environments. Wang et al. (2009).

2.3   The Impact of Built-up Expansion on Population Growth and Socio-Economic Aspects

Urbanization is a complex process that not only caused profound changes in cultural, sociological, and economical aspects but also caused significant changes in ecological, Population and environmental aspects. Weber et al. (2003). Since the end of World War II, population growth and economic expansion have been the primary drivers of land use/land cover (LULC) change associated with urbanization worldwide, especially in developing countries that have an increasing desire for prosperous economy. Wang et al. (2009). Globally, with ongoing urbanization, a large population is inclined to concentrate in urban areas. It is estimated that more than 50% of the world's population lives in urban areas, and the projected proportion of urban population will reach 69.6% by 2050. United Nations (2010). Given the importance of

urban growth, LULC, and their long-term adverse effects on ecological functioning, modeling LULC and urban growth has been greatly emphasized. Geymen and Baz (2008). As the largest developing country in the world, China has recently experienced unprecedented economic growth and rapid urbanization since 1978. The country's total number of cities increased from 193 in 1978 to 660 in 2008, and its urban population rapidly increased from 172.45 million to 606.67 million. CNBS, (2009). Today, many large cities in the coastal economic zone, which are the preferred destination for millions of internal migrants and overseas investors, have been the locomotives in propelling China's economic growth. Chen et al. (2000). However, with rapid development of the economy and urban expansion, the accompanied ecological deterioration and economic loss have been pronounced in these hotspots. Wang et al. (2006). Therefore, the sustainability of environmental and economic systems for these large cities has attracted much attention. As documented, in the field of land use and socio-economic development, there have been thousands of significant journal papers related with China's cities. For example, more than twenty papers on land resources exploits and sustainability of China's cities have recently been published in Applied Geography. Su et al. (2011) and Wang et al. (2006).

2.4 The Effect of Built-up Expansion on the Surface Temperature of the Earth

Urban development usually gives rise to a dramatic change of the earth's surface, as natural vegetation is removed and replaced by non-evaporating and non-transpiring surfaces such as metal, asphalt and concrete. This alteration will inevitably result in the redistribution of incoming solar radiation, and induce the urban-rural contrast in surface radiance and air temperature between an urban and its surrounding rural areas. Given the relationship between surface radiant temperature and the texture of land cover, the impact of urban development on surface temperature in the area can be assessed. Nichol, (1994).

2.5   The Implication of Built-up Expansion on Geomorphology

Urbanization and urban growth has been considered as one of the essential indicators of economic growth and development of a country. This process of urban expansion has brought about significant changes in landscape pattern and land cover of the area concerned. At the same time it has cause various negative effects in terms of physical environment such as loss of agricultural land, surface and groundwater depletion, changes in geomorphic features, flooding, and landslides. With the increase of population day by day it has become inevitable to adopt proper urban planning to attain a sustainable environmental stability of an area. Rapid growth of urbanization along with poor planning and unregulated industrial activities cause contamination surface as well as groundwater. In urban geomorphology man acts as physical process to change the natural terrain to cityscape. Urban geomorphology is the surface component of urban geomorphology and forms the important subfield of environmental geology. Towns and cities are mostly expanded in accordance to the relief of the terrain and the relief changes as per the planning and needs of construction. The other factors that influenced the geomorphological process in the building stones due to air pollution. Anthert was of the opinion that settlement geography is incomplete without taking in to consideration the morphology and hydrology of an area. Anthert, (1997).

There is a need to understand the dynamic interaction between the different aspects of urban expansion as expansion of built-up area. Construction activities over natural features which cause diversion and destruction of aquifers, and the specific geomorphic features of the urban area. The streams become overloaded with sediments and thus change the courses. The groundwater supply of the urbanized area also gets reduced and as a result drainage frequencies increase. The local landforms or geomorphic features have played a very crucial role in the

establishment of settlement in the history or civilization. A settlement to flourish has always taken advantage of local topography or relief and the hydrological condition. The expansion of a city cover the years and the construction activities gradually alter the topography of the area. These changes Ultimately affect the rate of geomorphic process such as weathering and erosion. D.Coates, (1976).

2.6   Environmental Impact of Urban Expansion

The growth of cities can have significance impact on the surrounding environment.   According to Myers (1990) the effects of urban expansion can be seen in the following ways;

- **Air Pollution:** One of the most obvious differences between an urban and a rural area is the air quality, due to large part of heavy motor vehicle traffic, and also to energy production. A blanket of smog hangs over many cities. Thus polluted air, in addition to being quite ugly, also poses a public health problem.

- **Water Issues:** When area is urbanized, the water cycle in the area changes dramatically. First of all, cities have more precipitation than surrounding areas with pollutants and convection current serving as magnet to rain drop formation. A waterfall, instead of being absorbed by soil, is channeled in to run-off system picking up ground pollutants along the way. This pollution is added to that brought about by industrial waste and sewage disposal, which is often untreated, especially in cities of the developing world.

- **Destruction of Habitat:** The conversion of natural area to an urban area means the destruction of whatever was there previously. When wetlands, for example, are paved over an ecosystem is lost, and any species dependent on that ecosystem die

out in the area. A less drastic example is that erosion valleys tend to contain fertile top soil, which tends to get washed away if the valley is urbanized.

2.7   Health and Environmental Impact of Urban Expansion

Urban sprawl is associated with a number of negative environmental and public healthy outcomes with the primary result being increasing dependence on automobiles.

However, this is mitigated significantly with nearby development of shopping and recreational areas. Also many people prefer to live close to their place of business which increasingly centered less ground urban areas.

- Increased pollution and reliance on fossil fuels

- Increased in traffic and traffic related fatalities

- Increased personal transportation cost

- Increased infrastructure cost

- Increased obesity

- Decreased in land and water quality and quantity

- Decreased in social capita.

2.8   Environmental Impact of Urban Expansion on Biodiversity

During the last century, the erosion of biodiversity has been increasingly observed; some studies show that about one eight known plant species was threatened with extinction. Some estimates put the loss at up to 140.000 species per year (based on special-area theory) Butler (2008).

The factors that threatened biodiversity have been variously categorized. Jared Diamond described an "Evil Quarter" of habitat destruction, overkill introduced species, and secondary extensions.

Wilson (1975) prefers the acronym Hippo, standing for habitat destruction, invasive species, pollution, population, and over harvesting.

2.9 Usmanu Danfodiyo University, Sokoto Master Plan

The Usmanu Danfodiyo University, Sokot master plan was written by Archeon, Norman and Dawbarn in 1977, which provide the philosophy, concept and model for physical development of the University. The guiding philosophy of the plan is to purposefully integrate the town grown Iliya and Zwal (2000).

There are two principles used to define the concept in the master plan, these two guiding principle include;

a. The Kandoli Shela stream is taken as the backbone of the plan i.e. to have development on the both sides with a system of cross movement linkages. The stream divide the University into almost two equal halves east and west which will provide or create conducive atmosphere for learning throughout the seasons, its fadama provide good vegetation which consist of fruit trees and prospect to grow a wide range of vegetables. The environment will form the basis of experiments for the science and agriculture faculties: this is because the environment is important for the growth of cassava, sugar cane, coco yam among others.

b. The strategy of zoninng is applied to allocate land uses for various parts of the campus, given a close link between the University and township using a new access road. In all

there are four principal zones proposed by the planners, which include the academic core, student's halls of residence, staff housing and sports area. There are also three other small zones, these are; the University farm, maintenance base and town Centre.

2.10   The Land Use Plan of the Usmanu Danfodiyo University, Sokoto

Land use competition is a principle which recognizes that a given peace of land can normally be put into a number of uses, and that if decision makers are deciding which uses to put the land in to Giwa A.B. (1977). The Usmanu Danfodiyo University, Sokoto has a total land area of nearly 6,000ha of land, which is located in the north-west of the Sokoto town across the Rima valley system. The land is being used in different ways ranging from residential, commercial, open space, recreational, institutional among others Field course (2004).

The current study focuses on the built-up expansion in Usmanu Danfodiyo University, Sokoto (UDUS) which is one of the initial twelve federal Universities in Nigeria founded in 1975. It is in the ancient city of Sokoto. Due to its advantageous location, international recognition, peaceful nature of the state as well as its ranking as the most peaceful University in the country.

However, for better understanding of this study and in other to fill in the gap in previous   work, a review of related literature has been carried out. These includes, An Assessment of Urban Expansion; A case study of Bodinga Town by Lawal, (2008), Environmental Impact of Urban Expansion on Biodiversity; A case study of Gidan Igwai by Rukayat, (2008) and Appraisal of Usmanu Danfodiyo University Sokoto Master Plan from 1980 to 2004 by Zayyanu, (2005).

Some of the findings of these literatures have been taken into cognizance. As in the work of Zayyanu (2005) where he stated that, "the University has a total land area of nearly 6000 ha of land. This is located in the north-west of Sokoto town across the Sokoto Rima Valley. The land

use of the study area is in different zones, these include; the academic core, student facilities, sport facilities, staff housing, University farm, town centre, maintenance base, land scaping and campus infrastructures. Finally, from all the total land area only 35% of the land was put to use, while the remaining 65% of land remain unconstructed or unused".

It was also clear in the work of Lawal (2008) where he stated that "the expansion of Bodinga town has been assessed in relations to a number of variables which include among others; educational attainment of respondents, facilities in the study area, source of water, social services available and industries. Other variables include institutions, settlement types, road types, recreational centers, the direction of expansion of the town as well as the major reasons behind the expansion. More so, shopping centers, the extent of its expansion between 1960s and 2000, reasons behind the transition as well as farmland location, major contribution to the town, were some of the variables.

Traffic congestion is experienced only on market days when a lot of people converge into the market. Noise nuisance is a problem encountered especially to the people who are very close to roads as there is a secondary road that goes through the town and both cars and Lorries are crossing the road day and night. Pollution was mainly due to emission of carbon monoxide per household and Automobiles. Population coupled with migration has contributed significantly to the expansion of the settlement".

However, Rukayat (2008) also mentioned that "Biodiversity is only known to the public as vertebrate animal and flowering vascular plants when in fact there exists 20 times that number of flora and fauna species such as insects and microbes which are 5 times as many flowering plants. While many of these species are highly valuable to the human race, biodiversity is a very vital

component of the environment. It acts as a carbon sink which maintains the earth's temperature and prevents harmful gases from reaching the ozone layer. Most of the drugs we take come from plants species.

On the basis of the analysis conducted, it is clearly seen that urban expansion has a very great impact on biodiversity which include fragmentation of habitat and the endangering and subsequent extinction of species from the environment".

All of these researches did not explore the use of spatial technologies i.e. Geographic Information System (GIS) and Remote Sensing (RS) techniques in their work and this tend to limit.

Therefore, as a result of this that, this research work tend to incorporate an integrated approach of Geographic Information System (GIS) and Remote Sensing (RS) techniques so as to bridge the gap left by the other researchers.

CHAPTER THREE

RESULTS AND DISCUSSION

3.0   Introduction

This chapter deals with the presentation and discussion of the data collected during the field work. The chapter is divided in to two sections, the first section deal with the trend and direction of built-up expansion in the study area (Usmanu Danfodiyo University, Sokoto) and the second section is to identify the deviation of built-up in relation to master plan in the study area.

3.1   The Trend and Direction of Built-Up Expansion

There is a great expansion of built-up in the study area. This expansion is concentrated more toward the north-eastern part of the study area as well as a potion of the central part of the University i.e. Academic core, and the hostel area. This is as indicated in fig. 5 showing the extent of built-up in 2015.

For clear understanding of built-up expansion as well as the direction, four different maps where produced showing the expansion of built-up areas at different period.
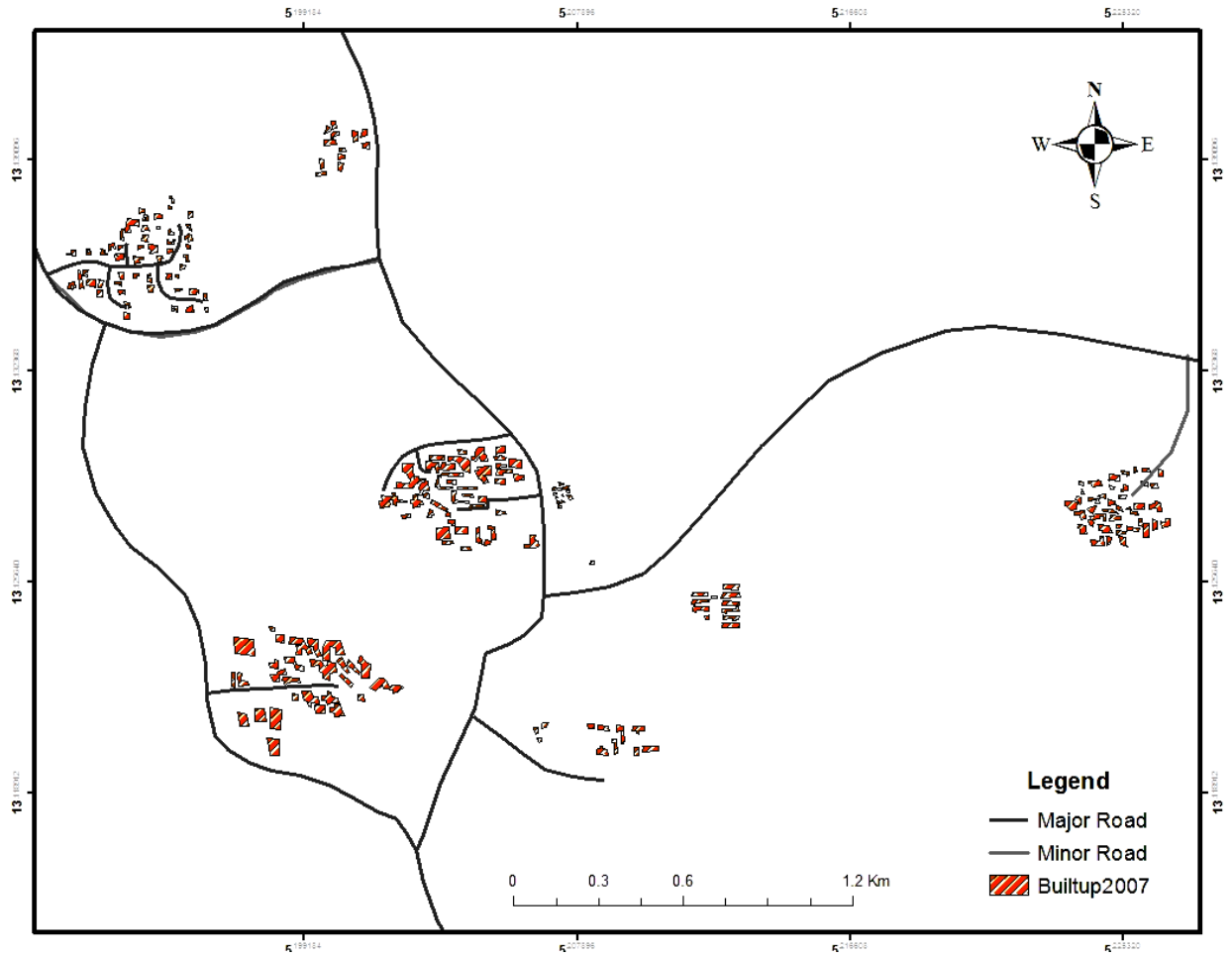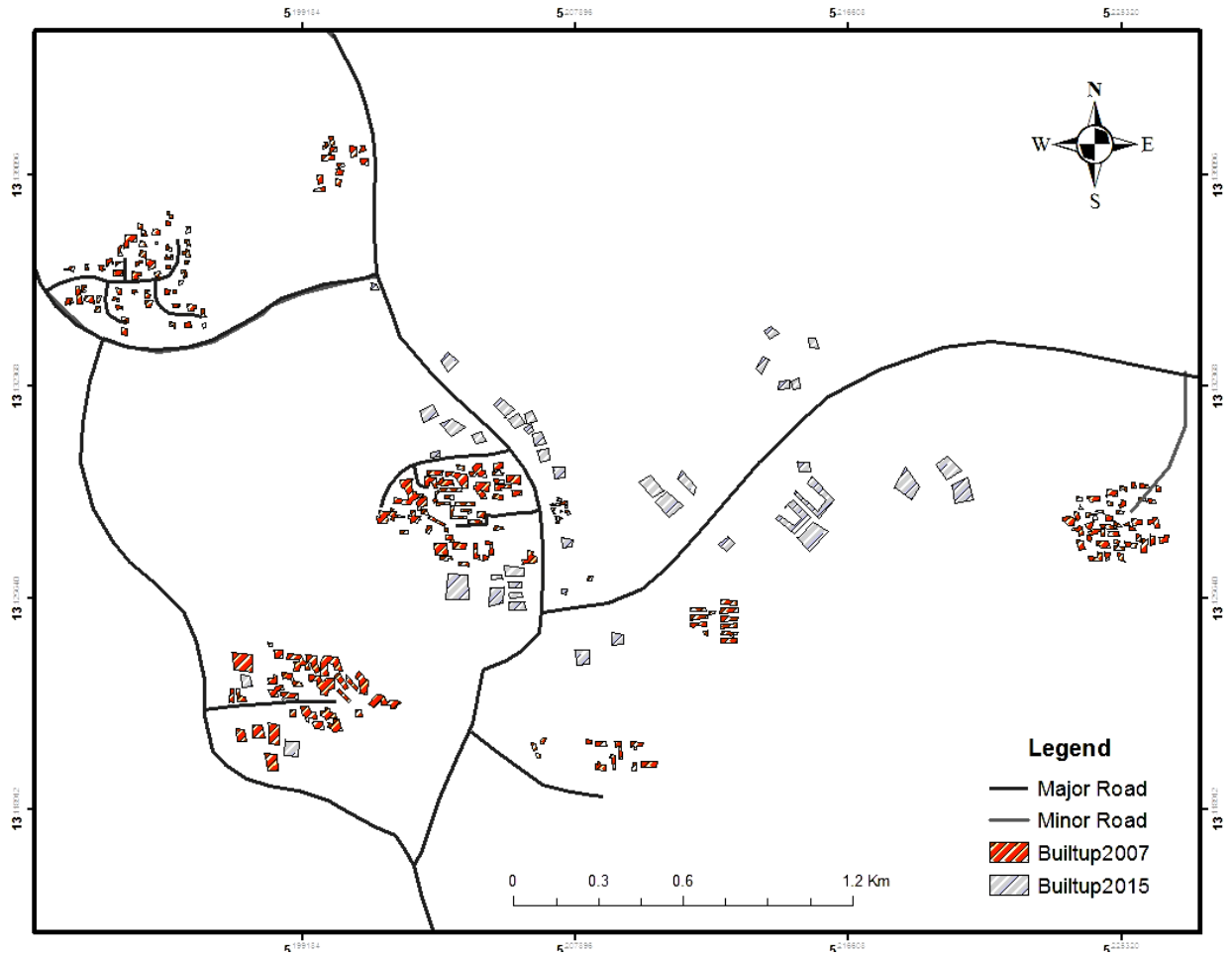
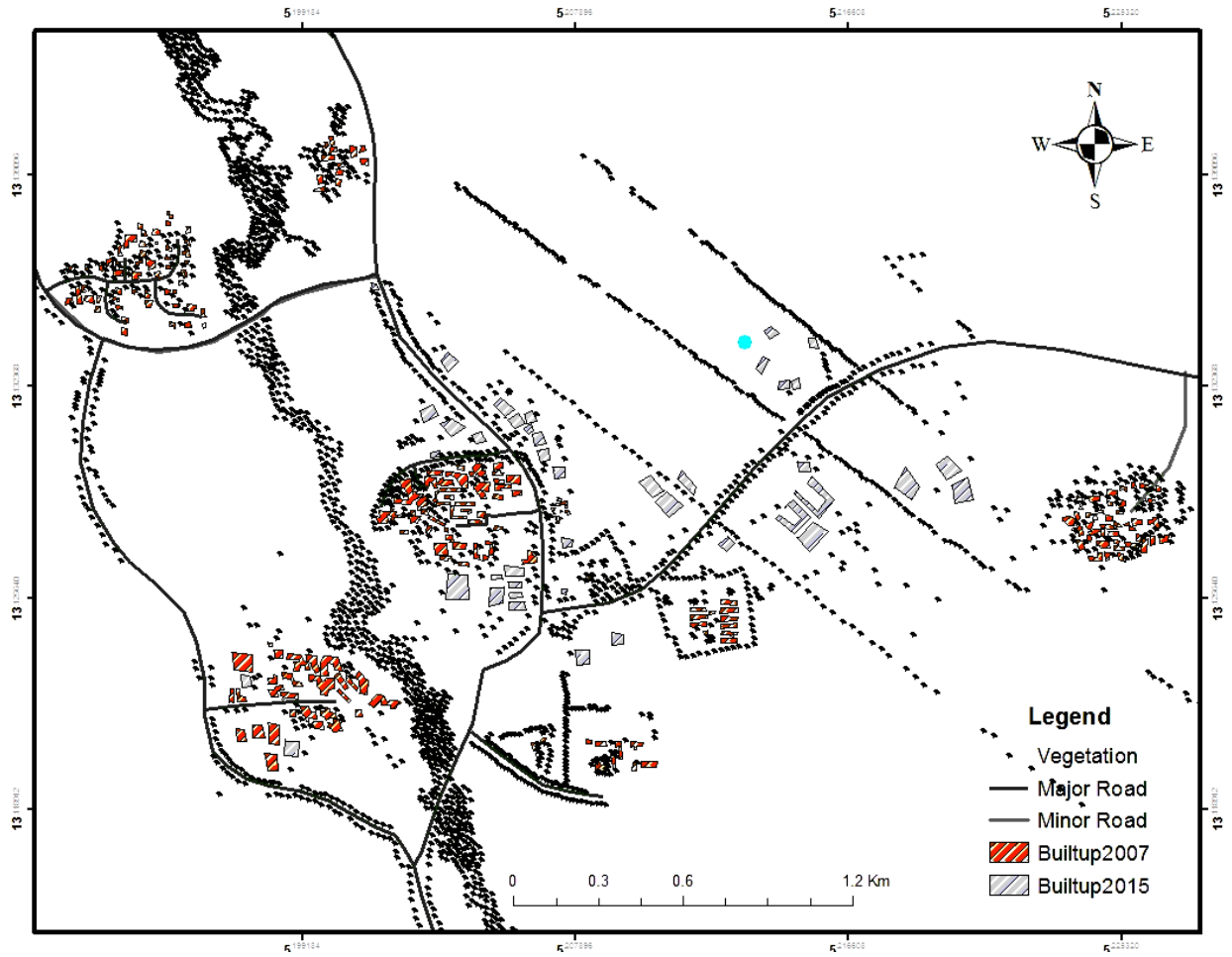Source: GIS Lab, Department of Geography UDUS.

Fig. 3: Built-up 2007.
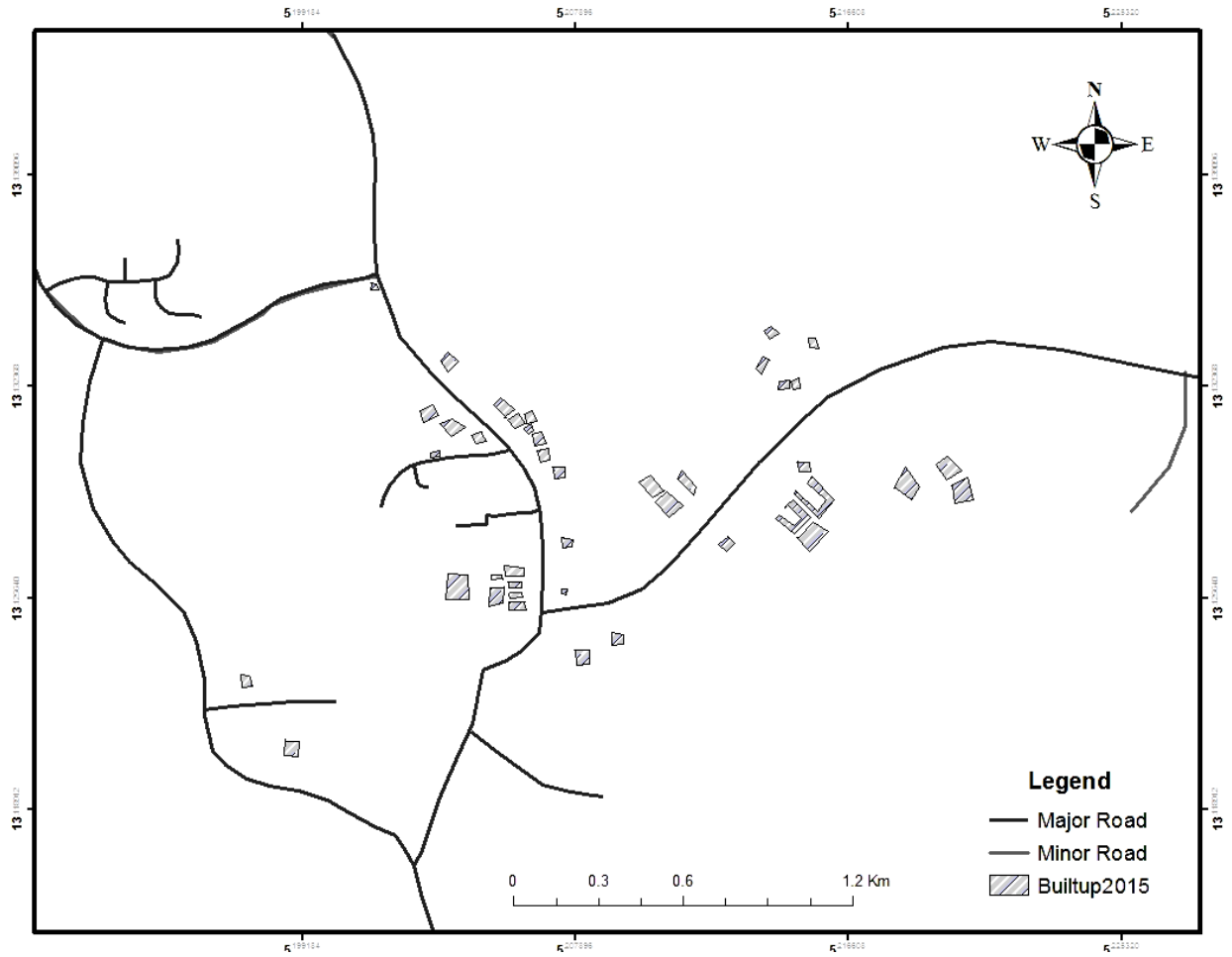
Source: GIS Lab, Department of Geography UDUS.

Fig. 4: Built-up 2015.

Source: GIS Lab, Department of Geography UDUS.

Fig. 5: Built-up 2007 and 2015.

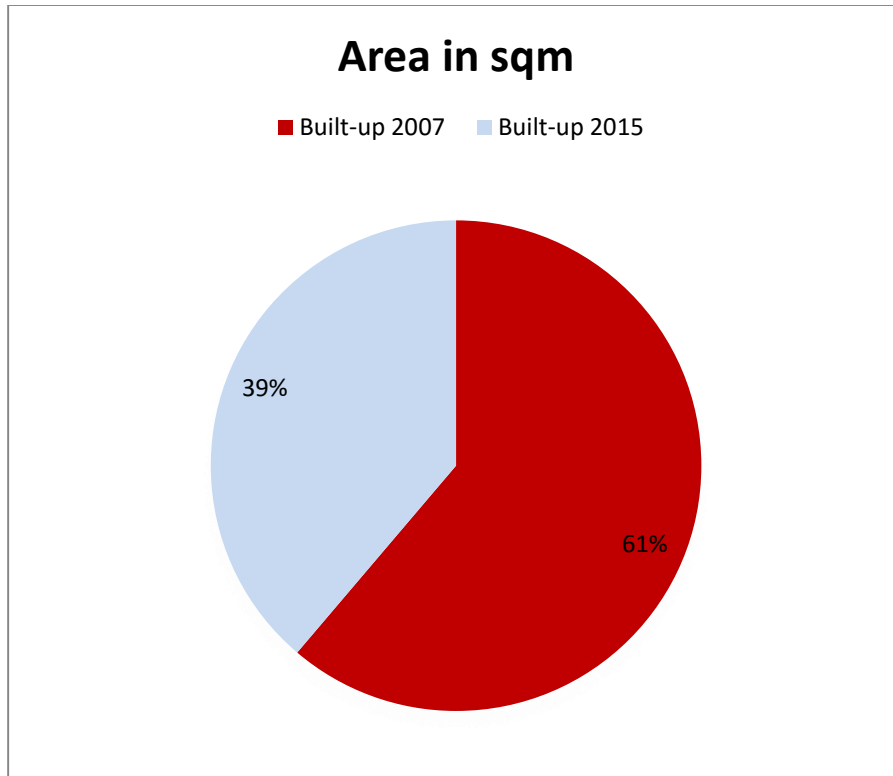Source: GIS Lab, Department of Geography UDUS.

Fig. 6: Built-up 2007and 2015.

Area in sqm

■ Built-up 2007 ■ Built-up 2015

39%

61%

Fig. 7: Pie chart Showing percentage of built-up in 2007 and 2015.

From the foregoing it can be stated that, the built-up expansion is high towards the north-east and eastern part of the university. This show that the trend and direction of built-up expansion is toward north-east and eastern ward. This is as indicated in fig. 4.

From the result of analysis, it was discover that in 2007, there are 208 structures covering 145,715 square meters. While in 2015, 50 structures were raised with an area of 92,328 square meters. The total built-up structures are 250 with a total area of 238,044 square meters.

3.2   The Deviation of Built-up in Relation to the Master Plan

In regard to the extent in which the built-up expansion conformed with the master plan, the entire physical structures design in the master plan about 50 structures found to be existing on ground these include those that are implemented, fairly implemented and those not implemented.

Table 2: The extent of implementation of the existing physical structures

S/No	Physical Structures	Total No of Structures	Percentage (%)
1	Implemented	28	56
2	Fairly Implemented	10	20
3	Not Implemented	12	24
	Total	50	100

Source: Dept. of works and services Memo (2015)
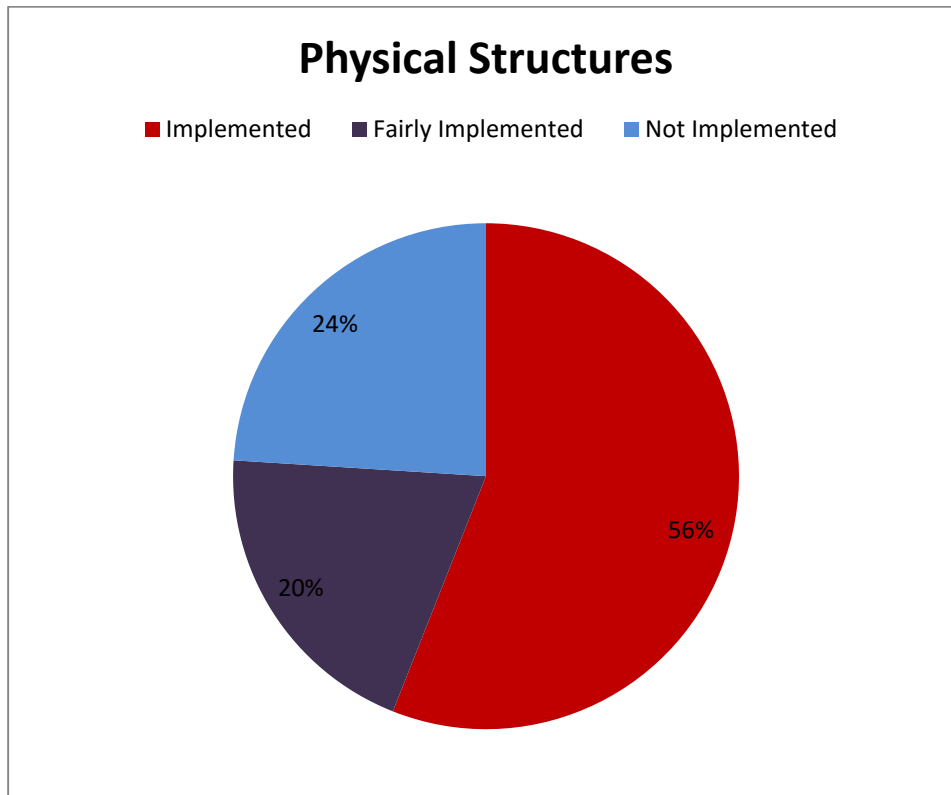
Fig. 8: Pie chart showing the extent of Implementation of the existing physical structures.

From the table and chart above, it was found that out of 50 physical structures only 38 were originally designed in the master plan. The remaining 12 structures are new development which did not conform to the master plan.

Furthermore, out of these 50 physical structures 56% were implemented, those that were fairly implemented constitute about 20% and also 24% of which are yet to be implemented. The reason for this deviation of structures from the master plan has been attributed to inadequate funding from the authority and the nature of the terrain. For example the location of the new hostel close to the new faculty of social sciences and faculty of management sciences, is not in line with the master plan.

CHAPTER FOUR

SUMMARY, CONCLUSION AND RECOMMENDATIONS

4.0   Introduction

This chapter presents the summary, conclusion and recommendations. However the primary aim of this research is to assess the built-up expansion in Usmanu Danfodiyo University, Sokoto for sustainable development. To achieve this aim the following objectives have been formulated; to determine the trend and direction of built-up expansion in the study area and to identify the deviation of built-up in relation to the master plan. These have been achieved through various process which are discussed in summary.

4.1   Summary

This research work assessed the built-up expansion in Usmanu Danfodiyo University, Sokoto. Data collected from the field was analyzed. Satellite images were processed through image classification, overlay operations, vectorisation and digitizing. The result of analysis shows that, the expansion is toward north-east and eastern part of the University permanent site.

In terms of deviation of built-up in relation to the master plan. Some built-up did not conform to the master plan as indicated in table 2 were 24% of the physical structures have not been implemented from the master plan. This is as a result of either inadequate funding or the nature of the terrain.

4.2   Conclusion

The research work assessed built-up expansion in the Permanente site of the Usmanu Danfodiyo University, Sokoto. However, conclusion can be drawn based on the findings which clearly show that, the direction of built-up expansion is concentrated towards the north-east and eastern part of the study area.

Going by the above findings, it was observed that, the extent of implementation of the school master plan was not completely adhered to. Some of the structures that are found are completely out of the main plan. These include new school library, new school clinic, and other lecture halls such as MH, NLH and Department of pure and applied Chemistry.

4.3   Recommendations

After undertaking all the necessary steps which lead to the overall findings and result, the following recommendations are proposed

- The settlement policies should be properly implemented for regional and town planning by the school management and department of works Usmanu Danfodiyo University, Sokoto.
- The school management should embark on serious environment impact assessment (EIA) before any project is fully initiated.
- The management should solicit for adequate funding in order to maintain and sustain the original master plan.

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LIST OF TABLES

LIST OF FIGURES