UNIVERSITY FOR DEVELOPMENT STUDIES

URBAN TRANSITION OF WA TOWN FROM 1986 TO 2016: A GIS PERSPECTIVE

BY

JOSEPH NYAABA AKONGBANGRE [B.A. Integrated development Studies (Environment and Resource Management Option)]

UDS/MEM/0040/14

THESIS SUBMITTED TO THE DEPARTMENT OF ENVIRONMENT AND RESOURCE STUDIES, FACULTY OF INTERGRATED DEVELOPMENT STUDIES IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF PHILOSOPHY IN ENVIRONMENT AND RESOURCE MANAGEMENT

DECEMBER, 2016

Declaration

Student

I hereby declare that this dissertation/thesis is the result of my own original work and that no part of it has been presented for another degree in this university or elsewhere:

Candidate's Signature: ……...…… Date: ……..……

Name: ……...……..

Supervisors

I hereby declare that the preparation and presentation of the dissertation/thesis was supervised in accordance with the guidelines on supervision of dissertation/thesis laid down by the University for Development Studies.

Principal Supervisor's Signature: …… Date: ……..…..…

Name: Issaka Osumanu Kanton (PhD)

Co-Supervisor's Signature: ……... Date: ……..……

Name: Gordon Nyelkabo Tuu (PhD)

Abstract

Urban transformation is one of the striking human induced phenomena in the 21st century as small settlements are gradually becoming large urban centres with significant physical transformations and functional changes. This study sought to investigate the urban transition of Wa from the last three decades and beyond. It specifically provided time series information on urban sprawl, population growth and the spatial expansion as well as land use changes and the social and economic issues that arise from the growth of Wa. This study combined conventional Geographic Information System with the accumulated local knowledge of indigenes to describe the urban transition process and explain the forces behind the transition. The population of the Wa increased over 110 percent between 1986 to 2016, whilst the built-up areas increased over 1,130 times within the same time period. However, built up density within the Wa town has been reducing since 1984 as a result of urban sprawl. Also, development has been compact in the urban core resulting from infill but extends outwards in the suburban areas as more agricultural land is being converted to residential and commercial facilities. Peri-urbanization is also on the rise and also linear strip developments along roads. These have increased land values in sub-urban and fringe communities. These changes have resulted in poor and uncoordinated developments with poor layouts and few utilities and inadequate social amenities coupled with rising land values. Also it has resulted in conversion of closed woodlands to open spaces, farmlands, grasslands and shrub lands to residential uses thereby reducing the land available for farming.

The study concluded that, based on the trend of growth and the rate of growth, Wa is likely to continue its growth trend, moving towards the south and south west of Wa, but will also move Westward and Eastward because of the new tertiary institutions in these areas.

Acknowledgement

I wish to thank Almighty God for His guidance and support throughout this study. I send my profound gratitude and appreciation to my Supervisors Dr. Osumanu Kanton and Dr. Gordon N-yelkabo Tuu for their directions and constructive criticisms during their supervision.

I also extend my appreciation to Mr. Joshua Toxla and Mr. Rockson Nimenga-Beka of Lands Commission and Town and Country Planning respectively, Wa for their support.

I would like to thank Mr. Atawula Siitah and Mensah Kafui for their support during my field data collection and also to Benjamin for his support.

I am equally indebted to Jennifer Awuni for her support given to me during the time of this study, I would forever be grateful.

Dedication

To my Mum, Madam Agnes Adongma, My Brother, Alhassan Anafo, My Dad, Mr. Yaw Berko Mainoo and my late Dad, Akongbangre

Table of Content

Content **Page**

List of Tables

List of Figures

List of Acronyms

AOI …… Area Of Interest

AVHRR …… Advanced Very High Resolution Radiometer

CBD …….. Central Business District

CBR ……..… Crude Birth Rate

CCRS ……..... Canadian Centre for Remote Sensing

CIESIN ……. Centre for International Earth Science Information Network

ETM+ ……..… Enhanced Thematic Mapper

GFR …… General Fertility Rate

GIS ……..……Geographic Information Systems

GPS …… Global Positioning System

GSS …… Ghana Statistical Service

LC ……. Land Cover

LI …….. Legislative Instrument

LU……..Land Use

MODIS ……..…… Moderate Resolution Imaging Spectroradiometer

MSS ……..… Multi Spectral Scanner

NDVI … ……...Normalised Difference Vegetation Index

NGO ……..… Non-Governmental Organization

NOAA ……..... National Oceanic and Atmospheric Administration

OLI ……..……..… Operational Land Imager

PGIS ……...… Participatory Geographic Information Systems

RS …….. Remote Sensing

SPOT ……...…….…. Systeme \Pour la Observation

SSNIT ……...…… Social Security and National Insurance Trust

TnCPD …… Town and Country Planning Department

UN… …….....United Nation

USGS …… United States Geological Survey

WMA ……..……...…… Wa Municipal Assembly

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

One of the most striking human induced land transformations of the current era is urbanization. This process involves large numbers of people congregating and settling in an area, eventually developing social institutions to support themselves. Urban areas are therefore created and are characterized as relatively dense settlements of people (Anthony, 2011). Urban transformation involves a wholesale modification of natural processes such as runoff and transpiration, and the short-term and long-term impacts touch every member of the human race every day (Clark 1997). Growth of urban areas involve spatial expansion as well as functional changes (Barnes *et al.*, 2002), which is fuelled by population increase.

More than half of the world's population lives in urban areas than in rural areas, with 54% of the global population residing in urban areas in 2014 (UN, 2014). This is almost double of the world's urban population in 1950, which had 30% of the world's population in urban areas. The trend continues as 66% of the world's population is projected to live in urban areas by 2050 which will add 2.5 billion people to the world's urban population (UN, 2014).

Virtually all countries of the world are becoming increasingly urbanized, but there is varying expressions across regions and development levels: richer countries and those of Latin America and the Caribbean have already a large proportion of their population residing in urban areas, whereas Africa and Asia are still mostly rural

but will urbanize faster than other regions over coming decades (UN, 2014). The most urbanized regions in the world in 2014 included North-America (82%), Latin-America (80%), and Europe (73%).

In contrast, Africa and Asia remain mostly rural, with 40% and 48% of their respective populations living in urban areas. Whilst continuing population growth and urbanization are projected to add 2.5 billion people to the world's urban population by 2050, nearly 90% of the increase will be concentrated in Asia and Africa (UN, 2014).

About one century ago, the urban population in Africa was less than 8% of its total world population. At the end of the 20th century, Africa was 35% urban, 40% in 2009, 41% in 2012, and 40.0 % in 2014 (UN, 2014). United Nations' data also show that Africa is experiencing unprecedented population growth as the total African population is projected to nearly double from around one billion in 2010 to almost two billion by 2040, and may well reach 3 billion by 2070. Africa's urban transition is also taking place at the same time with the accumulated relative growth rate of African cities now among the highest in the world (UN 2014). The United Nations projections also suggest that Africa will enter its urban age by 2035 when 50% of the population will live in urban areas. African cities with less than 500,000 inhabitants are now absorbing about two-thirds of all urban population growth. But, African larger cities continue to grow fast as well. This is because in 2005, Africa had 43 cities with more than one million inhabitants, up from 28 a decade earlier (UN, 2013).

Traditional city-based urbanization is moving towards regional urbanization patterns, including the emergence of new cities, urban corridors, and mega urban regions. However, largest cities continue to grow faster than smaller cities as a result of failure of smaller urban centers to specialize in innovative economic sectors, unfavorable national government policies, in terms of investment, infrastructure and regional development, ineffective leadership by local sector officials, and lack of flexibility and openness to new emerging economic strategies (Osumanu, 2009). Also there are great variations between rich and poor countries with a general pattern: the richer countries are more urbanized than the poorer ones, while landlocked countries are less urbanized than coastal ones at the same income level (UN, 2014).

Africa's urban areas are characterized by low densification. At the same time, suburbanization and peri-urbanization are on the rise. This sprawling nature of urban growth requires the conversion of agricultural/rural lands to residential land use. There is, however, no common definition of urban sprawl. It is seen as the deconcentration of urban functions in combination with spatial expansion of urban settlements into rural areas (Harvey and Clark, 1971; Pumain, 2003), dominance of low density settlement structures (Pendall, 1999; Gläser and Kahn, 2003), transformation of formerly monocentric compact cities into discontinuous, polycentric, and dispersed urban pattern (Torrens and Alberti, 2000). Barnes *et al.* (2002) posited that sprawl must be considered in a space-time context as not simply the increase of urban lands in a given area, but the rate of increase relative to population growth.

Another seemingly new dimension in urban growth in Africa is peri-urbanization. Peri-urbanization is on the rise on the continent (UN-HABITAT, 2008; United Nations Population Fund, 2007). Allen (2003) points out that rural areas are assuming some form of urban characteristics and tend to be subjected to the same planning criteria used for urbanized areas. According to him, fringe communities are constantly being introduced to new expectations, requirements, and standards by local governments, to which they must conform.

Ghana follows the same trend of urbanization as the rest of Africa. The Population and Housing Census conducted in 2010 reported a total of 24,657,823 people residing in Ghana with an inter-censal growth rate of 2.5% with 50.9% of the total population residing in urban areas and 49.1% in rural areas. This contrasts with the 43.8% of urban dwellers in 2000 (GSS, 2012). This trend is a result of rural-urban migration, natural increase in towns and cities and reclassification of villages as towns after villages have attained the threshold population of 5,000 or more persons, which is the definition of an urban area in Ghana (Songsore, 2002).

A very important application that has been used to assess urban growth are the concept of Remote Sensing (RS) and Geographic Information Science (GIS). (Source). RS and GIS have proved to be effective means for extracting and processing varied resolutions of spatial information for monitoring urban growth (Masser, 2001). Remote sensing provides insights into the multi-dimensional urban sprawl phenomenon. The techniques show their value predominantly in space-oriented questions regarding the various definition of urban sprawl. Remote sensing provides spatially consistent data sets that cover large areas with both high

spatial detail and high temporal frequency. Recent research (Adarkwa, 2012, Owusu, 2012) has used satellite images to quantitatively describe the physical spatial structure of urban environments and characterized patterns of urban morphology.

The limitations, however, with developing countries are that there are non-existent satellite systems owned by countries and are, therefore, dependant on developed countries for remotely sensed data which are very costly to acquire. Some open access satellite imagery are being provided by United States Geological Service Department (USGS) for free, however, these data are of low resolution and mostly contain noise (source).

Participatory GIS (PGIS) can help remedy this challenge by complimenting classical GIS, where the data are of low quality and where data are too costly to acquire by the researcher. As an offspring of GIS, PGIS gained nascence in the 1990s with increasing public participation in GIS. Its success is partly because PGIS researchers and practitioners are actively engaged in on-the-ground research with communities in many parts of the world. The emphasis of PGIS is to better understand and represent underprivileged groups in societies (Schuurman, 2006) and to provide synthesis of quantitative technological data and qualitative information relating to social issues.

Conventional GIS was criticized by many authors in the early 1990s for relying heavily on data rather than information, subject to naïve empiricism, a positivist technology that assumes the possibility of objectivity, complicit in warfare, and

based on Cartesian framework incapable of describing social/natural phenomena (Taylor, 1990; Taylor and Overton, 1991; Smith, 1992, Lake, 1993; Pickles, 1993).

PGIS has therefore received great attention over the last decade as a tool that involves local people in identifying societal problems for development and planning of projects (Alcon, 2000; King, 2002). It integrates accumulated knowledge of local residents into the planning process from beginning to the end thereby reversing top-down approaches of conventional GIS. This enables local actors to create representations of local knowledge of space engaging in analysis of objects, relationships and issues (Minang, 2003).

Satellite Imagery as well as indigenes historical accounts may give accurate information on how urban areas have been like in the past. However, predicting the future size of African cities is risky since the spatial transformations that accompany development cannot easily be foreseen (Henderson, 2003).

Urban growth is in essence a complex subsystem; it involves multiple actors with differing patterns of behavior at various spatial and temporal scales. It centers on understanding the dynamic interactions between the socio-economic and built environments and major natural environmental impacts.

1.2 Problem Statement

Wa has witnessed significant growth since it assumed the status as the capital of the Upper West Region in 1983. From a population of 2,806 in 1921, the population increased to 5,558 in 1948, the population further rose by 178.2% to

1,342 people in 1960 and again rose by 49% to 21,374 people in 1970. The town continued to witness a rise in the number of people after assuming the status of the Regional capital in 1983. With a total population of 36,067 in 1984, the number of people increased to 66,644 in 2000 and 71,051 in 2010 (Wilks, 1989, GSS, 2000, 2012). Administrative, economic, social and physical infrastructure have also increased significantly. Although the built-up area of Wa town has not been established anywhere in available in current literature, that of the municipality recorded an increase of 34.15% from 1986 to 2011 (Aduah and Aabeyir, 2011).

The growth in population has also resulted in urban sprawl where property developers resort to outward development rather than dense and compact development. These development take up much space and reduces the land available of agricultural purposes (Amoah 2013). This type of urban growth which is predominant in most sub-Saharan African countries is usually not accompanied by the necessary spatial planning resulting in poor layouts with inadequate access roads that make it difficult for utility and service lines and increases the cost of extending utility services to these areas.

The growth of Wa has been faster for the last one and half decades due to the establishment of University for Development Studies (UDS) in 2002 and the Wa Polytechnic in 2003 (Peprah, 2013; Amoah, 2013), as well as the upgrade of Wa Township to a municipality in 2004 (Peprah, 2013).

This growth has prompted several researches into the phenomenon. Owusu-Sekyere and Amoah (2015) looked at the municipal solid waste in the

municipality and concluded by projecting that urban waste will more than triple in the coming decade. Peprah (2014) concluded that the rapid infrastructural development (mostly residential) have degraded most lands in the periphery due to sand winning activities, whilst Aduah and Aabeyir (2011), who investigated the land use changes in Wa, revealed that the size of bare lands have nearly doubled while a tenth of the original vegetative cover has been lost from 1986 to 2011. However, no research has been conducted on the spatial urban expansion and as such there exist little or no information on time series historical growth of Wa as a settlement. Aduah and Aabeyir (2011) only looked at the land-use change between two extremes - 1986 and 2011. Also, there has been little or no literature on the various forms or nature of growth of Wa. This study therefore seeks to leverage on the strong capability of Geographic Information System (GIS) and Remote Sensing Technology and local knowledge to provide time series spatio-historical data on Wa since its establishment from the early 18th century to 2016.

1.3 Research Questions

The main research question is: what has been the spatio-temporal pattern of Wa since the early1980s?

The specific research questions are:

1. What was the settlement of Wa in in 1986, 2001, 2014 and 2016?
2. How did spatial expansion affect the land use changes from 1986 to 2016?
3. What is the nature of urban development from 1986 to 2016

4. What are the policy implications of Wa's expansion for socio-economic development?

1.4 Research objectives

The main aim of the study is to spatially delineate the spatial extent of Wa since the early 1980s.

Specifically, the study seeks:

1. To provide time series urban sprawl and population growth of Wa in 1986, 2001, 2014 and 2016
2. To examine the spatial expansion and land use changes of Wa from 1986 to 2016
3. To examine the nature of urban development from 1986 to 2016
4. To examine the policy implications of Wa's growth for socio-economic development.

1.5 Scope of Study

This study focused on the spatial development of Wa from 1986 to 2016. It deals with the spatio-temporal changes of Wa and how the changes have impacted socio-economic activities. It is mainly concentrated on Wa Township, the capital of the Upper West Region of Ghana.

1.6 Study Area

1.6.1 Background of Wa

Wa is an urbanizing town located in the Upper West Region of Ghana. The exact time for which the town was founded is not known but records have it that has been in existence for between four to five millennia (Wilks, 1989). Wa and the Upper West region in general initially formed part of the then Upper Region with Bolgatanga as the regional capital which was itself carved out of Northern Territories in July 1960. In the pursuit of the decentralization policy of Ghana government, the Upper region was divided into Upper East and Upper West with Wa as the regional capital of Upper West Region (GSS, 2005).

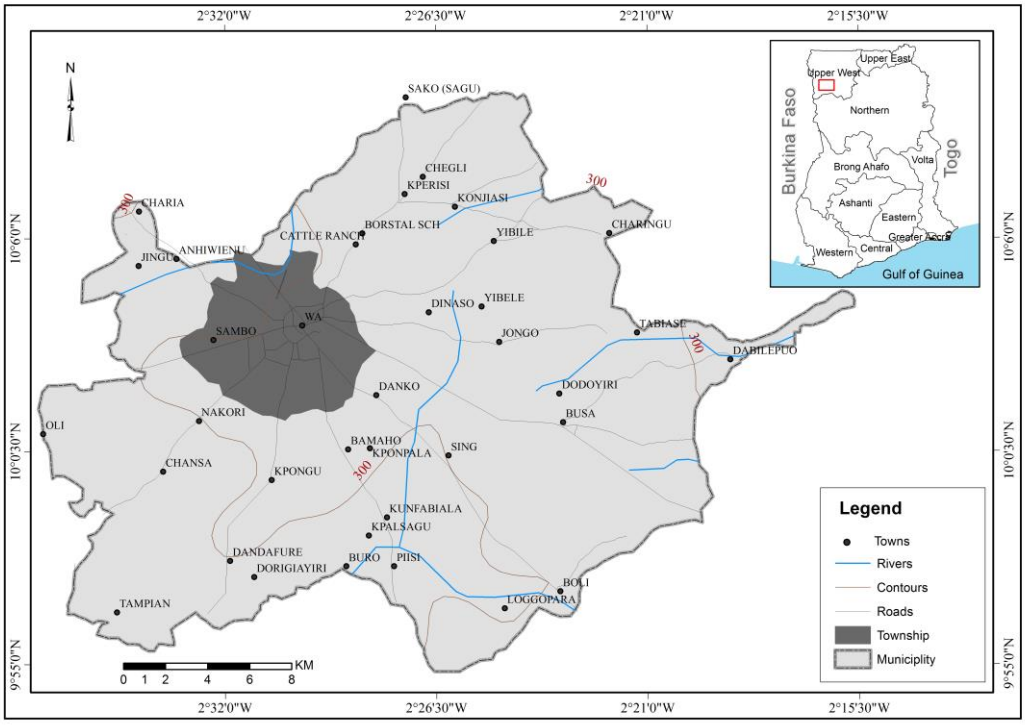
Wa Municipality is the only municipality out of the eleven District/Municipalities that make up the Upper West Region (UWR) of Ghana. Wa District formally comprised of what are now Wa East and Wa West Districts but was carved out in 2000 and upgraded to a municipality in 2004 with Legislative Instrument (LI) 1800 in pursuant of the policy of decentralization which started in 1988 (GSS, 2014) and has Wa as its capital which also serves as the regional capital

1.6.2 Location and Size

Wa municipality is located in the southern part of Upper West region of Ghana and covers a land area of approximately 579.86 square kilometres representing about 6.4% of the Region. The municipality is bounded by Nadowli-Kaleo District to the North, Wa West district to the West and South and Wa East District to the East. It lies within longitudes 2º38’0’’W to 2º15’30’’W and latitudes 9º54’0’’N to 10º10’0’’N (Figure 1).

The location of Wa is strategic and serves as transit point for people travelling from Burkina Faso, the northern and north eastern parts of the region to the rest of the regions southwards. It also serves as destination for intra-regional migrants within the region. Also the architecture of the people suggest that most of the earliest settlers were Sudanese (Islamic) traders who used the route from the North to the southern part of Ghana during the Trans-Atlantic slave trade era. The central mosque of Wa typically suggest this claim (Wilks, 1989). This has contributed to the growth of the town ones described as a rural and agrarian based community to fast growing urban centre.

Figure 1: Map of Wa Municipality Showing Wa Township



Source: Wa Municipal Assembly, 2016

1.6.3 Physical Features

Wa Municipality lies in the Savannah high plains, which generally, is gently undulating with an average height between 160 m and 300m above sea level. Low lying areas are found in the suburbs such as Kambali, Dobile, Douri and Sawaba. Valleys such as the one running from Konta through Kabanye and Kpaguri and intersects a drain from Kambli at Mangu and a second valley that runs down from Douri down to Dobile constitute the two main drainage systems in the capital. These are the Sing-Bakpong and its tributaries to the south and Billi and its tributaries to the north. There is also a third valley towards the North-eastern part of the town that is currently serving as a drain for the newly relocated industrial area off the Wa-Tumu road (Wa Municipal, 2016).

Underlying the Municipality are predominantly Pre-Cambrian, granite and metamorphic rocks that have seen lesser weathering than similar rock types elsewhere in the country due to low rainfall, high evapo-transpiration and less vegetation, has created the opportunity for the development of a quarry on the Wa-Busa road (GSS, 2005).

1.6.4 Population Dynamics

The 2010 Population and Housing Census conducted by the Ghana Statistical Service reported a total population of 71,051 people residing in Wa town out of 107,214 people in the municipality. This was 6.6 percent increase from the previous census population of 66,644 people out of 224,066 in the year 2000. This may not be attributable to natural increase (birth rate) since all three indicators of birth rate decreased from the 2000 census figures. Thus, Crude Birth Rate (CBR)

decreased from 34.1 percent to 22. 66%, General Fertility Rate (GFR) decreased from 150.1 to 82.63 percent and Total Fertility Rate also decreased from 5.6 percent to 3.3 percent in 2010. However, the immigrant population (internal migrants from other regions of Ghana) increased significantly (about 3.9 percent between the inter-censal periods. The proportion of immigrant population from other regions in Ghana increased from 18.7 percent of a total population of 213,144 people in the year 2000 to 22.6 percent of a total population of 107,214 in the year 2010. The Municipality is also reported as having an urban population growth rate of 4% as compared to the national urban growth rate of 3.4% (GSS, 2012).

1.6.5 Cultural Characteristics

The 2010 Population and Housing Census show that 80.4 percent of the people in the Wa Municipality belong to the Mole-Dagbani group which comprises the Waalas who are the indigenous people, Dagaabas and the Sissalas. Other ethnic groups found in the Municipality include the Frafra, Akan, Ewe, Ga, Dagomba, Grushi, Gonja and Moshies who are engaged in secular work and commercial activities. The role of the peace and security agencies, NGOs (Non-Governmental Organizations), the Municipal Security Council, the Regional House of Chiefs, Family Tribunals, Imams, Juvenile court have helped to maintain the needed social cohesion to support development.

1.7 Significance of the Study

This study contributes to knowledge by revealing the histo-urban change of Wa Township as little of such information currently exists. Also, the results of this study would be beneficial to the Wa Municipal assembly, Town and Country Planning and other relevant bodies in their land use/zoning plans for the Wa Township. It will also serve as reference material for academic research and for further research that seeks to build on this study.

1.9 Research Challenges and Mitigation Measures

The major challenge encountered during this study was how to get training samples and reference data for training signatures and accuracy assessment respectively for the anniversary years (1986 and 2001). Getting these data would have meant travelling back in time to 1986 and 2001 and doing a field data collection, but since the researcher is not a time traveler, the alternative was to locate old land marks that existed in 1986 and 2001 and these features formed reference points from which coordinates were collected and used as training samples and reference data for the post classification accuracy assessment. Also, old land use maps were digitized, georeferenced and used.

1.10 Organization of work

The thesis consists of five chapters; chapter one entail the background of the study and the problem together with the research questions that the study seeks to provide answers to, the research objectives, justification as well as the organization of the thesis. Chapter two focused on the literature review, in which

the conceptual and empirical issues are covered. In chapter three, the methodological procedures that regulate the study are described, while chapter four will deal with presentation and analysis of data. The thesis ended with chapter five as the key findings, conclusions and recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews existing literature so as to identify the gaps in knowledge that this research intends to fill. It contains relevant issues and debates on thematic areas such as urbanization trends and urban expansion, the application of GIS in urban research and urban growth models are reviewed.

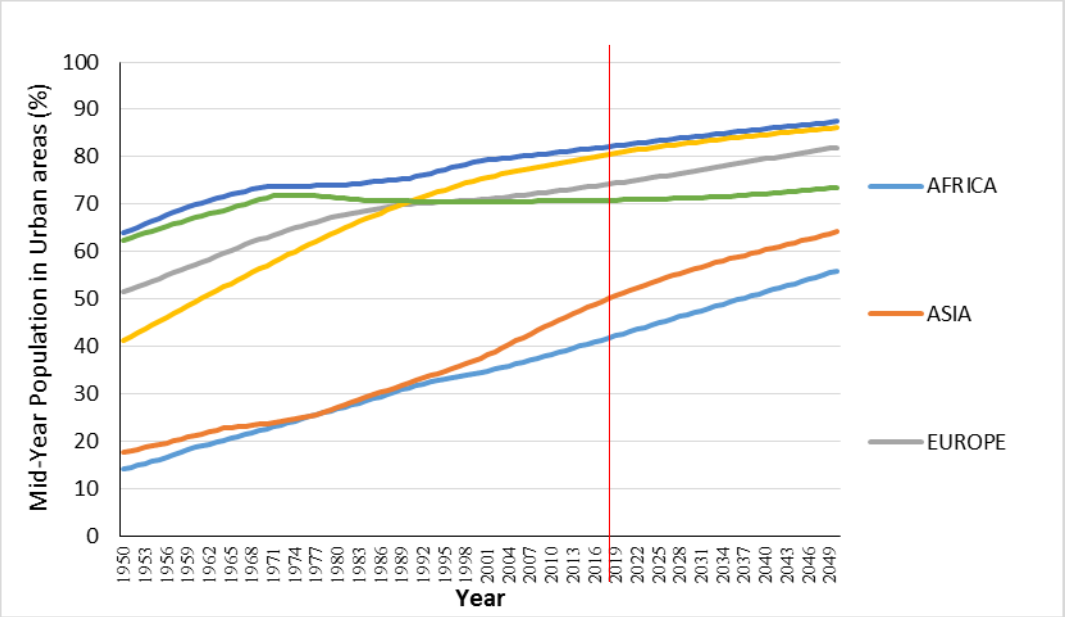
2.2 Trends of Urbanization

United Nations data show that, globally, more people live in urban areas than in rural areas, with 54 per cent of the world's population residing in urban areas in 2015. This is nearly double of the world urban population in the 1950s. In 1950, 29.6 per cent of the world's population was urban, and by 2050, 66.4 per cent of the world's population is projected to be urban (UN, 2014). There is great diversity in the characteristics of the world's urban environs: close to half of urban dwellers reside in relatively small and medium settlements of less than 500,000 inhabitants (UN, 2014), while nearly one in eight live in the 28 mega-cities of 10 million inhabitants or more. The number of mega-cities has nearly tripled since 1990; and by 2030, 41 urban agglomerations are projected to house at least 10 million inhabitants each. Whereas several decades ago most of the world's largest urban agglomerations were found in the more developed regions, today's large cities are concentrated in the global South, and the fastest-growing agglomerations

are medium sized cities and cities with 500,000 to 1 million inhabitants located in Asia and Africa (UN, 2014).

For Africa, the urban population increased from 14 per cent in 1950 to 40.4 % in 2015 and is projected to reach 55.9 per cent in 2050. Compared the global urban population (54 %), Asia (48.2 %), Europe (73.6 %), Latin America and the Caribbean (79.8 %) and North America (81.8 %), it is clear that Africa has the least urban population (Figure 2). However, the average annual rate of change of urban population is the second highest (1.06 %) next to Asia (1.23 %) between 2010 and 2015 and is projected to remain steadily high till 2050. Figure 2.1 shows the annual percentage of population living in urban areas from 1950 to 2050.

Figure 2: Annual Percentage of Urban Population at Mid-Year, 1950 - 2050



Source: United Nations, Department of Economic and Social Affairs, Population Division (2014)

Figure 2 suggests that, there is rapid transition from rural population to urban population as the urban share of the total population is gradually on the rise. The "urban transition" refers to a change from a predominantly rural to a predominantly urban population, but it is a lot more than that. It represents a fundamental transformation of society, affecting everything from culture to social relations, political systems, institutions, the economy, and the environment.

Population dynamics are radically altered by the urban transition. Newcomers to the city quickly find that the large families, of such importance to the household economy in rural areas, are a liability. Smaller housing and the costs of child rearing quickly put a brake on fertility, whereas better access to health care, piped water and sanitation dramatically reduce infant and child mortality for most urban residents. Couples increasingly choose quality over quantity, investing in education for fewer children (Caldwell, 2005). However, these characteristics or urban transition is not the same across all regions. Africa's urban transition is seen by many commentators as the opposite, as it is marked by high fertility, and low death rates coupled with high rural-urban migration (Osumanu, 2009). Heterogeneity is a common characteristic of the African continent. Sub Saharan Africa consists of several countries and cities with remarkable levels and patterns of urbanization. It therefore differs from other industrialized countries in aspects such as urbanization rate, population growth rate and economic growth accompanying such growths (Freire *et al.*, 2014; Osumanu, 2009).

Urbanization has been a long phenomenon in Africa. The rise of pre-colonial sub-Saharan Africa led to the concentration of power, natural and human resources in

cities, particularly through the influence of Islam, as in Sahel (Timbuktu, Gao, Kano, Katsina) and along the east African coast such as Kilwa, Lamu, Bagamoyo and Shanga (Anderson and Rathborn, 2000). But these cities could not compete on global scale. A vast of Sub-Saharan Africa were scattered across large pieces of land with weak concentration of human population (Bocquier, 2003).

The dawn of colonialism disrupted the pattern of urbanization in sub-Saharan Africa, although some urban centres were developed on the basis of pre-colonialcentres (Mombasa, Kampala, Kumasi, etc.), most commercial and administrative centres were created out of nowhere, often on the coast for ease of transport and, ignored previous commercial centres which were thereafter marginalized (eg. Salaga in Ghana).

In his work, 'urbanization challenges in Africa', Osumanu (2009) revealed that Africa's urbanization of less technological and market forces, but a consequence of 19th century colonial policies, that networked African economies into international trade by making African countries specialize in cash crops and minerals exploitation because of the abundance of natural resources. Consequently, large towns emerged along the coast and ports were developed in these towns and that served as links from the local economies to the international markets. These towns also served as sites where the colonial administrators administered the colonies from. Eventually these towns grew into large commercial towns with well-developed financial services and local governments.' Osumanu (2009) also highlighted three stages that forms the African urbanization model; an initial rapid population growth and commercial development of a main

city; decentralization or urbanization of population and commercialization into the city outer rings and satellite settlements; and decentralization of commercial and service activities from major metropolitan area into other smaller regional centres of the country.

As the focus of this work is on expansion and or growth (population and spatial), this work would consider population growth and urban sprawl and peri-urbanization in the following section as they fit into the stages of Africa's urbanization above.

2.3 Spatial Urban Expansion

Globally, there have been several studies on the extent of the urban interface relative to the total land area or the globe (Dank, 1992; Bartholome and Belward, 2005; Arino *et al.*, 2007; Schneider *et al*., 2009). Each study adopted a different definition of an urban area and used different methodologies and data sets; as a result, the statistics given for global urban extents differs in all of these studies. For instance, the Global impervious surface area (Elvidge *et al.* 2007) produced by the US national Geo-physical data centre, defined urban area by the density of impervious surface area, reported a global urban extent of 572,000 km square (0.44%) of the total land area. Whilst, Global Cover (second version) (Anino *et al.*, 2007) by the European commission Joint research centre, defined urban areas as artificial surfaces and associated areas, also reported a the global urban extent to b 313,000 (0.24%) of the global land area. Nonetheless, these studies provide the points of departure in the investigation of urban expansion at various scales.

Schneider *et al.*, (2010), adopted an approach for stratifying global urban systems known as eco regions, based on the natural, physical and structural elements of urban areas. The justification for this stratification lies in the fact that, although urban environments present some of the most complex and heterogeneous landscapes in the world, research within the urban studies, urban land change science has shown that there is surprising regularity in city structure, configuration, constituent elements, and vegetation types within geographic regions (Angel *et al.*, 2005, Schneider and Woodcock, 2008). They therefore exploited the local similarities and classified global urban change based on these 'ecoregions' (temperate, tropical, arctic etc.).

A more recent and accurate global urban change research that defined the global regions using administrative boundaries was carried out by Schneider *et al*. (2009) using data from 2000 to 2001. This study used MODIS 500m map which provides foundation for refined representations of global urban land use. According to this study, 658,780 km2 (0.51%) of the total land cover is composed of urban areas Western Europe has the highest urban expansion with a percentage of 2.11, whist sub-Saharan Africa is least with a percentage of 0.13. Other regions include; North America (0.72 %), Central America and the Caribbean (0.50 %), South America (0.47 %), Eastern Europe (0.36 %), East Asia (0.97 %), Western Asia and North Africa (0.37 %), South-Central Asia (0.62 %), South-East Asia and Pacific Islands (0.63 %) and Australia and New Zealand (0.14 per cent) (Schneider *et al.*, 2009).

Despite the numerous global studies on urban extent (Bhaduri *et al.*, 2002; CIESIN,2004; Elvidge *et al.*, 2007; Schneider *et al.*, 2009, 2010, 2003), a meta-

analysis of urban expansion indicates that local- to regional-scale studies are geographically biased, leaving even many large cities unstudied (Seto *et al.*, 2011). Detailed maps on regional- to global-scale changes in urban land do not exist. Previous efforts have been sample-based (Angel *et al.*, 2005; Schneider & Woodcock, 2008; Taubenböck *et al.*, 2012). There exists limited information on urban extent at African (local scale), as such most rely of data and figures provided global urban maps (Snow *et al.*, 2005, Tatem *et al.*, 2005). Occasional settlement maps for cities however do exist (Tatem *et al.*, 2005, 2007).

Tatem *et al.* (2005) investigated automated approaches to national-scale urban mapping from medium scale satellite imagery for Kenya. The results were compared to global maps such as AfriCover and it revealed that, global urban maps overestimate the extent of the urban area. This according to them is because the scales adopted by the global maps aggregates the urban pixels and is not able to differentiate the various mixtures of the heterogeneous urban interface. Also, while Africover's object-based and spatial resolution of analysis resulted in the identification of a total of 244 separate urban areas, Tatem and his colleagues identified a massive 8621 distinct groups of 10 or more contiguous 'urban' pixels.

This suggest that routine monitoring of urban expansion at regional or local scale could therefore provide the spatial information on patterns of urban growth that are essential for understanding differences in socioeconomic and political factors that spur different forms of development, as well the social and environmental impacts that result (World Bank, 2014).

2.4 Nature of Urban Expansion

Urban expansion takes places in substantially different forms. In any given city, new urban expansion can take place with the same densities (persons per square kilometre) as those prevailing in existing built-up areas, with increased densities, or with reduced densities. It can take place through the redevelopment of built-up areas at higher densities, through infill of the remaining open spaces in already built-up areas, or through new development in areas previously in non-urban use. New development can either be contiguous with existing built-up areas thus extend from existing built-up area or can "leapfrog" away from them, leaving swaths of undeveloped land that separate it from existing built-up areas (World Bank, 2005).

Several attributes of urban growth are therefore considered in popular literature when seeking to determine the nature of urban growth or development. Amongst is in the literature synthesis by Burchell *et al.*, who list the following as the spatial patterns of urban sprawl: low density, unlimited outward expansion, land uses spatially segregated, leapfrog development, and widespread commercial strip development (Burchell *et al.*, 1995, 1998).

Density

An attribute of urban sprawl is typically characterized by the decline in average density. In fact, low density urban land use is by far the most commonly mentioned attribute of urban sprawl in the literature. It is indeed a common

attribute and most certainly a consequence of all the manifestations of sprawl identified in the literature (Angel *et al.*, 2007).

The measurement of population density typically refers to the ratio of the population a particular place the area of that place, measured, in persons per hectare or persons per square kilometre. Clearly, for a given population, a city occupying a smaller land area will be considered more compact and less sprawled than a city occupying a larger land area. Angel *et al.* (2007) argued that, the value of using the average density as an attribute of sprawl is that it brings out the intensity of the use of land in the city as a whole. (ibid). Density metrics includes built-up area density which is a ratio of the town/city population to the built- up area, and urbanized area density – ratio of City/town population to the urbanized area.

Infill

Despite the reduction of the contiguity of built-up areas and the preponderance of vacant spaces in and around them, there is gradual increase in compactness of cities especially within the core as a result of developments occurring in underutilized and undeveloped parcels in already developed urbanized areas (Northeast Midwest Institute, 2001). These developments are termed as infill. Infill is often associated with central city development, where such projects are seen as a policy tool to revitalize existing central city neighbourhoods.

Many in both the policy community and in urban planning have hailed infill development as a possible solution to sprawl that will both increase density and

revitalize depressed neighbourhoods (Farris, 2001; Haughey, 2001; Robinson and Cole, 2002; and Urban Land Institute 2001). It is argued that infill, or new development in existing urban areas, at relatively high densities would prevent additional dispersed, low density development at the periphery that claims many acres of forested and agricultural lands. And a host of recent state and local policies now promote or at least facilitate new infill development as an answer to urban sprawl

Leapfrogging

The fourth general attribute of sprawl is the decreasing contiguity of the built-up area of cities, typically exemplified by development that leapfrogs over open space, by the increase in the amount of leftover vacant spaces in the interstices of built-up areas and around them, and by the increasingly fuzzy boundary between town and country

Leapfrog developments usually skip over open space and leave it vacant and undeveloped either temporarily or permanently. The perception of sprawl as the reduction of the contiguity of the built-up areas of cities focuses attention on the relationship between the built-up area and the remaining open spaces in a given urban landscape. (Burchfield *et al.*, 2005).

Linear/Commercial strip development

Where rural arterial roads approach cities, they become magnets for urban commercial expansion. When approaching a city from the countryside, these roads too often present visually chaotic settings consisting of commercial development

that represents the worst of urban sprawl (Sullivan and Lovell, 2005). Commercial or retail businesses are mostly sited along major roadways providing ease of convenience to customers with the proximity to major roads and sometimes parking lots. Also, people want more goods and services available closer to their homes, in response people would either build their homes along roads and the market would also respond by developing commercial strips along major arterials, since they provide good accessible to large numbers of people (Moldoff, 2004). Also, there is greater land available for development in these areas and this attract lower taxes, rent, and land values and allows plenty of space for parking compared with the urban core settings where past businesses resided (Lynch and Southworth, 1996). Additionally, the expansion of individual businesses or developments can be made easily by extending the strip lengthwise to consume more land. Davies and Baxter (1997) also pointed out that, the controls on development are often not as strict as in other areas where ordinances and zoning restrictions can severely suppress growth In many fringe areas, development permits are not required or are easily obtained, and the involvement of city planners is very limited (Lynch and Southworth, 1996). This therefore leads to more development along major roadways as the city grows.

2.5 Land Use/Land Cover Change

The terms land cover and land-use are often used interchangeably, but their actual meanings are quite distinct. Land cover refers to the surface cover on the ground, whether vegetation, urban infrastructure, water, bare soil or other. Identifying, delineating and mapping land cover is important for global monitoring studies,

resource management, and planning activities. Identification of land cover establishes the baseline from which monitoring activities (change detection) can be performed, and provides the ground cover information for baseline thematic maps (CCRS, 2000).

Land use on the other hand refers the management of land to meet human needs. This embraces rural land use such as agriculture, forestry, and aquaculture as well as all forms of urban and industrial use (FAO, 1992). It is the purpose the land serves, for example, recreation, wildlife habitat, or agriculture. Land use applications involve both baseline mapping and subsequent monitoring, since timely information is required to know what current quantity of land is in what type of use and to identify the land use changes from year to year. This knowledge will help develop strategies to balance conservation, conflicting uses, and developmental pressures. Issues driving land use studies include the removal or disturbance of productive land, urban encroachment, and depletion of forests (CCRS, 2000).It is important to distinguish this difference between land cover and land use, and the information that can be ascertained from each. Urban Land cover can be best monitored using satellite imagery.

The development of an urban area inevitably results in *Urban Change,* where non-urban/rural land is converted to urban land. This urban change is such a fast process that the normal means of ground surveying methods are not suitable for detecting the change. As a result, there is a need for techniques which provide data at regular time interval much faster than the normal ground based surveying methods (Poulicus *et al.*, 2008).

Remote Sensing/GIS provide powerful tools for monitoring land use. However, the properties measured with remote sensing techniques relate to land cover, from which land use can be inferred, particularly with ancillary data or a priori knowledge (Chang, 2011).

Satellite imagery offers a unique multi-temporal, multi-spectral, and synoptic perspective on urbanization at regional scales, providing valuable data for monitoring and assessment of change. Proper monitoring depends critically on the capacity of (near-) real-time monitoring of land-use/cover change, so that solutions to a range of urban/rural-interface development issues can be managed promptly and adequately (Chang, 2011).

Using multi-date satellite remote sensing data to detect land-cover change goes back to the early 1970s. There are numerous sensors that provide imagery at different scales with different resolutions (SPOT, Landsat, Geo eye, MODIS Aster, etc.), which determines the accuracy of the land maps that would be produced (Belaid, 2003). However, most urban land-cover/land-use change studies utilized Landsat data due to the uniqueness of the dataset as the only long-term digital archive with a medium spatial resolution and relatively consistent spectral and radiometric resolution. Urban change studies using Landsat Multispectral Scanner (MSS) or Landsat Thematic Mapper (TM) data have been conducted either at a regional scale encompassing several urban areas (Todd, 1977; Royer *et al.*, 1988) or a single metropolitan area (Gomarasca *et al.*, 1993;. Recently, long-term urban land-cover/land-use changes (over two decades or longer) have been studied using the methodology of post-classification comparison using the Landsat

archive as a baseline data source (Chen *et al.*, 2002; Yang and Lo, 2002; Loveland *et al.*, 2002).

Yang *et al.* (2003) used a physical parameter, "anthropogenic impervious surface," as an indicator for identifying the spatial extent and intensity of urban development by quantifying sub-pixel percent imperviousness using Landsat and high-resolution imagery. The percent impervious surface and its change (30-meter resolution) were mapped for two points in time over western Georgia using a regression tree algorithm which was found to be satisfactory. They therefore concluded that, Change in percent imperviousness over time appears to be a useful indicator for identification of the spatial extent, intensity, and, potentially, type of urban land-cover/land-use changes. Verma *et al.* (2008) used images from Google earth to assess the change in the urban extent of Roorkee city. Since google earth data is proven to be within an acceptable error level, their study revealed significant change in the urban extent of the area between 2002 and 2011.

Rapid and widespread deforestation, and land degradation has been on top of the many reasons by which the valuable African landscape is closely monitored. Land cover change research in Africa includes efforts to monitor desertification and land degradation over sub-Saharan Africa using vegetation cover and surface moisture data derived from remote sensing data (Symeonakis *et al.*, 2004), and using Landsat ETM+ imagery to identify malaria vector breeding habitats in an irrigated rice growing area in Mali Diuk-Wasser *et al.*, (2004). Brivio *et al.* (2003) have shown remote sensing to be the most effective tool in monitoring biomass burning and its effects on natural terrestrial ecosystems in sub-Saharan Africa,

using SPOT-VEGETATION and Landsat ETM+ imagery in the Global Burnt Area-2000 (GBA2000) initiative. Nonomura *et al.* (2003) have used Normalized Difference Vegetation Index (NDVI) data from NOAA's AVHRR sensor to devise a digital vegetation model for eco-climatic analysis and mapping of African land cover types, and NDVI data from AVHRR imagery have been used to monitor phonological cycles in semi-arid lands and ecosystems in northern Africa (Dall'Olmo and Karnieli, 2002). NDVI data from the AVHRR sensor have also been used to assess habitat regimes in Tanzania at multiple spatial and temporal scales (Pelkey *et al.*, 2003). Additionally, in Tanzania, Landsat TM data have been used to study the impact of cattle ranching on large-scale vegetation patterns (Tobler *et al.*, 2003).

Wang *et al.* (2013) attempted at quantifying how the land cover had changed in the Amanzule area of western region of Ghana between 2002 and 2012 using Landsat 30m image Rapid Eye 5m for the two years respectively. Their efforts were however marred by poor quality of the 2002 image which made it impossible to deduce any significant land cover change. The land cover map produced from the Rapideye image of 2013 was more accurate and can be used as a baseline data for future research.

Stow *et al.*, (2011) sought to quantify, map, and analyse vegetation cover distributions and changes across Accra, Ghana, for 2002 and 2010. Pixel-level vegetation cover maps were derived using threshold classification of 2002 and 2010 QuickBird images. Normalized difference vegetation index images proved to

have very high overall accuracies and yielded an estimate of 5.9 per cent vegetation cover reduction over the study area between 2002 and 2010.

Adjei *et al.* (2014), generate land cover maps from Landsat Thematic Mappers of 1986 and 2002, as well as ETM+ of 2008 imagery of the Lake Bosomtwi basin in Ashanti region, Ghana. Statistical analyses of the land cover classifications indicated that forest cover around the basin has experienced remarkable loss in the past 22 years. Specifically, between 1986 and 2008, the basin lost 18.0% of the total forest. The study confirms that deforestation and forest degradation in the Bosomtwi District are still high due to unsustainable agriculture and other uncontrolled development activities underpinned by complex interactions of social, economic and political processes.

Aduah and Aabeyir (2011), in their investigation of the land cover dynamics of the Wa municipality, used two Landsat 5 images of 1986 and 2011 to derive the land cover change between the two years. The land cover maps generated indicated that built-up area has increased by 34% whiles total size of bare land has increased by 47% from 1986 to 2011.These increases have reduced the total area of vegetated land by 10%. Therefore, they suggested that if the current rate of degradation is not controlled, biodiversity of Wa and its surrounding areas would be lost in the near future. They however advocated for the intensification of GIS and Remote Sensing applications in land use and land cover change studies.

2.6 Urbanization and Socio-Economic Development

Urbanization inevitably results in both negative and positive impacts on the social and economic lives of people in the city/town. Although, negative impacts are generally more highlighted because this growth is often uncontrolled or uncoordinated and therefore the negative impacts override the positive sides (Bhatta, 2010), it is still important to highlight both impacts caused by urbanization.

Sprawl is usually accepted as being inordinately costly to its occupants and to society due to its environmental cost and economic cost. Cities have experienced an increase in demand for public services and for the maintenance and improvement of urban infrastructure. Sprawl requires more infrastructures, since it takes more roads, pipes, cables and wires to service these low-density areas compared to more compact developments with the same number of households (Bhatta, 2010). Other services such as waste and recyclables collection, mail delivery and street cleaning are more costly in low-density developments, while public transit is impractical because the rider density needed to support a transit service is not there (ibid).

Urbanisation generally, and sprawl in particular, contribute to loss of farmlands and open spaces Zhang *et al.,* (2007). According to Burchell *et al.,* (2007), urban growth, only in the United States, is predicted to consume 7 million acres of farmland, 7 million acres of environmentally sensitive land, and 5 million acres of other lands during the period 2000–2025. This case is enough to visualise the world scenario.

Low prices of farm commodity in global markets often mean it is far more profitable in the long term for farmers to sell their land than to continue farming it. In addition, thousands of relatively small parcels of farmland are being severed off to create new residential development. Collectively, these small lots contribute to the loss of hundreds of hectares of productive agricultural land per year. The loss of agricultural land to urban sprawl means not only the loss of fresh local food sources but also the loss of habitat and species diversity, since farms include plant and animal habitat in woodlots and hedgerows. The presence of farms on the rural landscape provides benefits such as greenspace, rural economic stability, and preservation of the traditional rural lifestyle (Bhatta, 2010).

Sprawl also has serious impacts on water quality and quantity. With miles of roads, parking lots and houses having paved over the countryside, rainwater and snowmelt are unable to soak into the ground and replenish the groundwater aquifers.

Urban growth and sprawl lead to an increasing imperviousness, which in turn induces more total runoff volume. So urban areas located in flood-prone areas are exposed to increased flood hazard, including inundation and erosion (Bhatta. 2010). As new development continues in the periphery of the existing urban landscape, the public, the government, planners and insurance companies are more and more concerned by flooding disasters and increasing damages (Wisner *et al.* 2004; Bhatta, 2010).

In the urban area, water runs off into storm sewers and ultimately into rivers and lakes. Extra water during heavy rain can dramatically increase the rate of flow through wetlands and rivers, stripping vegetation and destroying habitats along riverbanks. It can also cause damaging floods downstream and lead to an increase in water pollution from runoff contaminated with lawn and garden chemicals, motor oil and road salt. Widely dispersed development requires more pavements that cause more urban runoff that pollutes waterways Bhatta (2010). These pollutants can be absorbed by humans when they eat contaminated fish from affected water-bodies and when they drink from contaminated surface water or groundwater sources.

In addition, heavy rainstorms occurring in cities and towns with inadequate systems for managing storm water can cause untreated human sewage to enter waterways (combined sewer overflow. Accra, Ghana is manifestation of this scenario where excess rain coupled with inadequate planning continue to cause catastrophic flood every most heavy downpours in the Ghana's capital city.

Urban sprawl, a potential manifestation of development, has its negative impacts in coastal regions also, where beach-oriented tourism and amenity-driven population growth and land development are prominent Crawford (2007). Sprawl also includes aesthetic impacts such as more ugly and monotonous suburban landscapes.

With population growth and interface development increasing rapidly, the negative effects of urban sprawl need to be carefully considered and mitigated through effective land-use planning strategies.

On the other hand urban sprawl presents some advantages to new urban areas. One of such advantages of the sprawl is the extension of the national electricity grid to the newly developing areas. According to Peprah (2014) urban sprawl has benefitted many of the peripheral communities of Wa. These communities have access to portable water, particularly manual borehole (Peprah, 2014).

Urban growth presents new job opportunities in the cities which motivate the mass movement of surplus population away from the villages to the urban areas. At the same time, migrants provides cheap, plentiful labour for the emerging industries. The concentration of investments in cities attracts large number of migrants looking for employment, thereby creating a large surplus labour force, which keeps wages low. This situation is attractive to investment companies who can produce goods for far less than if the goods were produced where wages are higher (Bhatta, 2010). Also, peri-urbanization which is a form of urban sprawl as rural areas transition process to urban, are areas are zones of innovation that have fast growing infrastructure facilities, possess extensive green areas, and have lower land prices compared to the city, creating potential for future multifunctional development (Rauws *et al.*, 2011).

2.7 Theoretical framework

2.7.1 Informal property markets and the production of the urban built environment in Developing Countries

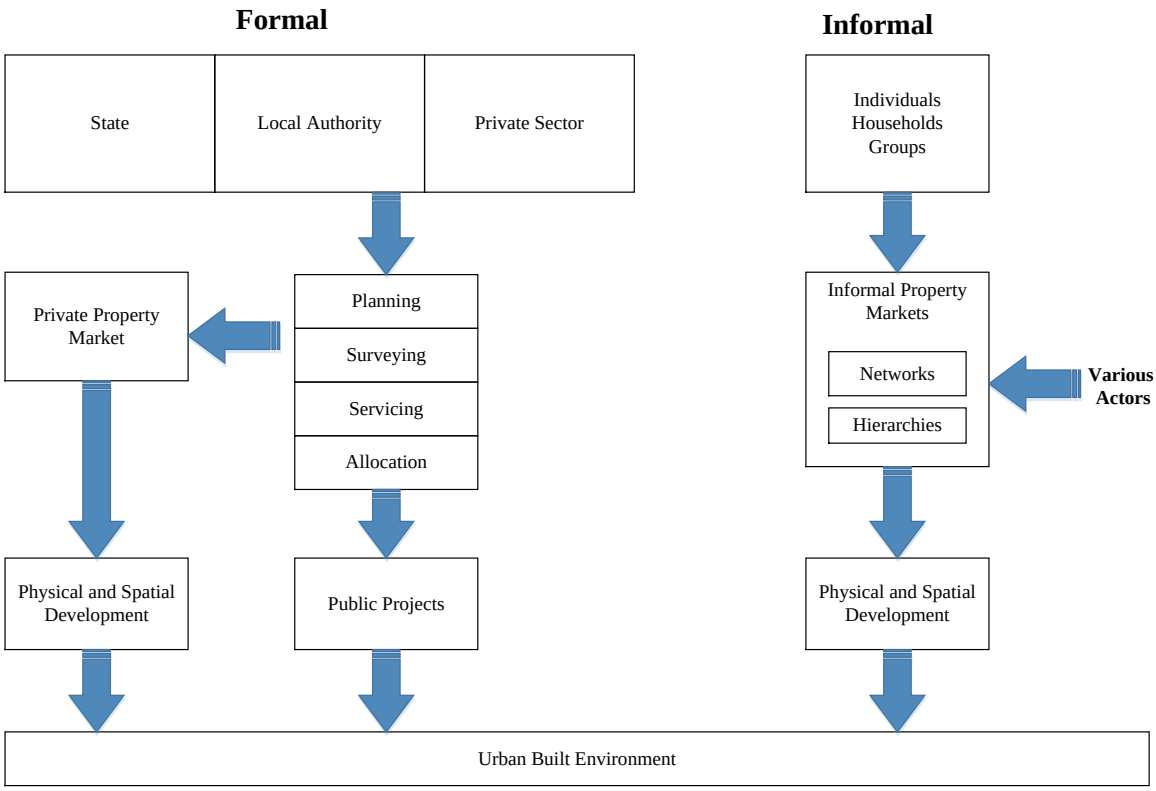
Conventional theories have been inadequate or inappropriate for the explanation of the production of the built environment, and of urban form, in developing countries. This stems from inappropriate fundamental assumptions underlying much of conventional theory, on one hand, and the characteristics of developing country environments on the other. With regard to the former, conventional theory, in keeping with its classical and neoclassical foundations, suffers from a number of weaknesses that renders it inadequate for explaining urban form. With the latter, the general context of developing countries is however patently different. For example, the character of the institutional environment, reflected in things like constitutions, property rights regimes, political power and patronage, social norms, corruption, market rules, etc is very different from the American and British context informing much of conventional theory. Developing countries tend to be characterised by the dominance of political power in the state, and dominance of the state in the economy. Institutions, such as formal property rights tend to be weak, ambiguous or arbitrary. Indeed, one of the defining features of the social and economic environment in developing countries is the preponderance of informal property rights, which ironically are mostly illegal in terms of the formal law of these countries. Relatedly there is a paradoxical contrast between the strong political coercive powers of the State and its weak enforcement capabilities in the sphere of economic transactions (Munshifwa and Mooya, 2013).

Judging from the weakness of conventional theories, a more appropriate theory explaining informal markets in the production of the built environment was theorised by Munshufwa and Mooya, (2013) is adopted in this study.

The theory outlines a generic process applicable to most developing countries through which the urban built environment is produced. As figure 3 shows, the outcome is a result of a combination of formal and informal processes. In the formal part the key actors are the state, local authorities and private sector who collaborate in creating development land from planning to physical development. One key difference between the developed and developing countries, particularly in Sub Saharan Africa, is that ownership of land is vested either in the state or the President on behalf of the citizens; the state then grants lesser rights to developers (this is the case for instance in Zambia, Botswana, Mozambique and Namibia). Development land provided through this collaborative process is then developed through the private property market as real estate or as public projects for infrastructure (roads, railway, airports, etc), public housing, government offices, etc.

In the informal process, all the activities from planning to development are conflated into the informal property market supported by social networks and local hierarchies. Individuals/households/groups are key economic agents with their actions based on individual motives and strategies. All the three forms of institutions of governance, that is; the market, networks and hierarchies are also represented. This also produces private residential and commercial infrastructure that form part of the urban built environment.

Figure 3: Theoretical Framework: Informal Property Market and the Production of the Built Environment



Source: Mushifwa and Mooya (2013)

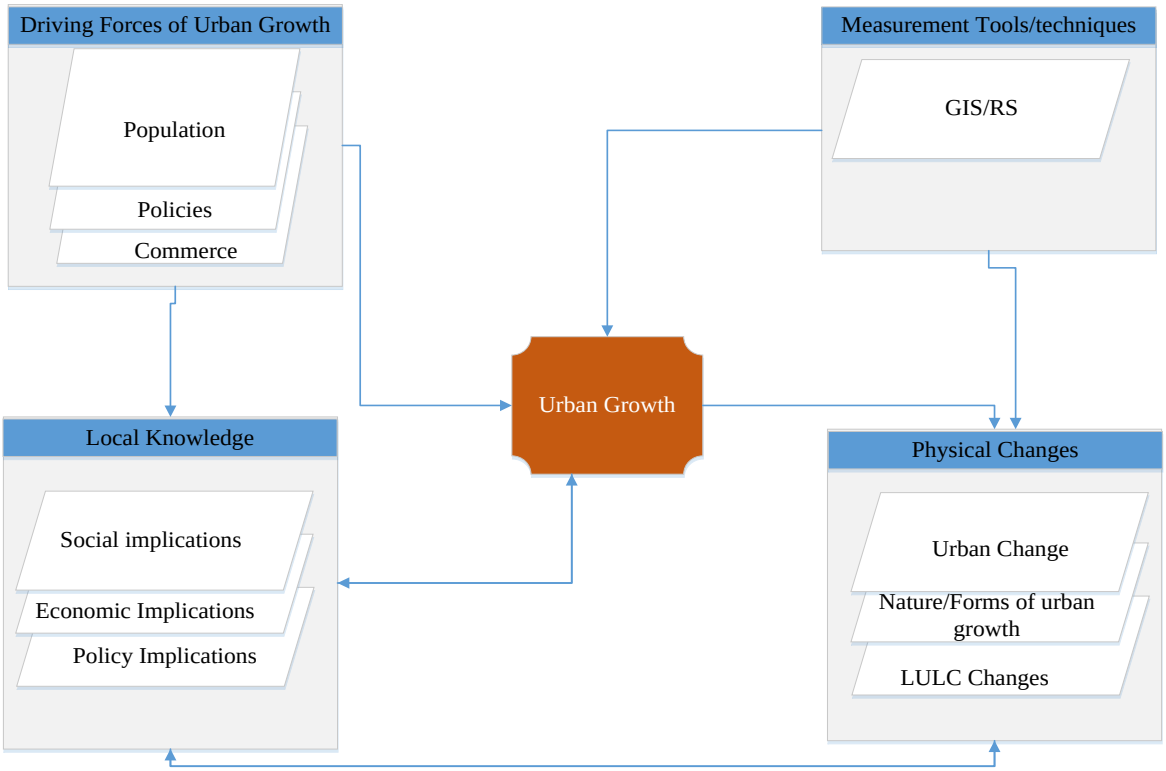
2.8 Conceptual Framework

This study is grounded on the concept of Participatory Geographic Information Systems/Science (PGIS) (see Figure 4). PGIS combines conventional GIS, which establishes a dialogue linking local knowledge and science, and national development strategies (Abbot *et al.*, 1998; Twumasi *et al.*, 2006). It allows local actors to create representations of local knowledge of space, engaging in analysis of objects, relationships and issues (Minang, 2003). With this, relationships are drawn between spatial phenomena by local residents, which are combined with the classical GIS mapping results. It is, therefore, bottom-up in approach and solves

the major weakness of conventional GIS which is top-down in approach (Minang, 2003).

Urban growth is driven by population growth as well as governmental polices and the local commerce. These forces influence urban growth directly and are therefore some of the major forces that propel growth of urban areas. However, in order to understand urban growth, the accumulated local knowledge is very essential as it explains how these driving forces have affected the growth and also explain the results of the physical changes brought by the urban growth. GIS/RS have proven to be powerful tools in measuring urban growth with satellite images as inputs. These provide powerful tools and techniques in assessing the physical changes such as urban change, land use/Land Cover change as well as the nature and form or physical growth.

Figure 4: Conceptual Framework



Source: Adapted from Koti, 2013

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter deals with methodological underpinnings of this research. It explores the design of this research, and the various techniques that were used to sample respondents and illicit information from them, as well as methods and procedure process the information/data in order to find answers to the research questions.

3.2 Research Design

Urban phenomena present a complex system. Urban growth results in spatial expansion and functional changes which can be directly observed using scientific tools. Knowledge gathered about urban growth should be objective, empirical and scientific. There should be a separation of the researcher from the urban phenomenon being studied so as to present objective, value-free results. However, with the current technological level, one cannot say with certainty the objectivity of observations and measurements used by technological tools and analysts. It is, therefore, convenient to assume a post-positivist world view of observations, measurements and predictions with some level of probability.

In contrast, the social world is a continuous process, created afresh in each encounter of everyday life as individuals impose themselves on their world to establish a realm of meaningful definition. They do so through the medium of language, labels, actions and routines that constitute symbolic models of being in the world. Scientific knowledge is thus socially constructed, through cooperative

interactions of people and their artefacts rooted in their history and culture (Gergen *et al.*, 1985). Unlike positivism, in constructionism, the researcher and the urban phenomena cannot be separated There is a total rejection of realism, rather it embraces relativism and subjectivity of all truths. Qualitative research methods should be employed to investigate knowledge claims regarding urban development. It is important, not just to describe, but to understand the social forces that bring about urban change; hence the goal is to gain the insiders view.

Judging from the ontological, epistemological and methodological stances of urban change, it is appropriate to adopt a mix method in eliciting information for this study. Both quantities and qualitative methods were employed in the study. Quantitative methods, such as image classification, GPS mapping, were used to describe spatial phenomena in Wa. Conversely, the functional changes posed by urban change were better understood using qualitative methods, such as face-to-face interviews, as well as participatory mapping.

3.3 Data Types and Sources

Transportation (road network), water bodies, preserved areas (forest reserve), reference geographic coordinates were mapped with GPS receiver and that formed primary data. Data gathered from interviews with section heads and Town and Country Planning Department also formed part of the primary data.

Satellite images, were acquired from the United States Geological Survey Department, journal articles, books and other reference materials from internet also constituted secondary data. Other secondary data include base maps and land

use plans/zones that were acquired from Town and Country Planning Department, and population data from Ghana Statistical Service Department.

3.4 Sample Design

Wa was purposely selected for this study because of its relatively small size and the potential for expansion in the near future. Also, handling of larger data sets in the GIS environment consumes more time and resources. The relative small nature of Wa, therefore means that minimum data sizes would be required for the GIS analysis.

Snowball sampling was used to select elderly Section Heads or Sub – Chiefs who have lived in Wa continuously for a reasonably long period of thirty years or more and have accumulated much knowledge concerning the urban changes. Here, the section head of Tuomuni was identified and interviewed, he then recommended a section head of Limanyiri who also recommended the head of Dondoli. This process continued until a total of twenty section heads were interviewed.

The Wa Traditional Council and the Town and Country Planning Department and Land Valuation Office of Lands Commission were also selected purposively because the former has in-depth knowledge of the history of Wa and how the tradition/culture of the people have spurred the growth of the Town. TNCPD provided the researcher with local and sector plans and general land use planning in Wa. The Valuation Office provided data on land values of some suburbs of Wa.

In sampling the number of land-use classes for satellite image classification, a classification scheme was adopted to define the land cover classes to be

considered for remote sensing image classification. The classification scheme was chosen to conform to the existing geophysical characteristics of a tropical savannah land cover. Four land cover classes were sampled for this study - Built-up, water bodies, closed savannah and woodland and shrubs. Built-up encompasses all impervious surfaces, such as residential, commercial and asphalted roads. Water bodies entail rivers, dams, lakes and other reservoirs containing water. Woodland consists of dense population of trees, and shrubs and grassland refer to areas covered with grasses, farm crops, shrubs and scattered trees.

3.5 Target Population

The sample frame consists of residents who have lived in Wa for at least 30 years. This is because such persons should have lived in Wa for a long period to be able to form part of the sample size. Since there is no available data of people who have lived continuously in Wa for over 30 years, section heads/chiefs were targeted. A total of 20 section heads/chiefs were snowballed whist one person each was purposely interviewed from the Town and Country Planning Department and the Land Valuation Board respectively.

Table 1: Sample Techniques, Sample Frame and Sample Size of this Study

Sampling technique	Target	Size
Snowball	Section heads	20
Purposive	Town and Country Planning Department	1
	Land Valuation Board	1

Source: Author's construct, 2016

3.6 Techniques/Methods for Data Collection

3.6.1 Participatory Mapping

A popular method for data collection under the concept of PGIS is participatory mapping. It is any combination of participation-based methods for eliciting and recording spatial data. It includes sketch mapping, scale mapping and transect walking among others (Abbot *et al.*, 1998). In this study, participatory mapping took the form of a guided Global Positioning System (GPS) mapping, such that, local residents would participate by walking around historical land marks/buildings or features that existed in the various anniversary years together with the researcher recording the tracks/points with a hand-held GPS receiver. This enabled this study to capture indigenes' accumulated knowledge of the spatial urban phenomena and also capture historical urban extents and phenomena at various timescales. This method describes 'how' and 'where' people live/lived as contrasted with only 'where' people live/lived in conventional GPS mapping.

3.6.2 Interviews

Semi-structured interviews were used to elicit information from section heads/ sub chiefs (at least 30 years old in Wa) and the Wa Traditional Council about the urban change and what it implies on socio-economic development, and the Town and Country Planning Department on the on land use planning issues and regulations.

3.7 Data Processing, Analysis and Presentation

3.7.1 Software

Erdas Imagine (version 9.2) by Leica-GeoSystems was used to process the satellite images. Accuracy ratios, change rates, Kappa statistics were generated using ERDAS. ArcGIS 10.1 from Environmental Systems Research Institute was used to prepare all final maps. Microsoft Excel 2013 was was used to generate descriptive statistics from data collected using questionnaires.

3.7.2 Land Use/Land Cover Classification

In order to get the spatio-temporal changes that have taken place as the urban area changes, it is important to undertake land cover change detection. This was made possible by acquiring four satellite imagery of the same area at different timescales. The images were georeferenced with coordinate system Universal Transverse Mercator, Zone 30 North.

Landsat Images of January 1986, November 2001, January, 2014 and January, 2016 were processed and analysed. Detailed information of the images are provided in the table below.

Table 2: Characteristics of Satellite Images Used

Landsat (Sensor)	Spatial Resolution	Path/Row	Bands (False Colour)	Date
Thematic Mapper (TM)	30m x 30m	195/053	4, 3, 2	18/01/1986
Enhanced Thematic Mapper (ETM)	30m x 30m	195/053	4, 3, 2	03/11/2001
Operational Land Imager (OLI)	30m x 30m	195/053	5, 4, 3	16/01/2014
Operational Land Imager (OLI)	30m x 30m	195/053	5, 4, 3	21/01/2016

Source: Author's construct, 2016

The bands for the various images were stacked to form multi-spectral images. A shapefile of the municipal boundary of Wa was overlaid on the 1986 image and the Area of Interest (AOI) was derived from the municipal boundary using Erdas Imagine 8.3. This AOI was saved and used to subset all the four images in the Erdas Imagine 8.3 environment The images were not too bright so contrast stretched were performed on each of the images to increase the brightness. The band combinations were set to 4, 3, 2 for the TM and ETM images and 5, 4, 3 for the Operational Land Imager (OLI) images to be able to view the images in infrared colour.

The study adopted a supervised classification technique where training areas of each land-cover class were selected with the help of reference data (Lillesand *et al.*, 2008). Although supervised classification comes with difficulty and a high cost of selecting training sites, and there may be situations where training sites may not encompass unique spectral classes, the selection of appropriate training

areas was based on the analyst's familiarity with the geographical area and their knowledge of the actual surface cover types present in the image, which in this case was made possible by the geographic coordinates collected from the field. Supervised classification therefore gave the analyst more control over the type of classes defined within a geographic area and you do not need to match unknown spectral categories to real-world classes (Richards, 1999).

Geographic coordinates collected through ground truth field work were overlaid on the images. These coordinates were collected using Garmin etrex hand held GPS Receiver where random points were collected at places with at least 30 meters apart. This was to ensure that no two points fell on one pixel when overlaid since the satellite images used for the classification have spatial resolution of 30 meter by 30 meter. These coordinates represented the various land cover/land use types on the ground and this aided the definition of sample cluster of pixels for classification signature file derivation.

The classification algorithm used was Maximum Likelihood Classifier (MLC), which assumes that each spectral class can be described by a multivariate normal distribution. MCL takes advantage of both the mean vectors and the multivariate spreads of each class, and can identify those elongated classes. However, the effectiveness of maximum likelihood classification depends on reasonably accurate estimation of the mean vector m and the covariance matrix for each spectral class data (Richards, 1993).

The signature file was used in the supervised classification tool to classify the various images into five land use/Land cover classes. Thus, Water, Built-Up,

Closed woodland shrubs and grassland and bare ground. These five classes were further recoded to two classes – Built- Up/urban and non-built-up/Non-Urban. The classified images were imported to ArcMap 10.1 and final maps were produced and exported.

3.7.3 Accuracy Assessment

For a Land Use classification to be accepted or considered valid, its accuracy must be calculated and a decision is taken as to its acceptance or rejection. Accuracy assessment is a measure of a degree of correspondence between observation and reality usually in a percentage. Generally, Total accuracy does not reveal whether errors were evenly distributed between classes or if some classes were really bad and some really good. Therefore User and Producer Accuracy which corresponds to error of commission/inclusion and error of omission/exclusion respectively are provided (Congalton *et al.*, 1999). In this study, an accuracy assessment was performed on the images by taking 150 random points on the ground compared with the classified image. An error matrix revealing the User and producer Accuracies together with the Overall Accuracy is reported below for 1986, 2001, 2014 and 2016.

3.7.4 Nature of Urban Expansion

In exploring the nature of urban expansion of Wa Township since 1986, the classified images of Wa (built and non-built classes) were imported to ArcMap and analysed.

Urban Extent: This represents the largest continues zone of built up. This was extracted from the classified images using on-screen digitizing technique in ArcGIS 10.1 software. The results were vector files (polygons) representing the urban extent. The size of the polygons were calculated using ArcMap 10.1 area calculation tool in square kilometres (Km^2).

Built-Up Extent: this represents actual area occupied by buildings. It excludes open spaces and roads that are present in Urban extent. This was made possible by converting the classified image from a raster file to a vector file and extracting only built up areas excluding roads and pavements. This was done with ArcGIS 10.1 environment.

Density: The density of the town for the various years were derived by extracting the area of the township and matching that with the population of Wa for the respective years. However this represented the crude density since the township include open spaces, water bodies and other areas excluded from development like parks. Therefore, the actual area that is built was extracted by clipping the classified image to the digitized township extent for the various years. The areas were then extracted in squares of kilometres.

the population for 1986 was projected from the 1984 census figure for Wa using the intercensal growth rate of 1.7 percent (1984 – 2000) and the 2001 figure from 2000 population and housing census figure as base year population and an intercensal growth rate of 1.9 percent per annum (2000 – 2010). The 2014 and 2016 figure were projected using the 2010 population as base year and the

intercensal growth rate of 1.9 percent per annum (2000 – 2010), since no population census has been conducted in Ghana yet since 2010. The formula below was used to derive the final populations for the respective years (Harrison *et al.*, 2011)

$$P = P_o(e^{rt})$$

Where P = Population, $P_{o=}$ population of base year, *e* = a base of a natural logarithm equal to 2.718, *r* = rate of growth and *t* = time

Density was calculated as $D = \frac{P}{A}$ where *D* = Density, *P* = population and *A* = Area

Infill: Built-Up areas that developed in-between already existing urban area were classified as infill developments. These areas were identified by overlaying year t2 on Year t1 (also t3 on t2 and t4 on t3) and digitizing all new areas that have been built up in year t2 but were open spaces surrounded by built up areas in year t1.

Extension: Urban/built-up areas that extended from already built-up areas were classified as extended developments. These areas intersects with already built-up areas but extends outwards.

Leap Frogging: built-up areas that occurred over 200 metres away from an existing built-up area was classified as leap frog developments. These areas have no neighbour or do not connect with existing urban/built-up areas. These areas coincided with small villages that are growing rapidly away from the urban core.

Therefore these areas were classified as Leap frog development/Peri-Urban developments (Angel *et al.*, 2007).

Linear/Road Influenced: these were built-up areas along major routes of transportation (roads). New developments that were 10 to 500 meters away from road were classified as road influenced or linear developments.

3.7.5 Socio-Economic Implications

Data gathered from interviews using semi-structured questionnaire were processed using SPSS software. The descriptive statistics tool was used to export the result frequencies and percentages and MS excel was then used to present these frequencies and percentages in charts and graphs. This provided the locus for discussion and further content analyses of the information provided.

Also, planned and unplanned areas were mapped by georeferencing and digitizing google earth imagery. This was done by digitizing the planned areas and unplanned areas on google earth pro software. The results were converted from google earth format (.kml) to ArcMap format shapefile (.shp) and transferred to ArcMap 10.1 software where it was georeferenced and further digitized. All data were defined using the coordinate system projected coordinate system, universal transverse Mercator zone 30 North. The data were further refined and cleaned and overlaid with road network geographic data of Wa. A layout map was then produced showing the levels of planning in Wa was produced as the final output.

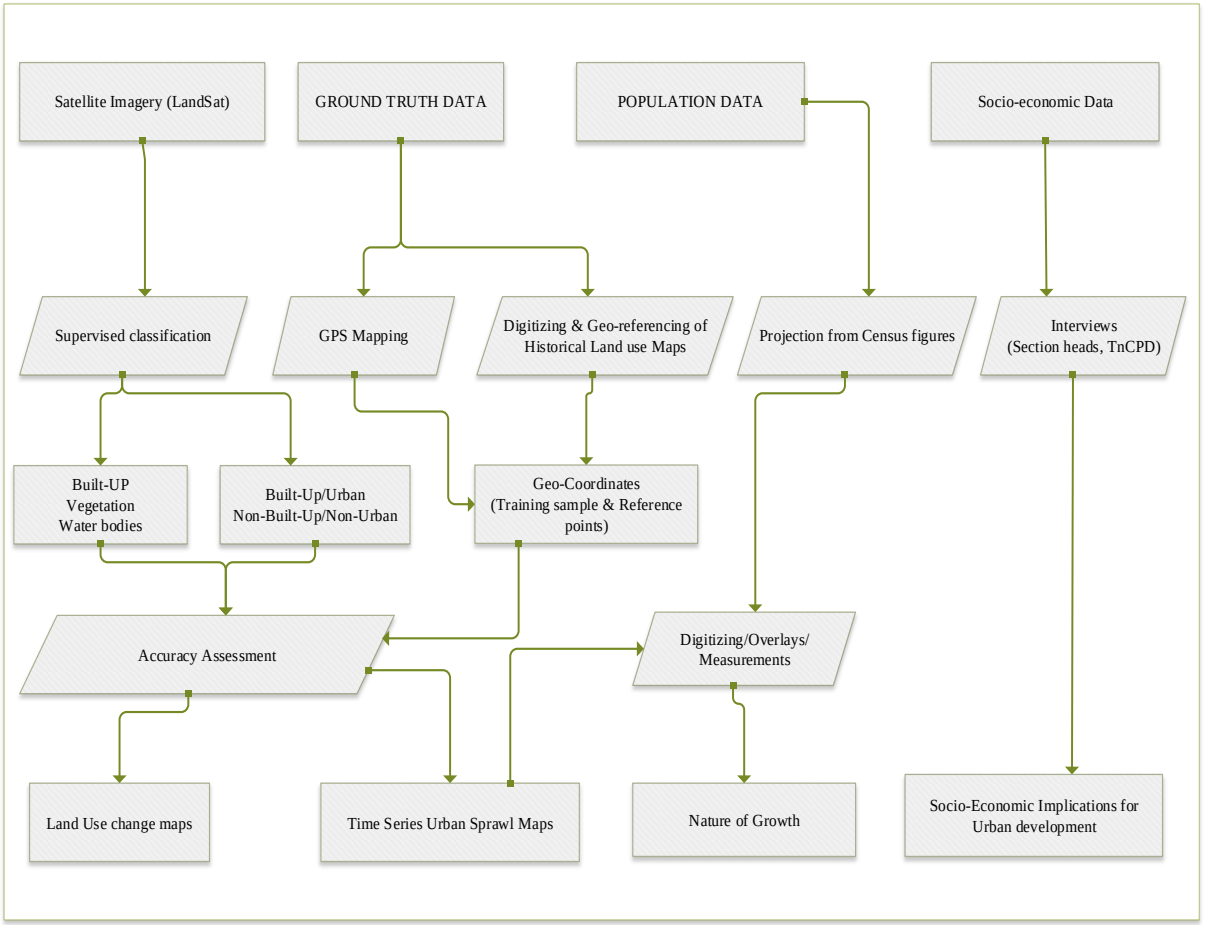
3.8 Summary of Methodological Framework

In order to provide time series urban sprawl and broad land use changes of Wa from 1986 to 2016, four satellite images were processed by classifying the land cover into built up and non-built up; Built up inhere refers to all impervious surfaces. The classification was done using the supervised classification technique. Ground truth data were acquired through field work. The ground truth data were used to train signatures for the classification process. Part of the ground truth data were also used as control points and used to perform accuracy assessment of the classified images. However, it was not appropriate to use current ground truth data to perform accuracy assessment of the anniversary images. A process like that would mean travelling back in time to 1986 with a GPS device and collecting ground data. Because of this, an alternative was to geo-reference and digitize old base maps and town and country planning maps and then select known land cover points on these as reference points; of key importance was a settlement map of Wa in the 1960 by Town Planning office of the then Northern territories (Wilks, 1989). Also, since the town grew from the central business district – oldest settlements, sample geographic coordinates were collected at these localities and were used as control points to assess the accuracy of the anniversary images. The same process was used for the broad land use classes with Built-up, Water, woodland and shrubs as the classification scheme.

Population figures from previous censuses were also projected using the growth rates for the different times to match with the urban extent at each time.

Finally, interviews with sections heads were processed with Microsoft Excel where descriptive statistics such as frequencies and percentages used to analyse results and charts and tables used to represent the results. The results from the interviews were also transcribed and used to support maps and other quantitative information derived from satellite imagery analysis. Figure 5 below represent the framework of analyses for this work.

Figure 5: Analytical Framework



Source: Authors construct, 2016

CHAPTER FOUR

ANALYSIS AND PRESENTATIONS OF FINDINGS

4.1 Introduction

This chapter presents the answers to the research questions of this study. It gives detail analyses of the data/results presented herein and discusses the major issues that have been uncovered by the study. The chapter covers population growth of Wa, urban sprawl and its indicators, land use and land cover changes of Wa and socio-economic implications of urban transition.

4.2 Population Growth and Urban Sprawl

4.2.1 Population growth of Wa from 1986 to 2016

The country shifted from the Local Authority system to the District Assembly concept of administration in 1988. With this change, the country was demarcated into 110 districts out of the existing local authorities. It is therefore not appropriate to compare population of the local authority system to the district assembly system because the boundaries of the districts do not necessarily conform to the boundaries of the local authorities, but are coterminous with regional boundaries (Ghana Statistical Service, 2002). Nonetheless, population figures for Wa Township can be compared.

Wa town recorded a significant growth in the number of people since 1986. With an intercensal growth rate of 1.7 percent from 1984 to 1999, the number of people in Wa stood at 37,954 in 1986. This figure increased by about 79 percent within 15 years to 67,922 in 2001. The 2010 Population and Housing Census gave an

intercensal growth rate of 1.9% per annum and since no census has been conducted since 2010, this growth rate was used to project the population for 2014 an 2016 resulting in 9,051 people and 2,981 respectively. In total, the population of Wa increased by 102.8 percent from 1986 to 2016. The projected population figures are presented in the Table 3 below.

Table 3: Population of Wa Town, 198 to 2016

Year	Population	Area (km^2)	Density (persons/sq. km)
1986	37954	2.0	18698
2001	67922	8.7	7819
2014	76973	15.7	4900
2016	79954	24.6	3253

Source: GSS (2012)

4.2.2 Factors accounting for Population Growth of Wa

4.2.2.1 Immigration

Migration is an essential component of population change of an area. It is caused by several socio-economic agents that either act as pull or push factors to a destination or an origin of migrants Henderson (2000). These are exemplified in respect to migration in Wa in the ensuing discussions. Over four millennia, people from within and out of Ghana migrated and settled in what is presently called Wa for various reasons. These groups of people, although settled in Wa at different times, have contributed to the formation of the town and its eventual expansion. The groups settled as families in small compound houses and, with time, grew to become sections or communities in Wa (Table 4).

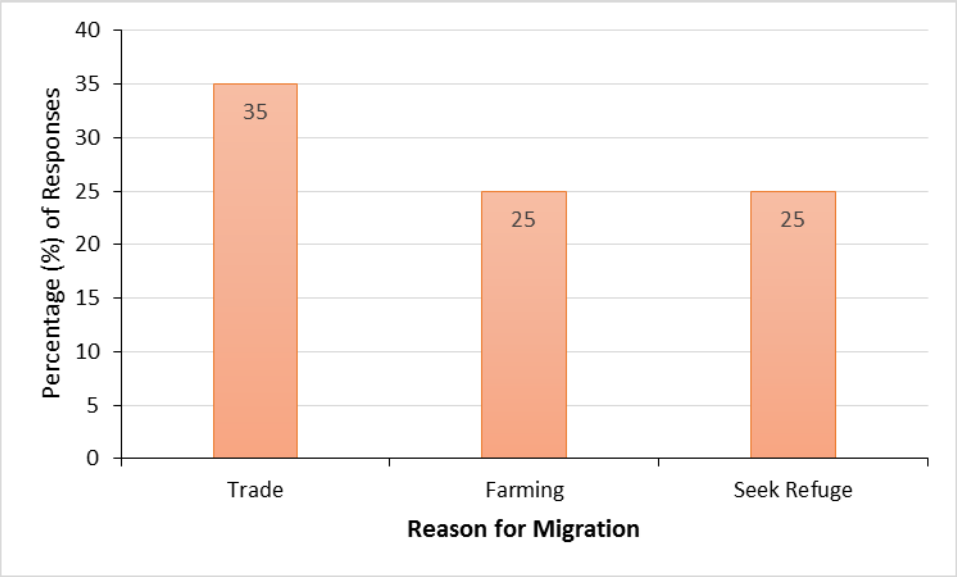
Table 4: Origin of Migrants in Wa

Present Community	Origin	Period of Settlement
Bamahu	Limanyiri	1900s
Bambiriyiri	Kpaluwogu	Over 200 years ago
Jengbayiri	Nigeria (Kano)	Over 200 years
Kabanye	Kpaluwogu	Over 300 years
Konta	Wa Nayiri	1900s
Kpaguri	Nalerigu	Over 300 years
Mangu	Bulenga	1800s
Nayiri	Nalerigu	300 – 400 years
Nupayiri	Buntuku	350 years
Sembeleyiri	Kpaluwogu	300 – 400 years
Sombo	Kperisi	colonial era
Suuriyiri	Dagbon	1670s (300 - 400) years
Tagrayir	Mande	1519
Tuomuni	Cameroon	1616
Watahiyiri	Mande (ivory coast)	Over 300 years
Zongo	Burkina Faso, Nigeria,	Over 200 years

Source: Field work, May, 2016

These old settlements are over 400 years old but the exact dates in which they came into existence cannot be traced. They included people from Dagbon (Nalerigu), Ivory Coast, Burkina Faso and Nigeria, who migrated to Wa to seek refuge, to acquire more land for farming and for trade (Figure 6). The latter included most of the people from Djengbeyiri and Zongo.

Figure 6: Reasons for Migrating into Wa



Source: Field Work, May, 2016

There is also the issue of relocation, where people from the old settlements relocate to outer places to secure lands for farming. Bamahu and Konta are typical examples of suburbs that came about through relocation. People from Nayiri and Limanyiri relocated to Konta/Napogbakole and Bamahu respectively for farming. These formed new localities which grew to become the suburban areas they are today.

Migration in Wa has not been with only early settlers, but new migrants as well. Following the formal reconstitution of the Northern Protectorate in September, 1901, migrants from the southern parts of Ghana moved to Wa and worked as Clergy men and women, cooks and other jobs for the colonial administrators. Others also worked as teachers in public schools in Wa which further increased the population. Also, migrants trooped into Wa following the creation of the Upper West Region, with Wa as the regional capital in 1983. Many public offices were

opened and this brought in more people to Wa. The commercial opportunities that were created as a result further pulled more migrants to the town.

Last but not the least, the establishment of Wa Polytechnic in 2002 and University for Development Studies, Wa Campus, in 2004, together with other second cycle institutions contributed to the growth of population in Wa. These educational institutions brought in larger numbers of students in addition to workers/staff employed by these institutions. It must, however, be emphasised that most of the people in this category are temporal migrants.

4.2.2.2 Natural Increase

With increase in healthcare delivery services in Wa, as can be seen in the numerous health facilities (Both Public and private), fertility rates have increased significantly with a reduction in infant mortality. This implies that there is a positive net increase in natural growth, and this has contributed to the growth of population in Wa.

4.2.3 Urban Sprawl

4.2.3.1 Spatial Extents of Wa since 1986

The first land cover/land use classification was done using only two classes as the classification scheme, Built–up and Non-Built Up. As explained in section 3.3.3, Built–up herein refers to all impervious surfaces like residential, commercial, pavement, roads but excludes rocky areas whilst Non-Built Up areas includes farmlands, fallow and range lands, and other land cover types that does not fall within the former class description. The Built-up interface of the municipality has increased considerably as can be seen on the three map composite in Figure 7. From

just a small radius in the middle of the 1986 map, it expanded and increased in density/compactness in the 2001 and, even, much further in the 2014 and 2016 maps.

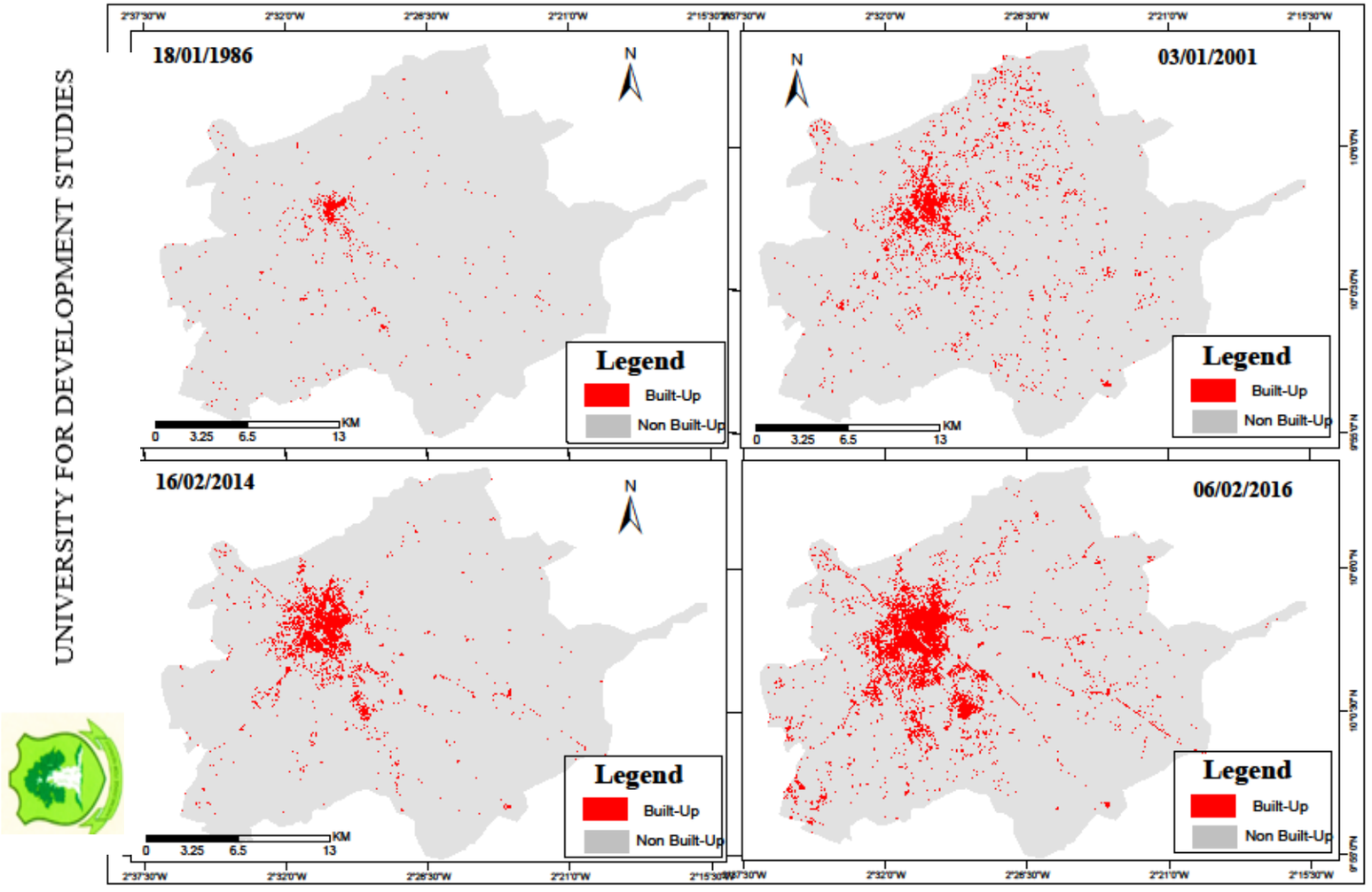
Statistics from the image analysis revealed that the built up interface has had a total increase of 100.5 percent of the total municipal area from 1986 to 2016. Between 1986 and 2001, thus a period of 15 years, the built - up area recorded an increase of 50.6 percent of the municipal area, but grew by 35.1 percent between 2001 and 2014. It further grew by 49.8 percent between 2014 and 2016.

Although the intervals are not the same as 1986 to 2001 covers 15 year period whilst 2001 to 2014 and 2014 to 2016 cover 13 years and 2 years respectively, one thing that is common is that, the built up area has been increasing significantly since 1986 reaching a total of 100.5 percent between 1986 and 2016.

It is good to note that the slight difference in the total areas between 1986 and the other years is as a result of pixel size difference. Whist the former has a pixel size of 28.5 meters by 28.5 meters, the latter two images have 30 meters by 30 meters as the pixel sizes. This has made the total area of the 1986 image to be a little less than the 2001 and 2014 and 2016 images.

The statistics of these images are summarized in Figure 7 and Tables 5 and 6 below.

Figure 7: Map of Built Up and Non Built Up extents of Wa Municipality (1986, 2001, 2014 and 2016)



Source: This Work, 2016

Table 5: Built Up and Non Built Up Areas of Wa Municipal (1986, 2001, 2014 and 2016)

Land Use	1986		2001		2014		2016	
	Hectare (ha)	Percent	Hectare (ha)	Percent	Hectare (ha)	Percent	Hectare (ha)	Percent
Urban	614.4	1.0	2012.2	3.4	4393.6	7.5	4587.7	7.8
Non-Urban	58044.4	99.0	56677.4	96.6	54296.0	92.5	54100.0	92.2
Total	58658.7	100	58689.6	100	58689.6	100	58687.6	100

Source: Author's construct, 2016

Table 6: Urban Change between 1986 to 2001, 2001 to 2014 and 2014 to 2016

Land Cover/land use	1986 to 2001		2001 to 2014		2014 to 2016	
	Difference (ha)	Percentage Change	Difference (ha)	Percentage Change	Difference (ha)	Percentage Change
Urban	1397.8	50.6	2381.4	35.1	194.1	49.8
Non-Urban	-1366.9	-49.4	-4393.6	-64.9	-196	-50.2
Totals	2764.7	100	6775	100	390.1	100

Source: Author's construct, 2016. NB; Totals have absolute figures

4.2.3.3 Population Growth and Urban Sprawl

In 1986 about 37,954 people lived in Wa Township, which extended to about 6.7 square kilometres. In 2001, as the population grew sharply to 67, 922 people, the township extent also increased to 20.2 square kilometres with only 8.7 square kilometres constituting the built environment. Further, in 2014, the township expanded to about 40 square kilometres with 76,973 people residing in Wa. Here, the built up space occupied 15.7 square kilometres. Finally in 2016, the township again rose 7.2 percent to 48 percent with a population of 79, 954 people.

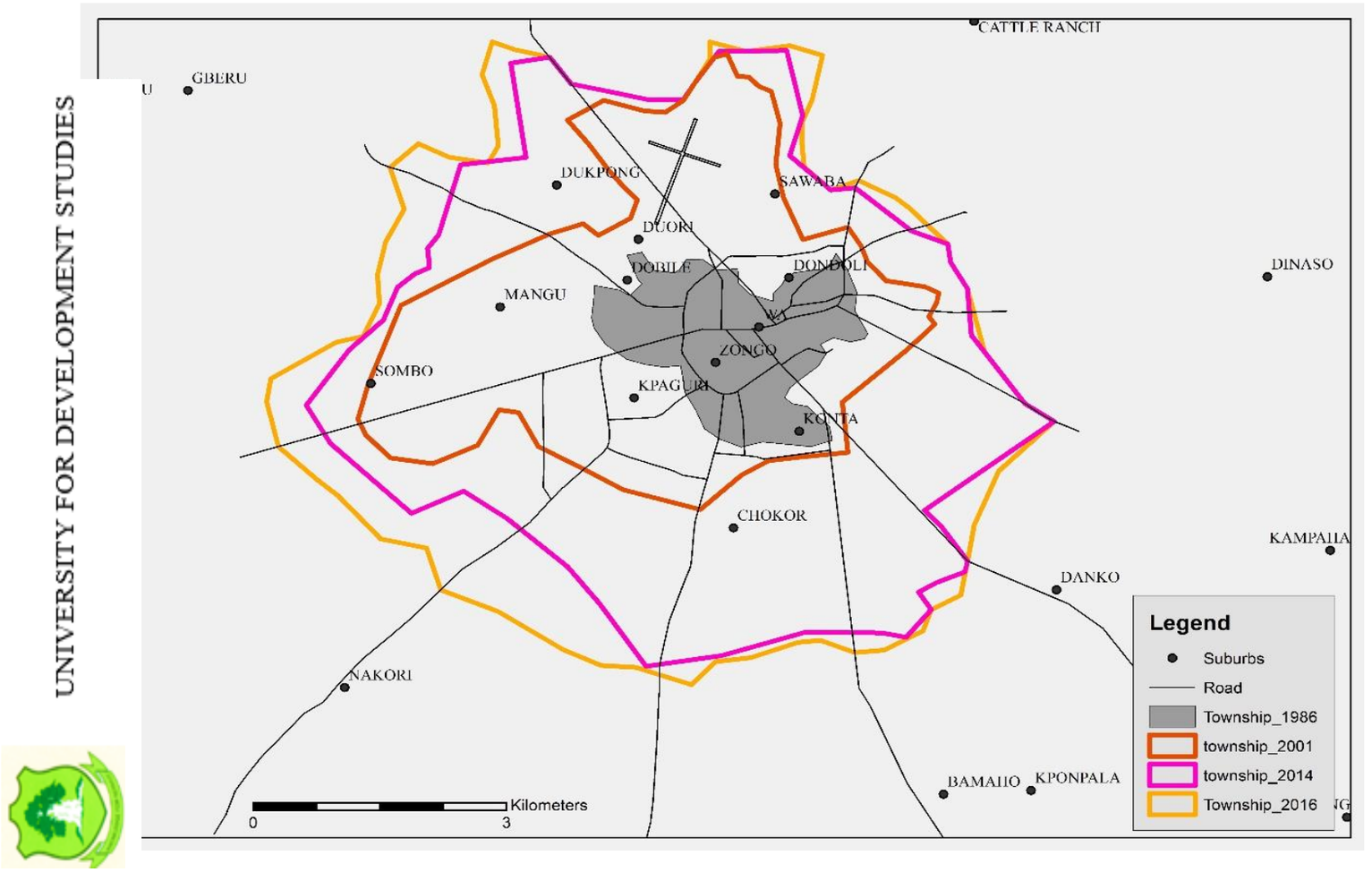
The population and the areas are presented in Table 7 whilst the extent is presented in Figure 8 below.

Table 7: Population, Urban Extent and Built-up Area of Wa from 1986 to 2016

Year	Population	Urban extent (km^2)	Built Area (km^2)
1986	37954	4.7	2.0
2001	67922	20.2	8.7
2014	76973	40.8	15.7
2016	79954	48.0	24.6

Source: Author's Construct, 2016

Figure 8: Map of Extent of Wa Township in 1986, 2001, 2014 and 2016



Source: Author's construct, 2016

Table 8: Population of Wa in 1986, 2001, 2014 and 2016

Year	Population	Increase	Percent increase (%)
1986	37,954	-	-
2001	67,922	30038	79
2014	76,973	9,051	13.3
2016	79,954	2,981	3.9

Source: Author's construct, 2016

4.3 Nature of Urban Sprawl in Wa

The Built-Up Map for the municipality revealed Wa as the largest contiguous zone of settlement and the only town that has achieved an urban status. Several types of growth have been revealed in this work.

4.3.1 Low Densification

Urban growth in Wa has been similar to general the characteristic of Africa's urbanization (Harvey and Clark, 1971; Pumain, 2003, (Pendall, 1999; Gläser and Kahn, 2003), there has been decrease in the number of people per a square kilometre since 1986. This study reported a total population of 37,954 people living in 2.0 square kilometres of land in Wa Township in 1984, which makes a density of 18,698 people per square kilometre. In 2001, the population of Wa increased to 67,922 people whilst the built up area increased more than 300 percent to 8.7 kilometres square, giving a density of 7,819 people per square kilometre.

Again in 2014, 76,973 people lived in 15.7 square kilometres of land in Wa town and this further decreased the density to 4,900 people per square kilometre. A similar situation continued in 2016, with a 3,253 people living in a square kilometre.

The Table 4.8 below depicts the population, total built-up area in Wa town and the density for the years 1986, 2001, 2014 and 2016.

Table 9: Population Densities for Wa Town from 1986 to 2016

Year	Population	Area (km^2)	Density (persons/sq. km)
1986	37954	2.0	18698
2001	67922	8.7	7819
2014	76973	15.7	4900
2016	79954	24.6	3253

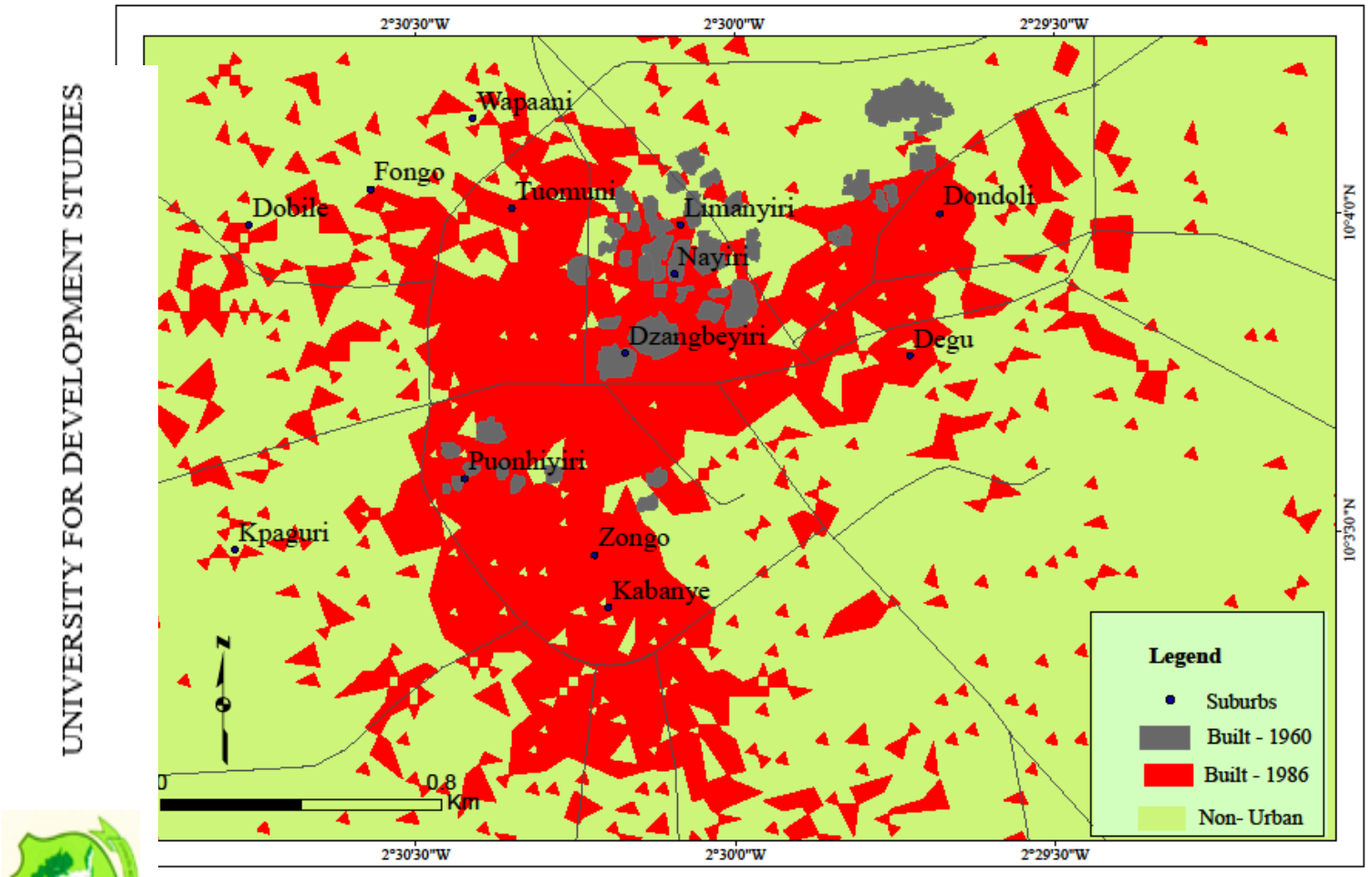
Source: Author's construct, 2016

4.3.2 Infill Urban Growth

As posited in the preceding discussions, after 1986, the town grew more concentrated as a result of infill developments and thereafter sprawled outside the 1986 township boundaries. The infill occurred more in the Zongo, Wapaani and Dondoli areas. The town then extended outward in all directions. Figure 9 below depicts this situation.

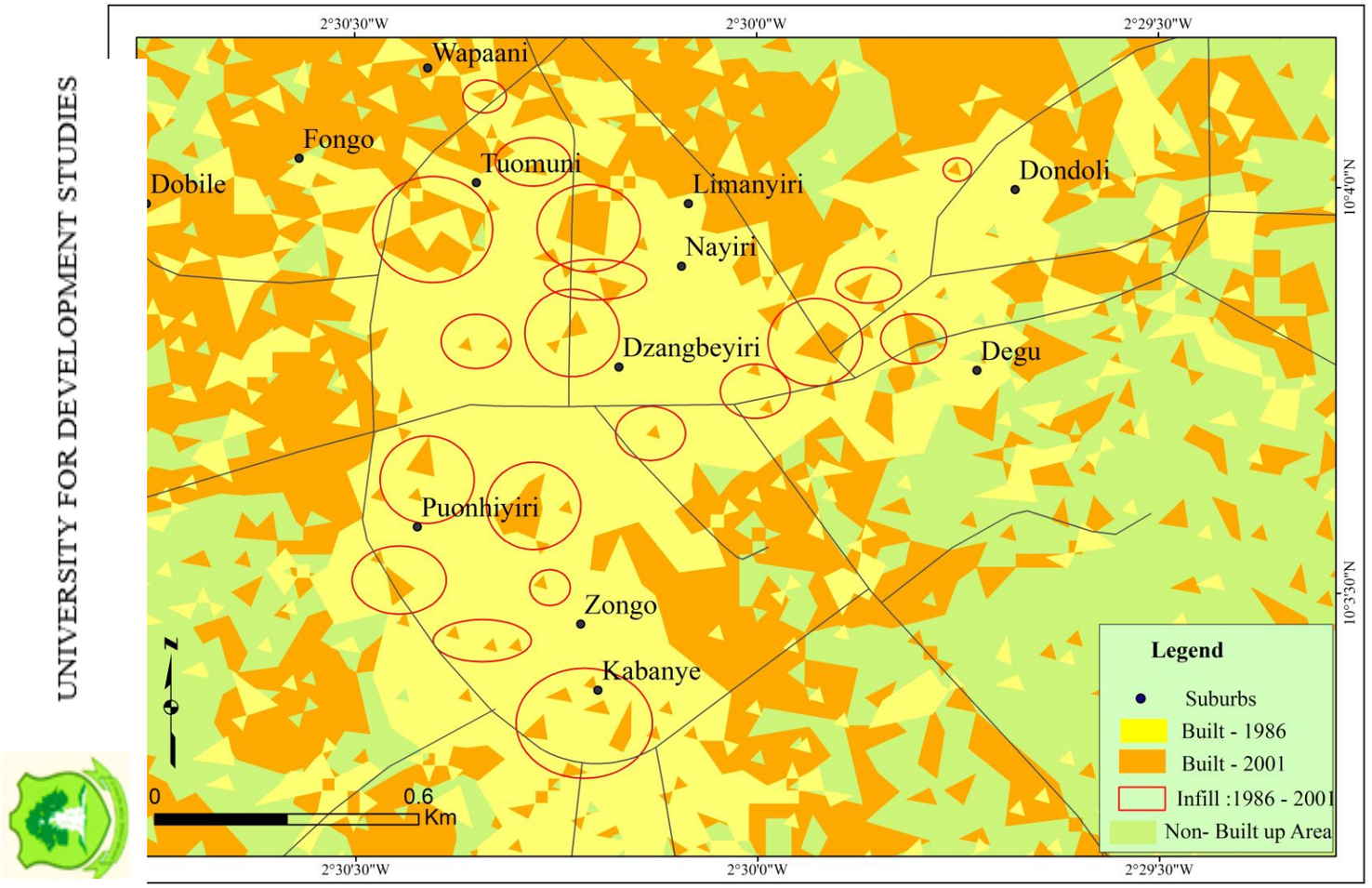
Prior to the upgrade of Wa to a district and regional capital, Wa was mostly indigenes and traders who preferred to live temporally around the CBD (closer to the market) whenever they came in. however, the upgrade brought in more workers who demanded more permanent accommodation away from the noisy and CBD. Also by this time the CBD was concentrated and open spaces available for development had been used up, therefore, the infilling reduced after 1986 and a new phenomenon – extension emerged. This is discussed in the next section.

Figure 9: Urban Infill Growth of Wa from 1986 to 2001



e: Author's construct, 2016

Figure 10: Urban Infill Growth of Wa from 2001 to 2014



Source: Author's construct, 2016

4.3.3 Extension

The results show that Wa did expand more beyond the areas depicted by the 1960 map in section 4.2.2. Although the 1960 map is a thematic map, it shows the areas occupied by settlements. The results of the 1986 built up area in Figure 11 presented a somewhat different phenomenon. Thus, the settlement expanded beyond what is presented in the 1960 map and intersected with one another forming a more compact urban interface. The Zongo area expanded outward the ring road towards Konta and Kabanye areas. Dondoli also expanded northward while a new area developed in-between Suuriyiri and Tuomuni and Fongo called Wapaani, which is translated as 'New Wa'.

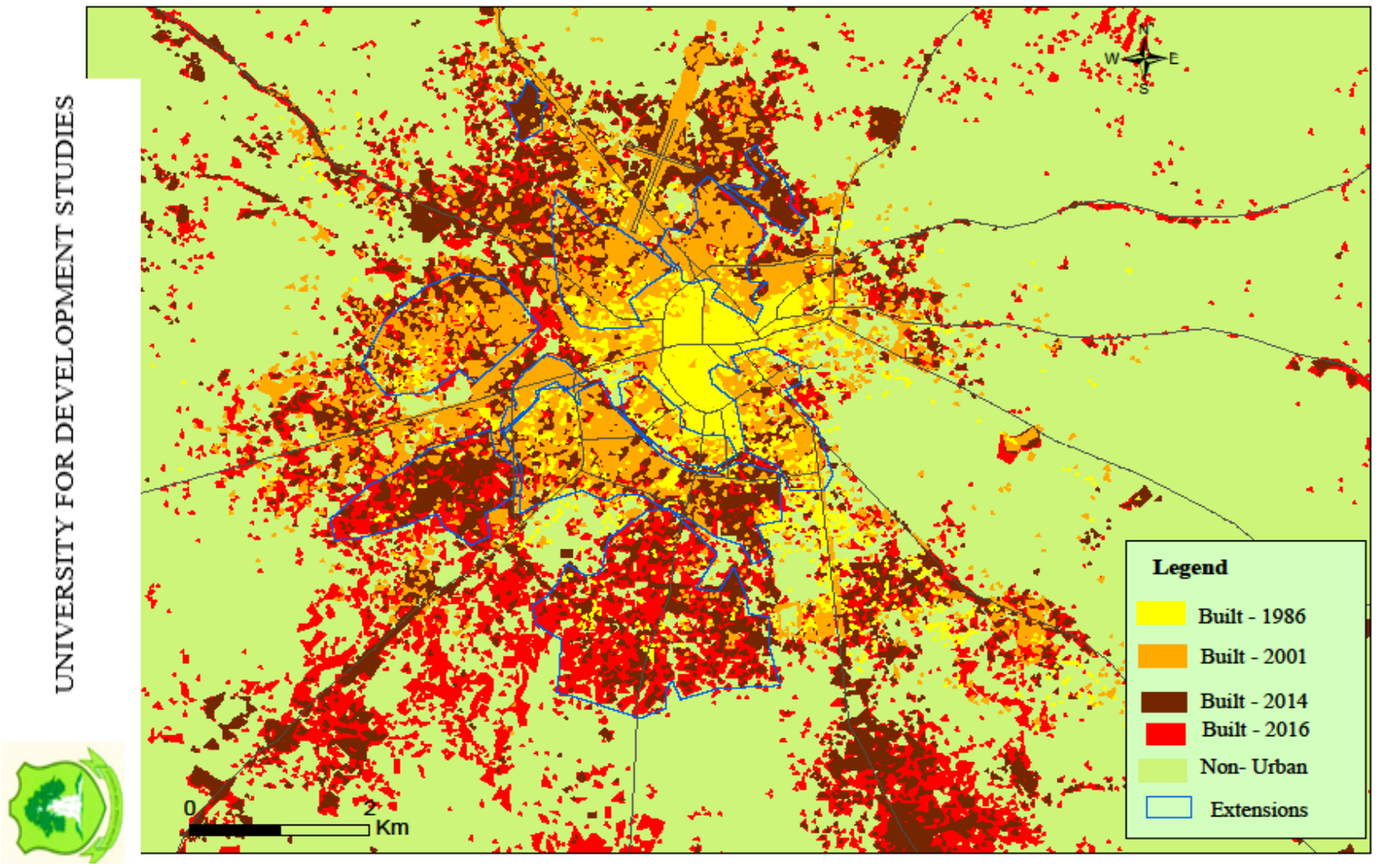
The location of the market also influenced the development of residential and commercial facilities around the market. This filled the open space around the market eventually connecting Dzangbeyiri, Puohuyiri and Fongo as one continues built up zone. Also, the results show new settlements to the west of the market – present day cereal and grain market area.

The location of the market also influenced the development of residential and commercial facilities around the market. This filled the open space around the market eventually connecting Dzangbeyiri, Puohuyiri and Fongo as one continues built up zone. Also, the results show new settlements to the west of the market – present day cereal and grain market area.

New areas emerged as demand for residential facilities increased, extension occurred outward the existing built areas, usually with at least one built – up

neighbour that is at most 200 meters. The map below (figure 11) depicts new areas growing outward from each of year.

Figure 11: Map of Wa Showing Extension Urban Growth of Wa Town from 1986 to 2016



Source: Authors Construct, 2016

4.3.4 Peri-Urbanization/Leapfrog Urban Growth

The results from 2001 did not only reveal an expanding Wa town that is about four times bigger than its extent a decade and half earlier, it also revealed an interesting phenomenon known as 'Leapfrog growth' (see Figure 12 below).

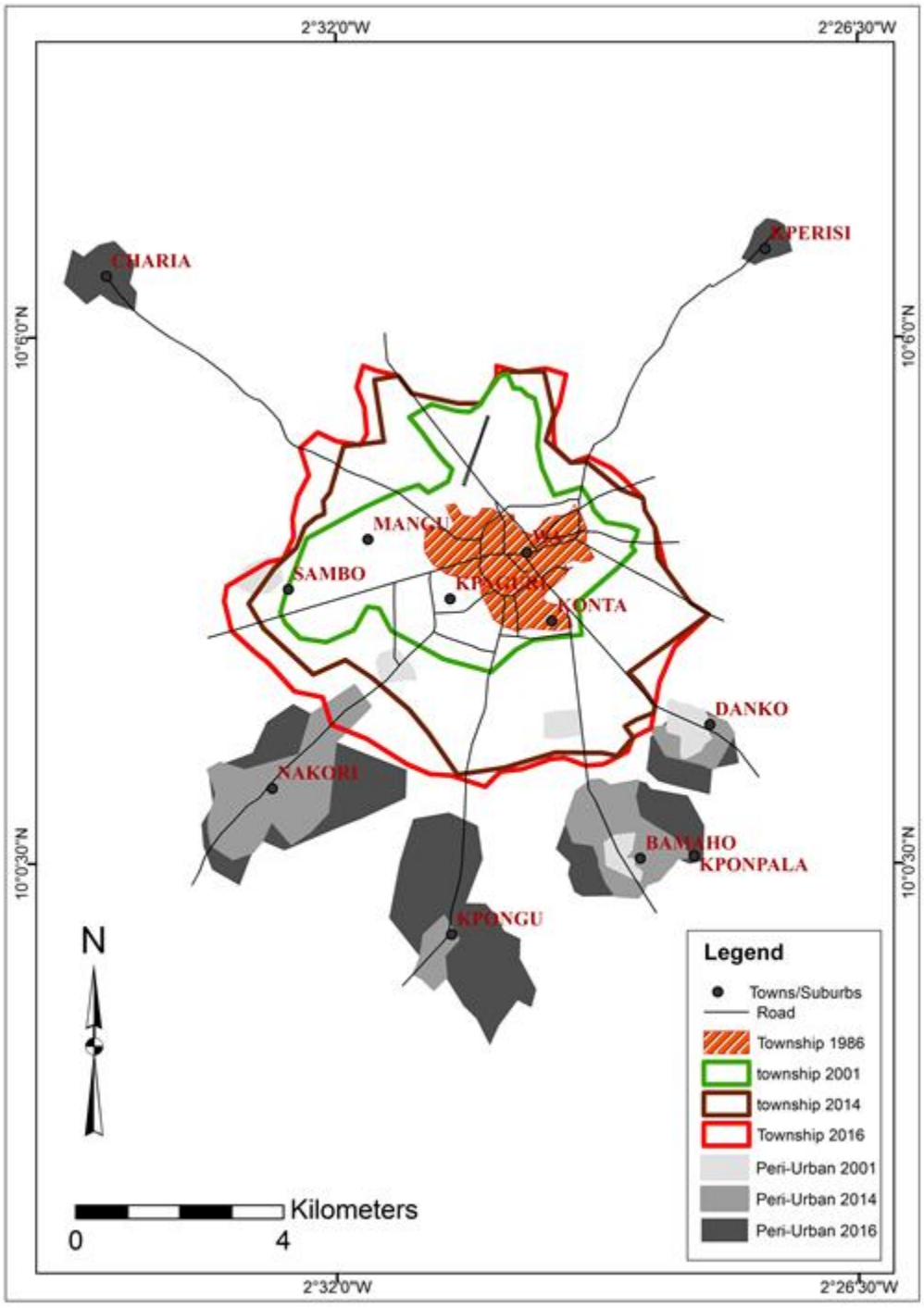
New areas developed outside the urban core southwards. These areas appear to be outliers with less concentration. SSNIT and its surroundings, Chorkor, Kpaguri Extension and Napokbakole can be identified as peri-urban areas in 2001. Bamahu and Danko also exhibited similar characteristics. These areas were developing areas that did not expand directly from the central core and hence existed as though the development had skipped certain areas for obvious reasons.

One of such reasons might have been the existence of second cycle and basic schools, such as Wa Senior High School, Wa School for the Deaf, Ahmadiya Basic School, and Djedjeyiri Basic Schools, that occupied relatively large expanse of land between Konta and SSNIT. This might have forced development to skip these areas to SNNIT and its surroundings and also to Danko. A similar reason is the Wa Technical School that lies in-between Kabanye and Kpongu.

In 2014, the township again grew bigger and now encapsulated areas that existed in 2001 as outliers or peri-urban areas. SNNIT and Chokor and parts of Napogbakole became part of the urban core and existed as a single continues area of built up landscape (presented in Figure 12 below). However, more peri-urban areas emerged, this time, only southwards. Kperisi and Charia grew as peri urban areas to the north-east and north-western parts of the urban core respectively. Bamahu and Kpongpala

became more concentrated. Kpongu and Nakori expanded but still laid outside the urban core.

Figure 12: Map Showing the Urban core of Wa township and developing peri urban areas from 1986 to 2016



Source: Author's Construct, 2016

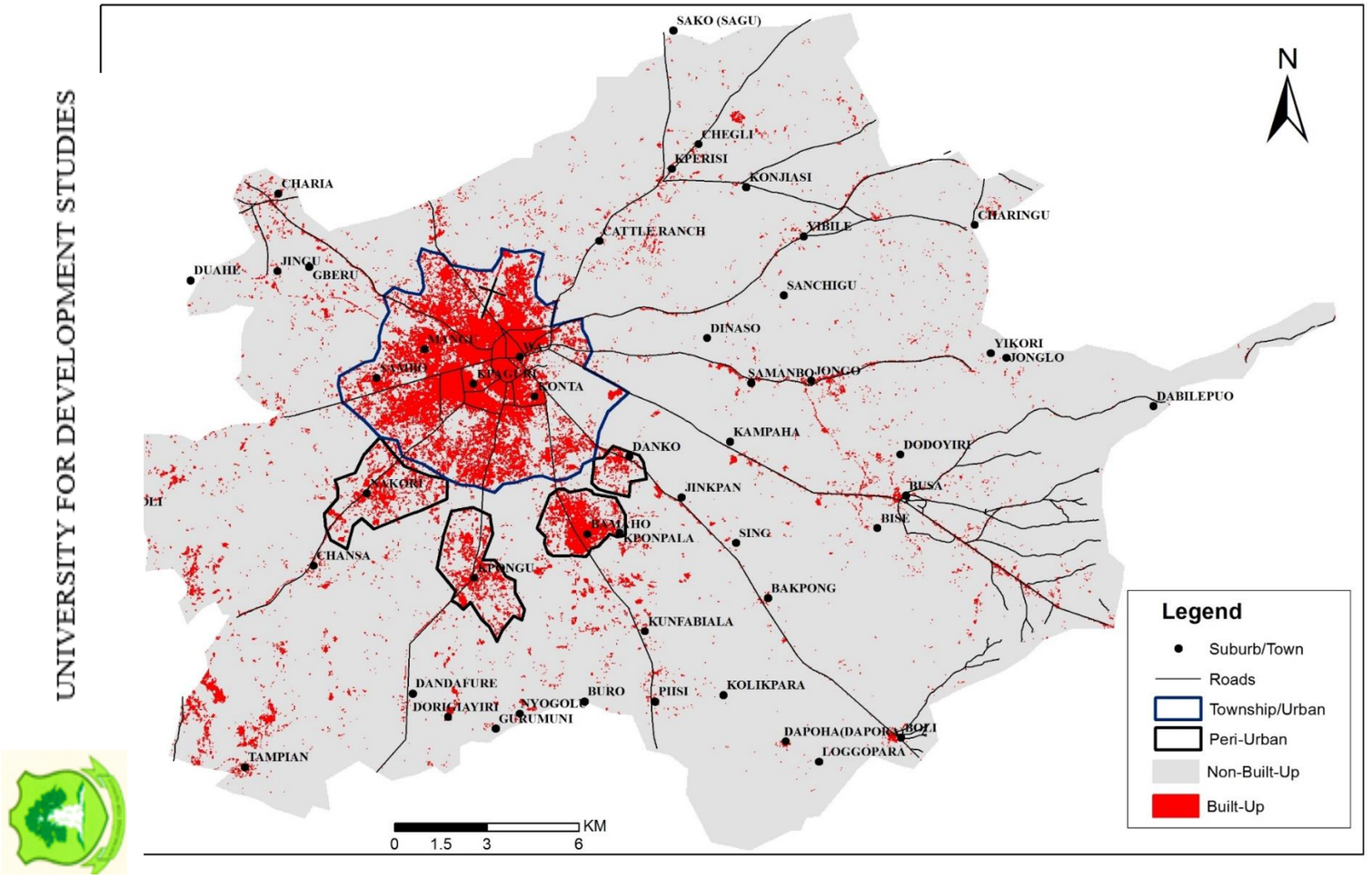
4.3.5 Linear Growth/Road Influenced Growth

The development of Wa, generally, has been along routes of transport. This is because sitting of residential facilities close to roads (Figure 13), which is the major route of transport in Wa, provides easy access to transportation and also promote the development of commercial activities. The major highway, which is the Wa-Kumasi road, has attracted more development than the rest of the transport routes in Wa. This is partly due to the reasons given above and also the sitting of UDS at Bamahu (along the Wa-Kumasi road) which drew development towards that route. Linear development can also be seen along the Wa-Kpongu road. Here, the presence of Wa Polytechnic and Wa Technical High School have contributed to the developments along that strip.

It is important to note that smaller communities/towns existed along this routes long ago, probably the reason for the routes' creation. These smaller villages, however, grew rapidly and more lands were acquired to build more houses. The suitability of these locations cannot be separated from their proximity to roads. Also of influence to the linear development is the development of access roads. In areas inhabited by people long ago, the development of access roads in those areas has resulted in the conversion of residential houses to commercial shops and the building of multiple story buildings for commercial space. Evidence of this phenomena can be found along the Kpaguri–Tendamba link and also the Kabanye–Konta link. These roads were created about a decade ago to ease access to transportation from these suburbs to the CBD. It has, however, presented opportunities of commercializing houses along these roads. Also, access roads linking Kpongu road to the Wa-Kumasi road

through SSNIT and Kpongu has increased land rent around that area. The area is currently rapidly urbanizing.

Figure 13: Map showing development along transportation routes (roads) in 2016

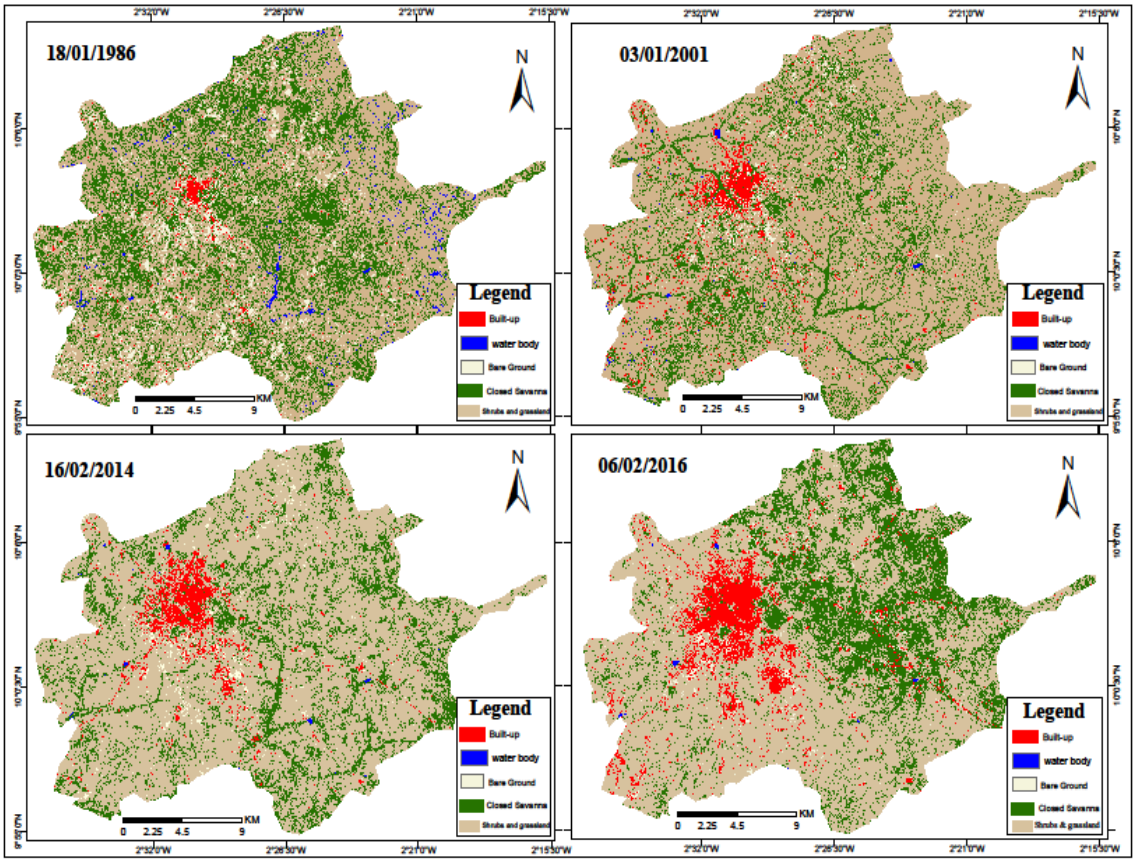


Source: Author's Construct, 2016

4.4 Urban Expansion and Land Use Change

There have been some changes in land cover resulting from the various uses to which land is being put to. The study revealed open savannah land cover, which comprise of grassland, shrubs and scattered trees, as the dominant land cover in the Wa Municipality (Figure 14). This land cover is the first cover that is usually converted to other land uses because it is easier to clear and convert. This land cover covered about 57.7 percent of the total land area of the municipality in 1986. It increased to 71.8 percent in 2001 before reducing to 70.8 percent in 2014 and then to 65.3 percent in 2016. This land cover can only increase when there is conversion of the closed woodland/savanna vegetation by factors such as wild fires, fuel wood harvesting among others. Similarly, the Closed Savannah land cover has also reduced from 33.3 percent of the land cover in 1986 through to 22.4 percent in 2001 and 16.9 percent in 2014 before increasing slightly to 22 percent in 2016.

Figure 14: Land Use/Land Cover maps of Wa Municipal in 1986, 2001, 2014 and 2016



Source: Author's Construct, 2016

Another interesting land use/cover change is bare ground. In 1986, bare ground covered 6.9 percent of the total land cover but decreased to 2.0 percent in 2001, 1.3 percent in 2014 and 1.3 percent in 2016. This was so because harvested farmlands appear bare and show similar spectral characteristics as any other bare ground. In the 1980s, farming was a dominant activity in and around Wa. The time in which the 1986 image was taken happened to be in the dry season, a period when all farms have been harvested and the land lays bare of any vegetative cover. This was confirmed by the interviews with section heads/elders who revealed that farming was actively practiced in and around Wa but have dwindled as urbanization set in.

Visual inspection of the land cover composite map shows clearly the gradual disappearance of the 'blue' color, which represents water. In 1986, water bodies where more in the municipality covering an area of 571 hectares (1.0 percent). Water occupied rivers and valley bottoms and in reservoirs (dams), most of which cannot be found in 2016. In 2001, the area decreased to 0.2 percent and in then further fell to 0.1 in 2014 and 2016 respectively. Lastly, the built up area of the municipality increased more than seven folds – from a total area of 614.4 hectares in 1986, the built up land cover increased to 2,012.2 ha in 2001 and doubled in 2014 and again rose to 4587.7ha in 2016 covering 7.8 percent of the total land area.

The built-up areas increased at an annual rate of 0.5 percent between 1986 to 2001 thereby consuming 1397.8 additional hectares of land. However, between 2001 and 2014, the built area increased at an annual rate of 3.8 percent and further increased at a rate of 23.7 percent per year between 2014 and 2016.

Continues increase in the built- up area meant that there would be a reduction in one or more land cover in the area. This is evident in the changes in the closed woodland land cover which reduced at an annual rate of 2.2 percent between 1986 and 2001, and further reduced but at a slight lower annual rate of 2.0 percent between 2001 and 2014 and subsequently recorded slowed at a 0.6 percent per year between 2014 and 2016.

With the shrubs and grassland cover, there was a positive change at a rate of 2.9 percent per annum between 1986 and 2001 but a negative changes at an annual rate

of 1.0 percent between 2001 and 2014. It however recorded a much higher loss at a rate of 23.4 percent per annum between 2014 and 2016.

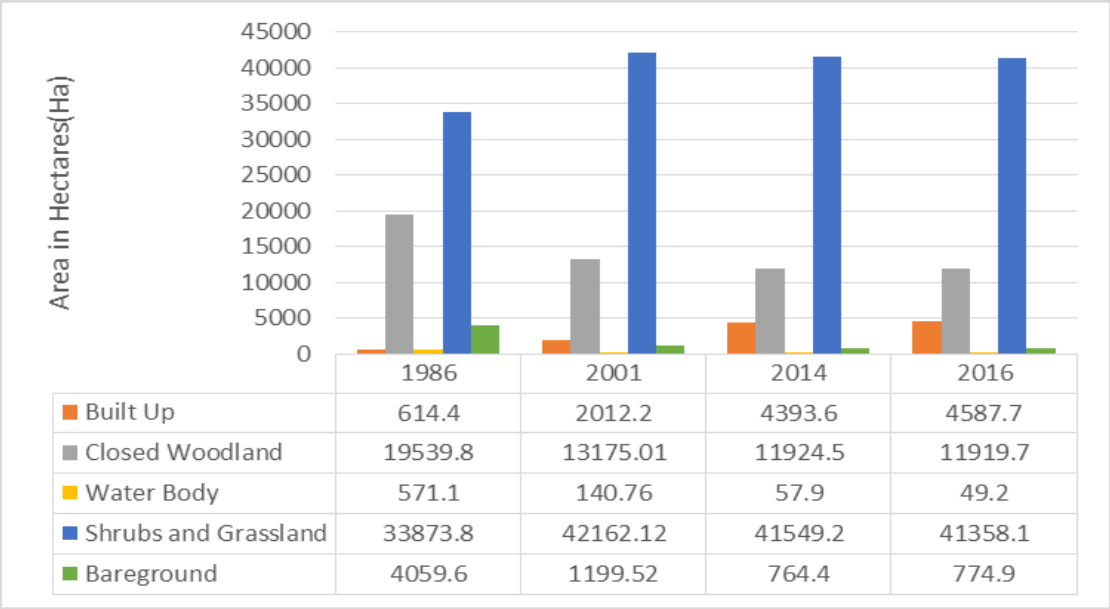
Water bodies in the area also recorded negative changes since 1986 to 2016. With a negative annual rate of 0.1 percent between 1986 and 2001, 0.1 percent between 2001 and 2014 and 1.1 percent between 2014 and 2016.

Finally, the Bare ground decreased at rates of 1.0 percent and 0.7 percent between 1986 and 2001 and between 2001 and 2014 respectively, it however recorded an increased between 2014 and 2016 at an annual rate of 1.3 percent.

The positive change in the built area points to the fact that, the built area of Wa has been increasing significantly since 1986. The increase/growth however was rapid between 2001 and 2014 than between 1986 to 2001. This supports the claim by Peprah (2013) that, the growth of wa has been rapid for the last decade. Also the positive annual change rate of 23.7 percent between 2014 and 2016 hints of another rapid growth of the built area of Wa at the moment.

The change consequently affects the natural environment as the closed woodland is giving way for shrubs and grass land and built areas. The shrubs and grass land has also been recorded negative changes since 2001 and that means that more of this land cover is being taken by Built-up. The changes has also resulted in negative change as the Bare ground increased between 2014 and 2016.

Figure 15: Land Cover/Land Use size (area) of Wa in 1986, 2001, 2014 and 2016



	1986	2001	2014	2016
Built Up	614.4	2012.2	4393.6	4587.7
Closed Woodland	19539.8	13175.01	11924.5	11919.7
Water Body	571.1	140.76	57.9	49.2
Shrubs and Grassland	33873.8	42162.12	41549.2	41358.1
Bareground	4059.6	1199.52	764.4	774.9

Source: Author's, Construct, 2016

Table 10: Land Cover/Land Use Change in Wa Muncipal between 1986 to 2001, 2001 to 2014, and 2014 to 2016

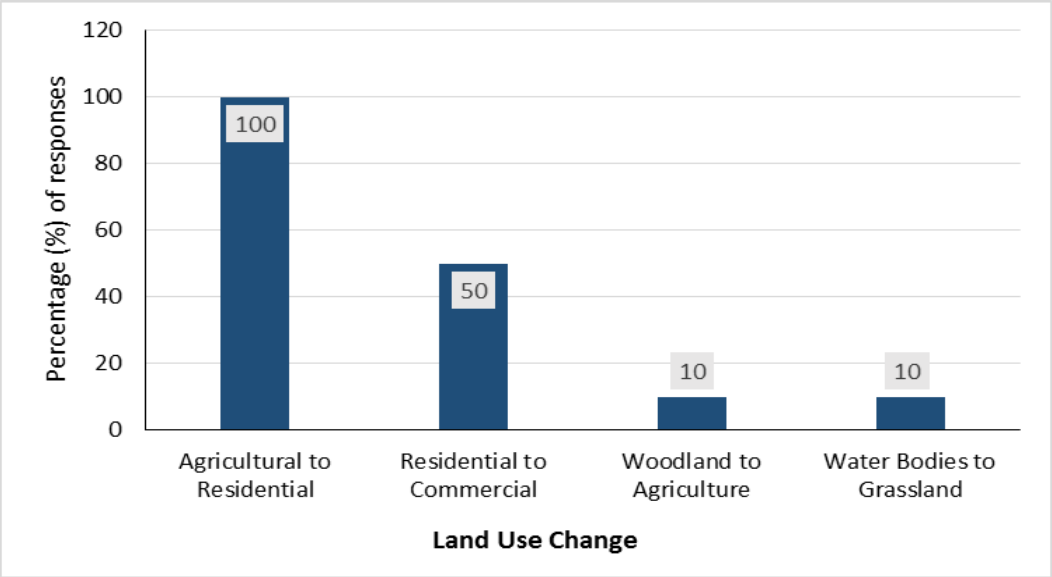
LandCover/Land Use	1986 to 2001		2001 to 2014		2014 to 2016	
	Difference	Rate of Change	Difference	Rate of Change	Difference	Rate of Change
Built Up	1397.8	0.5	2381.4	3.85	194.1	23.7
Closed Woodland	-6364.8	-2.2	-1250.5	-2.02	-4.8	-0.6
Water Body	-430.3	-0.1	-82.9	-0.13	-8.7	-1.1
Shrubs and Grassland	8288.3	2.9	-612.9	-0.99	-191.1	-23.4
Bareground	-2860.1	-1.0	-435.1	-0.70	10.5	1.3
Total	19341.3		4762.8		409.2	

Source: Author's Construct, 2016

The indigenes have accumulated knowledge of Wa for over centuries and were able to give accounts of the state of the land cover over four decades. As reported in Figure 16, all respondents interviewed had the conviction that there has been conversion of land from agricultural use to residential use. Fifty percent of the

respondents also reported the conversion from residential to commercial/industrial uses, while 10 percent of the respondents observed the conversion of woodland to agriculture uses and water bodies to open spaces.

Figure 16: Views of Respondents on Land Use / Land Cover Change



Source: Field Work, June, 2016

The section head of Konta gave the following remark when asked about the state of the land cover:

'*The original name of Konta is Napogbakole. I moved with my father here during the colonial era to secure the land for farming. I was around 18 years old. There used to be a stream at the valley where they used to come and bath the queen mothers any time a Chief died. Now that pond is dead.'*

He further explained that as at the time they moved to Konta from Nayiri, the whole Konta area was woodland which was cleared for farming and the development of housing facilities. As time went by, they had new comers, which he referred to as

'the Dagaabas'. The Dagaabas also migrated to the area and were given parcels of land for farming. Growth of the town has necessitated more housing facilities to house the growing population that led to more and more conversion of woodland to agricultural land and then to residential facilities.

When quizzed further about where they get land for farming activities now, he remarked, '*now we farm outside Wa, around Busa and Jonga areas but not all of us are able to secure land there for farming'.*

A similar remark was given by an elder of Sombo:

'My grandfathers migrated from Kperisi to this place because of farming. When I was a kid (1960s), this area used to be woodland, and we were all farming around our houses. Now we can't even get land to farm, we now farm around Siriyiri'.

This explains the fact that urbanization has resulted in the conversion of land from agricultural use to residential uses, which pushes agricultural activities to the peripheries such as Jonga and Busa. Urbanization results in functional changes of cities or towns (Barnes *et al.*, 2002). This was made known during an interview with the Chief of Mangu. He remarked:

'*... There was a market here. It was a major market in this area together with Tangasia and Sankana markets. This was before the establishment of Wa market. People from Wa and beyond used to come here for market transactions. But when Wa started growing bigger, another market evolved and subsequently this one died'*.

The above remark reveals the fact that urbanization brought about commercial boom in Wa which necessitated the establishment of a market for exchange of goods and services.

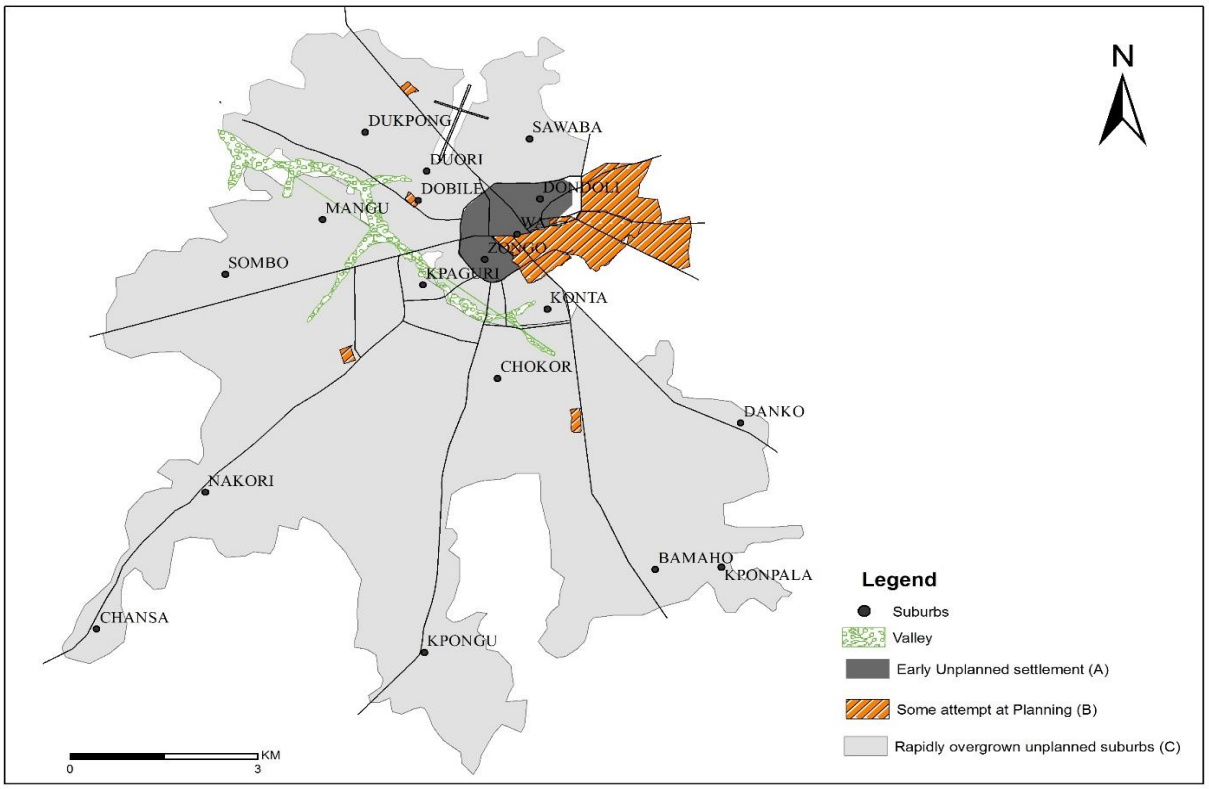
Also, Jengbeyiri and Zongo came about as a result of migrants from Northern Nigeria (Kano) and Burkina Faso (Moshi) respectively. These people migrated to Wa purposely for trade. And that also contributed to the increase in commercial land uses in Wa. Today, Wa is the biggest commercial centre in the Upper West Region of Ghana.

4.5 Implications of Wa's Growth for Socio-economic Development

4.5.1 Growth of Wa and Planning

Wa has received some level of planning since the Town and Country Planning Department (TnCPD) came into the area in 1948. There have been attempts to create spaces within early settlements that existed before the coming of the TnCPD, and there has also been an attempt to plan some areas with sector layouts and access roads. Figure 17 depicts the categories of planning in Wa.

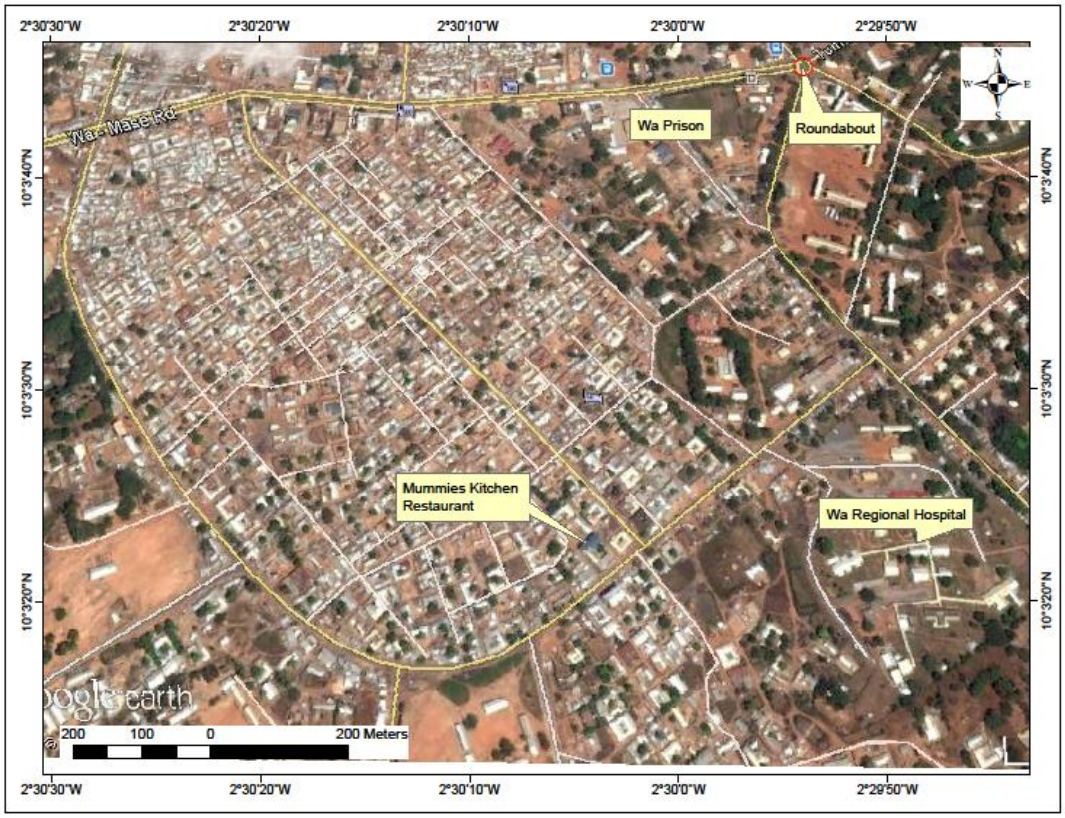
Figure 17: Map of Planned and Unplanned suburbs in Wa



Source: Author's Construct, 2016

For over 300 years, Wa has been in existence. From around the 17th century through to the 18th century and to 1948, early settlements that developed received no planning. These settlements contained old migrants who came from other areas within and outside Ghana and settled in Wa. Houses are built haphazardly and are dense/compact with poor access roads, dilapidated mud houses, and poor drains. These areas function as both residential and commercial suburbs and have highly insanitary conditions due to poor environmental management. These settlements include, Nayiri, Old Dobile, Sokpayiri, Puohiyiyi, Suriyiri, Limanyiri and Tagrayiri.

Figure 18: Early Unplanned Settlement (Sokpayiri, Puohiyiri, Tagrayiri)



Source: Google Earth Imagery, 2013

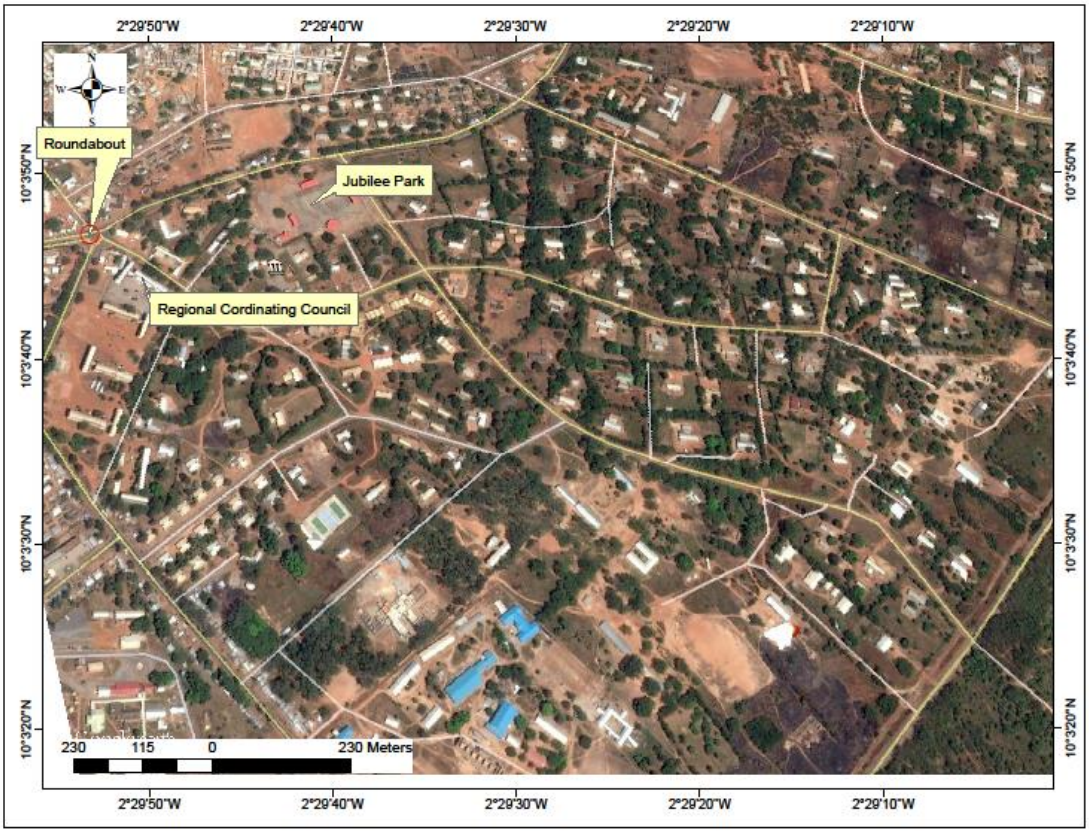
The second category (B) have had some attempts at planning since the coming of the Town and Country Planning Department in 1948 through to 2000. Also, visualized by the thematic map (Figure 117), these areas were covered by sector layouts prepared by the Town and Country Planning in 1993 but were not rigorously implemented and controlled. As a result, houses built, in most cases haphazardly with mud, have poor roofing and poor spacing. These areas, unlike category A, have better access roads but there is growing sanitation problems stemming from poor drainage, inappropriate attitudes and inadequate sanitation facilities. There is also

growing congestion and inadequate public and private resources to upgrade these areas.

Figure 19: Planned area of Wa (SSNIT residential area)

Source: Google Earth Imagery, 2013

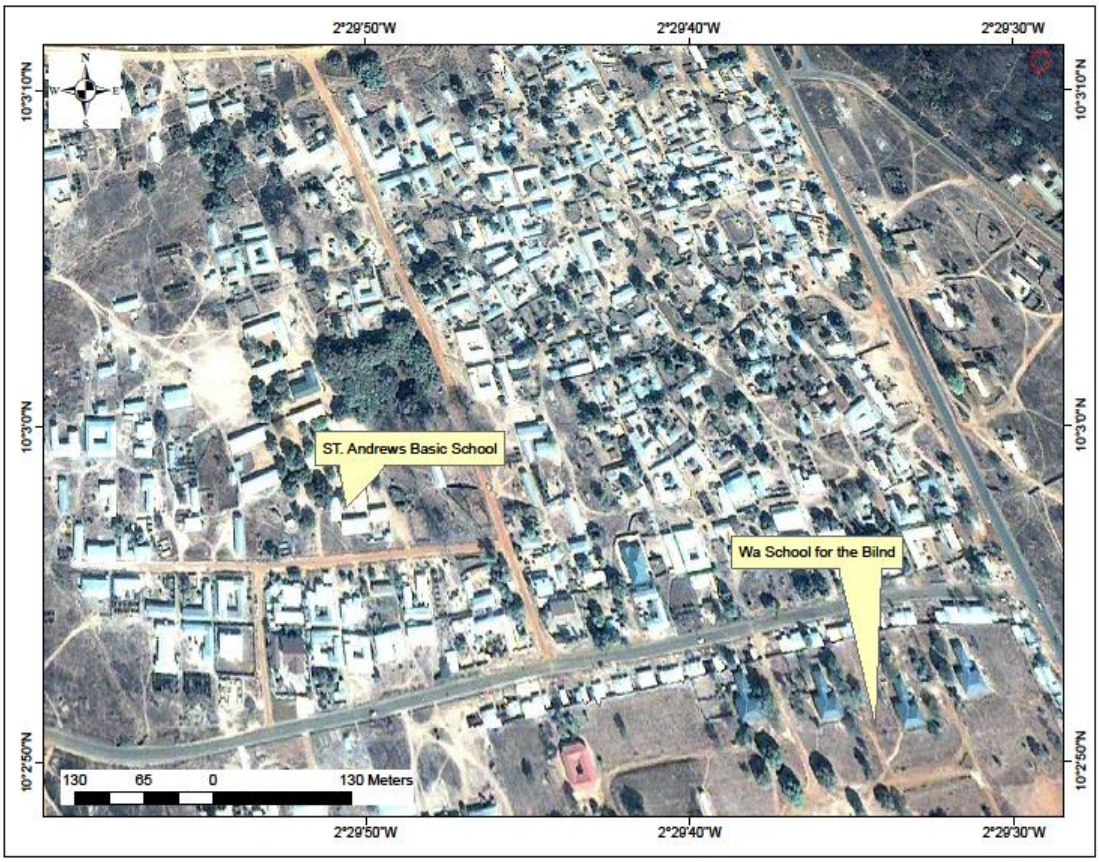
Figure 20: Planned area of Wa (Government residential area – Degu)



Source: Google Earth Imagery, 2013

A third category (C) developed after 2000. Although these areas existed long ago, these suburbs grew as a response to the growth triggers starting from 1983 with the creation of the Upper West Region with Wa as the regional capital. Also, these suburbs responded to speculative property development that resulted from the establishment of UDS and Wa Polytechnic which resulted in high demand for residential accommodation. Large parcels of land were given out with site plans and building plans. Buildings sprung up rapidly without layouts leading to haphazard development without roads and social services. There is also no drainage and growing sanitation problems in these areas.

Figure 21: Rapidly Overgrown unplanned suburb of Wa (Konta area)



Source: Google Earth Imagery, 2013

4.5.2 Growth of Wa and Changing Land Values

As population continue to grow with the urban extent in ascension, the values of land also continue to appreciate. Prior to the rapid growth of Wa, land parcels were usually given out to new migrants/settlers and cola nuts was taken as a token of appreciation. Land was not sold/leased. The Section head of Konta remarked that "*we would welcome them, give them parcels of land to settle and farm. We never sold land".* However, when the population grew and demand for land parcels increased, values of land were then measured in monetary terms. A query of

registered land archives at the Lands Commission, Wa, revealed that land values in Wa have been appreciating substantially since the early 1980s as indicated in Table 11 below.

Table 11: Average Land values for some Localities from 1986 to 2016

Year/locality	Wa (GH¢/1 acre)	Kpaguri (GH¢/1 acre)	Bamahu (GH¢/1 acre)	Degu (GH¢/1 acre)	Kpongu (GH¢/1 acre)	Sombo (GH¢/1 acre)	Kabanye (GH¢/1 acre)	Danko (GH¢/1 acre)
1986	1,400	600	40	1,400	8	40	8	40
2001	12,000	8,000	4,000	12,000	2,000	4,000	6,000	2,000
2014	20,000	12,000	12,000	20,000	6,000	8,000	12,000	4,000
2016	28,000	14,000	14,000	24,000	8,000	14,000	14,000	12,000

Source: Lands Commission, Wa

In 1986, the urban core – the central business district and Degu – had an acre of land parcel exceeding GHS1000. This was because, commercial activities were around the CBD and that resulted in the high values of land around that area. Degu, however, had high land values owing to the public housing project developed in that area in the 1970s. Suburban areas such as Kpaguri and Kabanye also witnessed a rise in land values. At this time, land owners saw the need to develop residential and other commercial facilities in these areas to ease the pressure on the CBD or urban core. Prices of land parcels still continued to be highest within the core but the adjacent suburban areas were also witnessing an increase in land values as a result

of increasing demand. For example, GHS1,200 per acre for Kpaguri and Kabanye respectively. The increase in land values in these areas were due to the new status of Wa as a regional and district capital which brought in more workers from other regions. These areas grew rapidly in response to the demand for accommodation facilities that resulted in demand for land parcels and subsequent development of more housing units.

By the year 2001, the value of a parcel of land in the core, Degu and Kabanye, tripled and that of Kpaguri increased thirteen folds from the 1986 values. Sombo, Bamahu, Kpongu and Danko became new growth areas with values ranging from GHS2,000 to GHS4,000. As a result of speculative land buying, land values in Bamahu increased rapidly more than any other area between the year 2001 and 2014, tripling its 2001 value while all other areas increased at most two folds. By 2016, the core still remained the area having the highest land values, whilst land values in Bamahu equalled Kpaguri, Kabanye and Sombo. Danko was the new hotspot also increasing more than three times in value since 2014. Values in Kpongu were also high.

4.5.3 Challenges of Urban Planning in Wa

The unsuccessful nature of urban planning in Wa has been due to certain factors which makes it difficult for authorities to implement plans effectively. These are examined below.

4.5.3.1 Speculative land buying without scheme/layout plan

Sub-urban areas often evolve when there are speculations about appreciation in land values in that area (Gurin, 2003). As such, there is always rushing for land parcels in such areas. This is a case in some sub-urban areas in Wa such as Bamahu, Kpongu and Kunfabiala. An interview with the Municipal Planning Officer revealed that the establishment of University for Development Studies, Wa Campus at Bamahu and Wa Polytechnic in Kpongu, brought about speculative land buying in Bamahu and Kpongu and their surroundings. Land owners and property developers anticipated a rise in land values because there was going to be the need for more residential/private hostels to support the inadequate hostel facilities provided to students by these tertiary institutions. They therefore acquired more parcels of land in these areas and put up residential structures illegally without a land use planning scheme just as Allen (2003) and Bocz *et al.* (2008) posited. This has led to unplanned and uncoordinated settlement with poor layout and no access roads and few utility services in such areas. This situation compounds the problems of urban planning in the municipality.

4.5.3.2 Urban Sprawl

Urban sprawl or low densification does not pay attention to local administrative boundaries. New sub-urban areas often develop extending beyond the municipal or metropolitan boundaries. This is a case in the Wa Municipality. New sub-urban areas are developing in Tanina and Siiriyiri, which for, a want of a better term, are qualified as peri-urban areas because of the mix of urban and rural attributes (Allen, 2003). These areas lie just outside the municipal boundary (in the Wa West District) but interacts with the Wa Municipality in their day to day businesses. The former

area is growing rapidly because of their proximity to UDS Campus, which led to the rush for land parcels in that area. Adjacent areas are now the hotspots, therefore, with Tanina lying next to Kunfaabiala and Piisi, it has become the new area for land rush leading to mass land registration. The latter, however, is the result of the establishment of a University for Cape Coast satellite campus in West Sombo, which again has brought about speculative buying of land in that area. The land Registration Office of the Lands Commission confirmed that there has been an upsurge in land registration by property developers in these areas and also attributed it to the reasons given above.

This issue complicates Urban Planning because the people in these areas transact with Wa the Municipality but are outside the planning jurisdiction of municipality. Their districts, however, are not equipped with resources to undertake planning properly.

4.5.3.3 Inadequate Resources Required for Land Use Planning

Another issue that inhibits the activities of urban planning is resources. That is, in the areas of human and financial resources. According to the Municipal Planning Officer, the Upper West Region, with 11 districts currently, has only two professional Urban Planners, which implies that nine districts are currently manned by unprofessional planners. He also noted that the growth of the Wa Municipality require more than one professional planner as is the case currently. Centralization compounds this problem because, even with the inadequate staff strength, they still cannot recruit professional urban planners because the law (Cap 84) that established the Town and Country Planning Department does not give authority to the offices

either than the headquarters to recruit human resources. This leaves the Wa Municipal TnCPD powerless as they have to pass their human resource requests thought a long chain of bureaucratic command and end up waiting forever for new recruits.

The second resource issue has to do with financial resources. The cost of producing a base map using conventional ground surveying methods is a cost that the Commission cannot bear. A much cost effective alternative is to rely on aerial photographs and high resolution satellite images which are also problematic because they cannot afford the cost of these products. They, therefore, resort to Google Earth Images which are not up to date for this part of the world.

4.5.3.4 Low Level of Enforcement of Planning Schemes

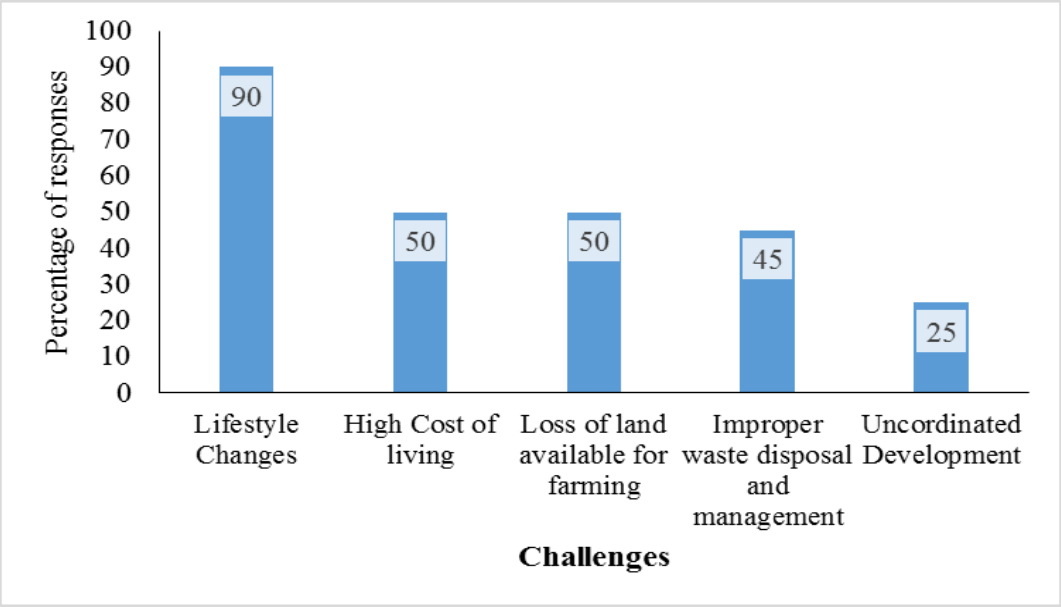
ACT 462 (Local Government Act, 1993) confers on the district assembly to undertake all planning functions within the district. The Town and Country Planning Department, therefore, acts as an advisory body to the District Assembly. This implies that local plans being developed by the TnCPD are enforced by the District Assembly after the Survey and Mapping Department sets out the plans on the ground.

The problem here lies in the fact that the district assemblies lack the willpower to enforce these plans. The Housing Inspectorate Division under the district assembly is also mandated to check for illegal buildings and apply the necessary measures, which most often than not, they are not able to enforce, resulting in unplanned suburbs with poor layouts.

4.5.4 Challenges Posed by Rapid Urbanization in Wa

The rapid urban growth of Wa, coupled with the lapses of urban planning in the municipality, has presented some challenges. An interview with section heads revealed the issues presented in Figure 22 as challenges brought to Wa by urbanization. Social Vices was cited by the respondents as the major challenge with 80 percent. Also, they revealed that urbanization has brought about high cost of living, with fifty percent of the respondents. A good number (50 percent) of the respondents also lamented about losing lands available for farming as a result of urban growth. Lastly, but not least, illegal and uncontrolled property developments has led to the development of slum communities in some of the earlier settlements and new sub-urban areas (35 percent) and improper waste collection and management (45 percent).

Figure 22: Challenges Posed by Urbanization in Wa



Source: Field Survey, May, 2016

4.5.5 Opportunities Presented by Urbanization

From small patches of villages, as seen in the 1960 map, to large a township with a radius of over seven kilometres and over 71,000 people residing within it, urbanization has presented some opportunities to the people of Wa (Figure 23). Commerce has contributed significantly to the growth of Wa. Most migrants, especially those who settled at Djangbeyiri and Zongo, were mostly merchants who were involved in trade. As the town grew, commercial activities also expanded with variety of commercial activities to serve the growing population. An interview with the section heads revealed that an increase in commercial activities has been one major opportunity brought to them by Wa's urbanization. With 100 percent of respondents noting this, commercial activities have boomed especially with the influx of public sector workers and students. There have been the conversion of residential properties along major roads to commercial stores and an increase in

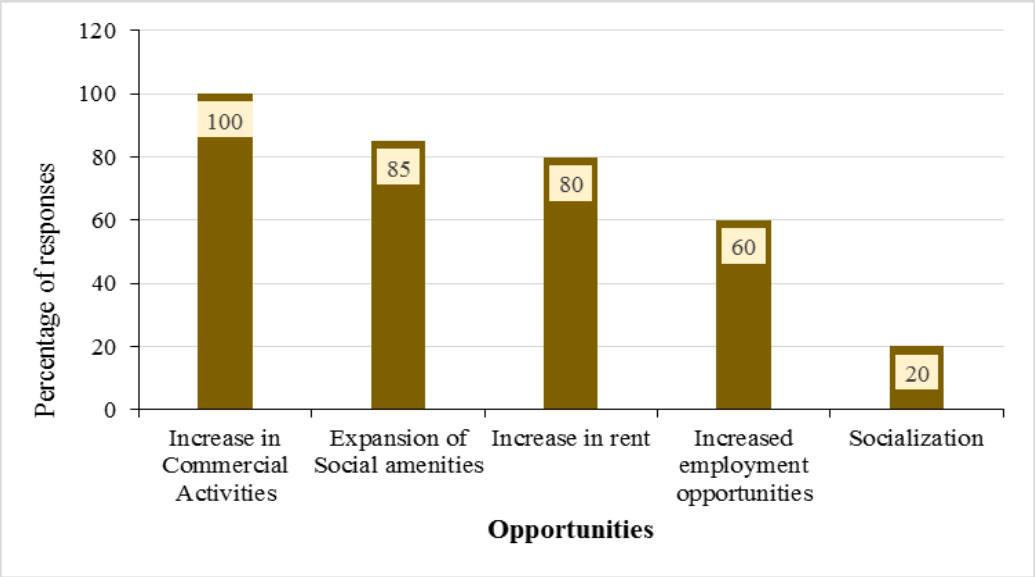
'container' kioks that provide daily consumables. There has also been a new phenomenon where there is the upgrading of single storey buildings within the inner areas to multiple storey buildings for commercial uses, a process known as gentrification (Amoah, 2013).

With five tertiary institutions, over seven public senior high schools and three private senior high schools adding to a regional hospital and numerous clinics and health centres, there has been an expansion of social amenities in Wa to serve the growing population. The Section head of Konta/Napogbakole remarked:

"..... when we moved here, we used to drink from a pond in the valley, but now we have pipe borne water and numerous boreholes. We also have electricity".

This supports the fact that social amenities have been increasing or improving as the town grows.

Figure 23: Opportunities presented by Urbanization in Wa



Source: Field Survey, May, 2016

The increase in population that led to increase demand for housing has led to the provision of housing facilities to meet that demand. As a result, there is return on investment and private property developers and landlords are reaping the benefits. There has also been an increase in land values, which land owners are also harvesting the benefits. Eighty percent of the respondents pointed out income from rent as an opportunity presented to them by urbanization.

Employment opportunities have also expanded as a result of the growth. The service sector has expanded to provide a wide range of services to people. There is also the growth of industrial services providing a range of employment for qualified people. The interview recorded 60 % of the respondents revealing this opportunity.

Lastly, but not least, social interactions have increased (30 % of respondents).

"*When we moved here, the whole area was bushy, so we were always welcoming new migrants, giving them land to settle and farm so that they can help us drive away wild animals*". The Chief of Mangu stated.

"We live together with the Dagaabas and the Gonjas. We are all brothers". Stated an Elder of Nayiri. Socialization has, therefore, been an opportunity that urbanization has presented to the people, bringing together people from different settings.

4.6 Conclusion

This chapter has demonstrated considerably how effectively GIS can provide spatial information about the state of the urban area at different times. Complimenting this tool is the accumulated knowledge of indigenes which gives further explanation to the changes in the urban extent.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents a summary of the major findings of this study from which conclusions are made on key issues and recommendations given for stakeholders.

5.2 Summary of Major Findings

This study sought to investigate the urban transition of Wa from the last three decades and beyond. It specifically provided time series information on urban sprawl, population growth and the spatial expansion as well as land use changes from 1986 to 2016. The study also investigated the social and economic issues that arise from the growth of Wa. The major findings are summarized below.

The population of Wa town grew nearly 2 folds from about 37954 people in 1986 to 67922 people in 2001. It further increased by 9051 people to 76973 people in 2014 before reaching 79954 people in 2016. Migration of people from nearby towns, the upgrade of Wa to a regional capital in 1983 and to a municipality in 2004, and the establishment of UDS and Wa Polytechnic are the major causes of rapid population growth in Wa. Early settlers in Wa were largely migrants from other parts of Ghana, especially the Northern Region and other West African Countries such as Northern Nigerian and Burkina Faso who settled in Wa for reasons such as trade, farming and to seek refuge from wars.

In 1986, the settlement occupied 614.4 hectares and this represented 1 percent of the current municipal land area of about 58,689 hectares. In 2001, the

settlement/built up area increased to 2,012.2 ha and then to 4,393.6 ha and 4,587.7 ha in 2014 and 2016 respectively. These represented 3.4 percent, 7.5 percent and 7.8 percent respectively. The urban change from 1986 to 2001 was 1397 ha, it is highest between 2001 and 2014 with 2381.1 ha and lowest between 2014 and 2016 at 194.1 ha. The rate of change was 0.5% per year from 1986 to 2001 (15 years), 3.8% from 2001 to 2014 (13 years) and 23.7% from 2014 to 2016 (2 years).

The growth of Wa has been more towards the south and south-western parts due to the presence of UDS at Bamahu to the south and Wa Polytechnic, at Kpongu, to south-west. Five types of growth were revealed by the study, that is low densification, infill development, extension, leapfrogging/peri-urbanization and linear/road influenced developments. The number of people living within a square kilometre has been decreasing since 1984 – 18698/sq. km in 1984, 7819/sq. km in 2001, 4900/sq. km in 2014 and 3253.3/sq. km in 2016. Infill development occurred where open space within and-in between the earlier settlements were filled with new residential facilities. This occurred more in the Zongo, Pounhyiri, Suuriyiri, Toumuni, Fongo, Liman yiri and Dondoli areas. By 2001, the Zongo area expanded outward the ring road around Konta and Kabanye areas. Dondoli also expanded northward while a new area developed in-between Suuriyiri and Tuomuni and Fongo called Wapaani which is translated as ‘New Wa’. Old Dobile and and Kpaguri also expanded outwards.

New suburbs that developed away from the core appear to be outliers with less concentration. Social Security and National Insurance Trust (SSNIT) residential area

and its surroundings, Chorkor, Kpaguri Extension and Napokbakole could be identified as peri-urban areas in 2001. Bamahu, Kpongpaala, Kpongu, Danko, and Kperisi, also exhibited these characteristics in 2016.

Most developments are linear, along major transportation route, and are therefore termed as road influenced. The Wa-Kumasi highway has seen most development along that road. Other routes are the Wa-Nakori road, Wa-Kaleo Road and Wa-Dorimon (Mase) routes.

Increase in residential land use has resulted in the conversion of closed woodlands to open spaces, farmlands, grasslands and shrub lands. Water bodies have also decreased at a rate of 0.1 % per annum from 1986 to 2001 and 0.1 % per annum from 2001 to 2014 and furthered decreased at a rate of 1.1 % from 2014 to 2016.

Urban planning in Wa has not been successful: early settlements are crowded with poor drainage, no access roads and poor sanitation. Areas that have had some level of planning still face issues such as poor drainage and utility services due to ineffective planning. Rapid growth has also led to overgrown unplanned suburbs with no access roads and no utility lines, especially water, and growing sanitation problems. Ineffective land use regulation has resulted in the development of settlements on major valleys which are potential risk for disasters, like flooding.

The growth of Wa and the resultant increase in housing demand has resulted in an appreciation of land values over 20 times from 1986 to 2016 within the CBD and over 700 times in Bamahu and Kpongu within the same time lines. The rise in values

of land have been rapid in Bamahu, Kpongu and Danko areas from the year 2001 till date.

The challenges of urban planning in Wa include speculative buying of land and subsequent development without planning schemes, inadequate resources for WMA to enforce sector plans and create access roads and other layouts and inadequate human resources to undertake planning activities. Also, some peri-urban areas are developing outside WMA boundary making it difficult to include such areas in WMA local plans, although residents in these areas do all transactions in Wa.

General problems posed by urban growth in Wa include the development of slum settlements, social vices, growing poor sanitation and rising high cost of living. Increase in commercial activities as well as employment opportunities, expansion of social services, income from rent and socialization with diverse social groups are some the opportunities presented to the people of Wa by growth and urbanization.

5.3 Conclusions

GIS has provided several effective tools such as overlays, image analyses, geostatistics, and measurement for investigating spatial problems. Remotely sensed multi-date satellite images are great source for extracting urban areas and other land cover types. This use of multi-date multi-spectral anniversary images combined with population data has proven to be effective in providing historical information on the urban extent of Wa and the rates of change of the urban area with respect to time.

The population of the Wa increased over 110 percent between 1986 to 2016, whilst the built-up areas increased over 1,130 percent within the same time period. However, built up density within the Wa town has been reducing since 1984 as a result of urban sprawl, however, development has been compact in the urban core resulting from infill but extends outwards in the suburban areas as more agricultural land is being converted to residential and commercial facilities. Peri-urbanization is also on the rise and also linear strip developments along roads. These have increased land values in sub-urban and fringe communities. These changes have resulted in poor and uncoordinated developments with poor layouts and few utilities and inadequate social amenities coupled with rising land values. Also it has resulted conversion of closed woodlands to open spaces, farmlands, grasslands and shrub lands to residential uses thereby reducing the land available for farming.

The study also revealed the significance of fusing local accumulated knowledge of indigenes as that explains the factors causing the urban transition and change and uncovers the socio-economic challenges and opportunities that are presented by the growth.

Based on the trend of growth and the rate of growth, Wa is likely to continue its growth trend, moving towards the south and south west of Wa. This is because, UDS and Wa Polytechnic still continue to pull developers to that area and this will result in more residential and commercial facilities around these areas.

Also, there is likely to be a merger of Wa Township with Bamahu, Kpongu and Danko, forming a larger urban extent as these peri-urban areas are rapidly becoming urban.

Report from the lands Commission also revealed that, there is massive acquisition and registration of land parcels in Kperisi and Wa Sombo and Siiriyiri. This is due to the citing of Health Assistant Training School at Kperisi and University of Cape Coast satellite campus at Wa Sombo. This is likely to spur rapid growth around these, there by changing the direction of growth to Westwards and Eastwards together the current southwards and south western directions.

The findings also support the theoretical framework adopted from Mushifwa and Mooya (2013) with the formal and informal actors and agents that shape the development of the built environment. Formal, which in this case is the government has contributed by the various housing projects, roads, public social amenities whilst the informal institution play a major role as much of the built environment is being created by individuals, households and groups which is often not coordinated and illegal but yet continue to add more to the built environment.

5.4 Recommendations

The following recommendations are made based on the findings of this study:

- The WMA should sensitize developers on the need to put up high rise buildings to minimize sprawl. This is because high rise buildings take up less space and makes development more compact as compared to sprawl development.

- The Municipal Assembly should create access roads in overgrown areas where possible and pull down unauthorised structures to make way for access roads and utility lines.

- The Building Inspectorate Division should be proactive and issue licenses to developers and bar illegal developers from putting up unauthorised structures in the municipality.

- The Lands Commission and WMA should liaise with land owners and traditional authorities to undertake n comprehensive scheme of development for the whole municipality to prevent property developments without layout schemes. The southern and western parts of wa should be the priority areas since these areas are hotspots for property developments. WMA should increase their budgetary allocation for implementing local and sector plans in Wa.

- Further studies on the use of satellite images in investigating urban growth should use higher spatial resolution than the 30m x 30m resolution images used in this study. This would reveal more details and more patterns may be identified.

- Future researchers should also adopt images captured around June to September of the years under study. This is because in the dry season (October to March) bare ground and harvested farmlands and some settlements have similar pixel values and might reduce the accuracy of the

classification process. Bush burning in the dry season also conflicts burnt areas and water bodies.

Reference

Abbot, J., Chambers R., Dunn C, Harris T., de Merode E., Porter G., Townsend J., & Weiner D. (1998). *Participatory GIS: Opportunity or oxymoron?.* PLA notes 33. pp. 27–34.

Adarkwa, K. K. (2012). The changing face of Ghanaian towns, African review of economics and finance. Vol. 4, No.1.

Adjei, P. O., Buor, D., Addrah, P. (2014). Geo-spatial analysis of land use and land cover changes in the Lake Bosomtwe Basin of Ghana. *Ghana Journal of Geography Volume 6.*

Aduah, M. S. and Aabeyir R. (2012). *Land cover dynamics of Wa Municipality, Upper West Region of Ghana.* Research Journal of Environmental and Earth Sciences, pages: 4, 6, 658-64 http://maxwellsci.com/print/rjees/v4-58-64.pdf.

Allen A., (2003) *Environmental planning and management of the peri-urban interface: perspectives on an emerging field. Environment and Urbanization.* 2003;15(1):135–148.]

Amoah, S. (2013). Gentrification and urbanization in Ghana; the case of the central business district of Wa the Upper West Region of Ghana. Lambert Academic Publishing, Germany.

Anderson S., and Rathborne R., (eds) (2000). *Africa's urban past*. James Currey Ltd, Oxford and Portsmouth.

Angel, S., Parent J., and Civco, D. (2007). *Urban Sprawl metrics: An analysis of global urban expansion using GIS.* ASPRS 2007 Annual Conference. Tampa, Florida

Angel, S., Sheppard, S. C., & Civco, D. L. (2005). *The dynamics of global urban expansion*. Washington D.C.: The World Bank http://www.williams.edu/Economics/Urban Growth/WorkingPapers.htm, last accessed September 5, 2015.

Anthony, O. (2011). Urbanization, Encyclopaedia of social theory. Sage Publications.

Arino, O., Gross, D., Ranera, F., Bourg, L., Leroy, M., Bicheron, P., (2007). *GlobalCover: ESA service for global land cover from MERIS.* Proceedings of the international geoscience and remote sensing symposium, 23–28 July 2007, Barcelona, Spain, doi:10.1109/IGARSS.2007. 4423328.

Barnes, K. B., Morgan, J. M., Roberge, M. C., & Lowe, S., (2002). *Sprawl development: its patterns, consequences, and measurement.* Towson University

Bartholome, E., & Belward, A., (2005). GLC2000: A new approach to global land cover mapping from Earth observation data Int. J. Remote Sens. 26 1959–77.

Belaid, M. A., (2003). *Urban-rural land use change detection and analysis using GIS & RS technologies.* 2nd FIG Regional Conference Marrakech, Morocco, December 2-5, 2003.

Bhaduri, B., Bright, E., Coleman, P., & Dobson, J., (2002). *Land scan: Locating people is what matters.* Geoinformatics, 5, 34–37.

Bhatta, B., (2010). *Analysis of Urban Growth and Sprawl from Remote Sensing Data. Springer*. XX. ISBN: 978-3-642-05298-9. http://www.springer.com/978-3-642-05298-9

Bocquier, P., (2005). Analysing Urbanization in Sub-saharan Africa. In: Champion T., and Hugo G., (2005). New forms of urbanization; beyond the urban-rural dichotomy. Hants, England, Ashgate.

Bocz, G.Ä., Nilsson, C. and Pinzke, S. (2008) *Periurbanity - a new classification model*. In: Warren, M. and Bissell, S. (eds.) *Rural Futures: Dreams, Dilemmas and Dangers*. University of Plymouth, United Kingdom.

Brivio, P.A., M. Maggi, E., & Binaghi, I. Gallo., (2003). *Mapping burned surfaces in sub-Saharan Africa based on multi-temporal neural classification.* International Journal of Remote Sensing, vol. 24 no. 20 , pp. 4003-4018.

Burchell R., and Mukhjerji, S., (2003) "Conventional Develop- ment versus Managed Growth: The Costs of Sprawl," *American Journal of Public Health*, Vol. 93, No. 9, 2003, pp. 1534-1540. doi:10.2105/AJPH.93.9.1534

Burchell, R. W., & D. Listokin., (1995). Land, infrastructure, housing costs and fiscal impacts associated with growth: The literature on the impacts of sprawl vs. managed growth. Cambridge MA: Lincoln Institute of Land Policy.

Burchell, R., (1998). Costs of sprawl revisited: The evidence of sprawl's negative and positive impacts, transit cooperative research program, transportation research board. Washington, D.C.

Burchell, R.W., Shad, N.A., Listokin, D., Phillips, H., Downs, A., Seskin, S., Davis, J.S., Moore, T., Helton, D., & Gall, M. (1998). *The Costs of Sprawl--Revisited*. Transit Cooperative Research Program (TCRP) Report 39, published by Transportation Research Board, Washington.

Burchfield, M., Overman, H. G., Puga, D., & Turner, M. E., (2004). *The determinants of urban sprawl: Portrait from space.* Unpublished manuscript, 7 October.

Caldwell, K., Henshaw, L., & Taylor, G., (2005). *Developing a framework for critiquing health research*. Health, social and environmental issues. 6:45–54.

Canadian Center for Remote Sensing (2000), *Fundamentals of Remote Sensing Tutorial.*

Center for International Earth Science Information Network (CIESIN), (2004). *Global Rural–Urban Mapping Project (GRUMP). Alpha Version: Urban Extents*. (available online at: http://sedac.ciesin.columbia.edu/gpw).

Chang, N., (2011). Satellite-based multitemporal-change detection in urban environments. Spie Newsroom, 10.1117/2.1201101.00350.

Clarke, K. C., Hoppen, S., & Gaydos, L., (1997). *Self-modifying cellular automation model of historical urbanization in the San Frasncisco Bay area.* Environment and planning B: Planning and Design, Vol 24, Pages 247 – 261.

Congalton, R. G. and Green K. (1999). Assessing the accuracy of remotely sensed data: Principles and practices. Lewis Publishers, Boca Raton

Crawford, T. W. (2007). *Where does the coast sprawl the most? Trajectories of residential development and sprawl in coastal North Carolina*, 1971-2000. Landscape and Urban Planning 83(4), 294-307.

Dall'Olmo, G., A. Karnieli., (2002). *Monitoring phonological cycles of desert ecosystems using NDVI and LST data derived from NOAA-AVHRR imagery*. International Journal of Remote Sensing, vol. 23 no. 19, pp. 4055-4071.

Danko, D., (1992). The digital chart of the world project Photogramm. Eng. Remote Sens. 58 1125-8

Davies, W.K.D., & Baxter, T., (1997). Commercial intensification: the transformation of a highway-oriented ribbon. Geoforum 28 (2), 237–252.

Diuk-Wasser, M.A., Bagayoko, M., Sogoba, N., Dolo, G., Toure, M.B., Traore, S.F., Taylor, C.E., (2004). *Mapping rice field anopheline breeding habitats in Mali, West Africa, using Landsat ETM+ sensor data.* International Journal of Remote Sensing, vol. 25 no. 2, pp. 359-376.

edition).

Elvidge, C., Tuttle, B. T., Sutton, P. C., Baugh, K. E., Howard, A. T., Milesi, C., (2007*). Global distribution and density of constructed impervious surfaces*. Sensors, 7, 1962−1979.

FAO (Food and Agriculture Organization of the United Nations), (1992). *Guidelines for Land Use Planning.* Prepared by the Interdepartmental Working Group on Land Use Planning, Soils Bulletin 66, Rome.

Freire, M. E., Lall, S., & Leipziger, D., (2014). *Africa's urbanization: Challenges and opportunities.* The Growth Dialogue. Washington.

Gergen, K. J. (1985). *The social constructionist movement in modern psychology*. American Psychologist, 40, 266–275. doi: 10.1037/0003–066X.40.3.266]

Ghana Local Government Act 1993 ACT 462 ACT.

Ghana Statistical Service (GSS), (2005). 2000 Population and Housing Census - Analysis of District Data and Implications for Planning. Upper West Region.

Glaeser, E. L., & Kahn, M. E., (2003). *Sprawl and Urban Growth.* Cambridge, MA: Harvard Institute of Economic Research, Havard University.

Glenn, A., (1984). *Urbanization of the non-farm population.* A Research Note on the Convergence of Rich and Poor Nations. Koninkhjke Brill Nv. Leiden.

Gurin, D., (2003). *Understanding sprawl, A Citizens guide*. David Suziki foundation, Vancouver, Cannada.

Harrison, M., & Waldron, P., (2011). *Mathematics for Economic Finance*. Routelege, New York.

Harvey, R. O., & Clark W. A. V., (1971). *The nature and economics of urban sprawl. In Internal Structure of the City.* Ed. L. S. Bourne. New York: Oxford University Press. 475-482.

Henderson, J.V., (2003). The urbanization process and economic growth: The so-what question. Journal of Economic Growth, 8, 47-71.

Henderson, V., (2000). *On the move: industrial deconcentration in today's developing countries.* In: S. Yusuf, W. Wu, & S. Evenett (Eds), Local dynamics in an era of globalization (pp. 65-86). New York: World Bank.

King, B. H., (2002). Towards a participatory GIS: Evaluating case studies of participatory rural appraisal and GIS in the developing world. Cartography and Geographic Information Systems, 29(1), 43–52.

Koti, T. F., (2013). Confronting sociospatial excusion on the fringe of Africa's cities using participatory GIS: Lessons from Athi River town, Kenya. Africa Today (56(3) pp 63 – 83.

Lake, R. W., (1993). Planning and applied geography: Positivism, ethics, and geographic information Systems. Progress in Human Geography 17:404–13.

Lillisand, T, Kiefer R. W., and Chipman J., (2008) *Remote Sensing and Image interpretation*. 6th edition Wiley and sons, Inc.

Loveland TR, Sohl TL, Stehman SV, Gallant AL, Sayler KL and Napton DE (2002) *A strategy for estimating the rates of recent United States land-cover changes.* PhotogrammEng Remote Sens 68:1091-1099

Lynch, K., & Southworth, M., (1974). *Designing and managing the strip.* In: Sullivan, C.W., & Lovell, T. S., (2005). *Improving the visual quality of commercial development at the rural-urban fringe.* Landscape and Planning vol. 77 pp 152 – 166.

Masser, I., (2001). Managing our urban future: the role of remote sensing and geographic information systems. Habitat International, 25 pp. 503-512.

McCall, M. K., & Minang, P. A., (2005). Assessing Participatory GIS for Community-Based Natural Resource Management: Claiming Community Forests in Cameroon. Geographical Journal 171.4 : 340-358.

Minang, P. A., (2003). Assessing Participatory Geographic Information Systems for Community Forestry Planning in Cameroon: A Local Governance Perspective. International Institute for Geo-Information Science and Earth Observation Enschede, The Netherlands.

Moldof, A. S., (2004). *Controlling strip development.* Planning Commissioners Journal, Number 53.

Munshifwa, E.K., & Mooya, M. M., (2013). *Theorising urban form in developing countries: Informal property markets and the production of the built environment.* University of Cape Town, Department of Construction Economics and Management.

Nonomura, A., Sanga-Ngoie K., Fukuyama K., (2003). *Devising a new digital vegetation model for eco-climatic analysis in Africa using GIS and NOAA AVHRR data*. International Journal of Remote Sensing, vol. 24 no. 18, pp. 3611-3633.

Osumanu, I. K., (2009). *Urbanization challenges in Africa: Creating productive cities under globalization.* In: Graber, D. S., & Birmingham, K. A., (Eds), *Urban Planning in the 21st Century*. (pp 129-138). Nova Science publishers, Inc.

Owusu, G., (2012). Coping with urban sprawl: A critical discussion of the urban containment strategy in a developing country city, Accra. The journal of urbanism n. 26 vol. 1/ 2013

Pelkey, N.W., Stoner, C. J., Caro, T.M., (2003). Assessing habitat protection regimes in Tanzaniausing AVHRR NDVI composites: comparisons at different spatial and temporal scales.

Pendall, R., (1999). *Do land-use controls cause sprawl?* Environment and Planning B 26:555–571.

Peprah K. (2013). Sand winning and land degradation: Perspective of indigenous sand winners of Wa, Ghana. Journal of Environment and Earth Science 3 (14), 185-195

Peprah, K., (2014). *Urban sprawl of Wa, Ghana: Socio-economic implications for small-holder farmers.* International Journal on Innovative research and Development, Vol 3 Issue 1, January, 2014 http://ijird.com/index.php/ijird/article/viewFile/46235/37575

Pickles, J., (1993). Discourse on method and the history of discipline: Reflections on Jerome Dobson's 1993 ''Automated geography.'' The Professional Geographer 45: 451–55.

Pumain, D., (2003). Urban sprawl: Is there a French Case? In: Richardson H.W., Bae, C.C. (Eds): Urban sprawl in Western Europe and the United States. London: Ashgate, pp.137-157.

Rauws, W. S., & De Roo, G., (2011*). Exploring Transitions in the Peri-Urban Area.* Planning Theory & Practice, Vol. 12, No. 2, 269–284.

Richards, J. A., (1993). Remote sensing digital image analysis: an introduction (second

Richards, J. A., (1999). *Remote sensing digital image analysis*. Berlin: Springer Verlag, p. 240.

Royer, A., Charbonneau L., and Bonn F., (1988). *Urbanization and Landsat MSS albedo change in the Windsor-Quebec corridor since 1972*, International Journal of Remote Sensing, 9:555–566.

Schneider, A., & Woodcock, C. E., (2008). Compact, dispersed, fragmented, extensive? A comparison of urban expansion in twenty-five global cities using remotely sensed data, pattern metrics and census information. Urban Studies, 45, 659–692.

Schneider, A., Friedi, A. M., &Potere, D., (2010). *Mapping global urban areas using MODIS 500-m data: New methods and datasets based on 'urban ecoregions'*. Remote sensing of environment Vol. 114(8) pp 0034-4257

Schneider, A., Friedl, M. A., Mciver, D. K., & Woodcock, C. E., (2003). *Mapping urban areas by fusing multiple sources of coarse resolution remotely sensed data.* Photogrammetric Engineering and Remote Sensing, 69, 1377–1386.

Schuurman, N., (2006). *Formalization Matters: Critical GIS and Ontology Research*. Annals of the Association of American Geographers, 96(4), 2006, pp. 726–739.

Seto, K. C., Fragkias, M., Güneralp, B., Reilly, M. K., (2011). *A meta-analysis of global urban land expansion.* PLoS ONE 6:e23777.

Smith, N., (1992). *History and philosophy of geography: Real wars, theory wars*. Progress in Human Geography 16:257–71.

Snow, R.W., Guerra, C. A., Noor, A. M., Myint, H.Y., Hay, S.I., (2005). *The global distribution of clinical episodes of plasmodium falciparum malaria.* Nature. 2005 in press.

Songsore J., (2002). Urban Transition in Ghana: Urbanization, National Development and Poverty Reduction. Acrra, University of Ghana

Songsore, J., (2010). *The urban transition in Ghana: Urbanization, national development and poverty reduction.* Study prepared for the IIED as part of its Eight Country case studies on urbanization.

Stow, D. A., Weeks, J. R., Toure, S., Coulter, L. L., Lippitt, C. D., & Ashcroft, E., (2011). *Urban vegetation cover and vegetation change in Accra, Ghana:*

Connection to housing quality. The Professional Geographer, XX(X) XXXX, pages 1–15.

Sullivan, C.W., & Lovell, T. S., (2005). *Improving the visual quality of commercial development at the rural-urban fringe.* Landscape and Planning vol. 77 pp 152 - 166

Symeonakis, E., & Drake, N., (2004). *Monitoring desertification and land degradation over sub-Saharan Africa.* International Journal of Remote Sensing, vol. 25 no. 3, pp. 573-592.

Tatem, A. J., Noor, A., Von Hagen, C. M., Di Gregorio, A., & Hay, S. I., (2007). *High resolution population maps for low income nations: Combining land cover and census in East Africa.* PLoS ONE 2(12): e1298. doi:10.1371/journal.pone.0001298

Taubenböck, H., Esch, T., Felbier, A., Wiesner, M., Roth, A., & Dech, S., (2012). *Monitoring urbanization in mega cities from space. Remote sensing of environment.* 117, 162–176.

Taylor, P. J., & Overton, M., (1991). *Further thoughts on geography and GIS: A pre-emptive strike?* Environment and Planning A 23: 1087–1094.

Taylor, P. J., (1990). Political Geography Quarterly. GKS 9:211–12.

Tobler, M.W., Cochard, R., Edwards, P. J., (2003). *The impact of cattle ranching on large-scale vegetation's patterns in a coastal savanna in Tanzania.* Journal of Applied Ecology, vol. 40 no. 3,pp. 430-444.

Todd, W. J., (1977). *Urban and regional land use change detected by using Landsat data,* Journal of Research by the U.S. Geological Survey, 5:527–534.

Torrens, P. M., Alberti, M., (2000). *Measuring sprawl*. CASA Paper 27. London: Centre for Advanced Spatial Analysis, University College London.

Twumasi Y. A., and Merem E. C., (2006) *GIS and remote sensing applications in the assessment of change within a coastal environment in the Niger Delta region of Nigeria*. International journal of environmental research and public health 3(1) 98- 106

UN, 2014 [United Nations, Department of Economic and Social Affairs, Population Division (2014). *World Urbanization Prospects*: The 2014 Revision, CD-ROM Edition.

UN-HABITAT, (2008). The state of African cities; a framework for addressing urban challenges in Africa. United Nations Human Settlements Programme.

United Nations Population Fund, (2007). State of world population: Unleashing the potential of urban growth. New York.

United Nations, (2013). *Africa Regional Report: Main Findings and Recommendations*. African Regional Conference on Population and Development , Addis Ababa (Ethiopia), ECA/SDPD/PYS/ICPD/RP/2013

Verma, P., & Ghosh, S. J., (2008). *Urban change detection using high resolution satellite.* Images international Journal of Emerging Technology and Advanced Engineering. (Volume 3, Issue 8, August 2013).

Wang, Y.Q., Damon, C., Archetto, G., Inkoom, J., Robadue, D., Stevens, H., & Agbogah,K., (2013). *Quantifying a Decade of Land Cover Change in Ghana's Amanzule Region*. 2002-2012: Map Book (A3 Format) USAID Integrated Coastal and Fisheries Governance Program for the Western Region of Ghana.

Narragansett, RI: Coastal Resources Center, Graduate School of Oceanography, University of Rhode Island. 22 pp.

Wilks I. (1989) *Wa and the Wala*. Islam and Polity in Northwestern Ghana. Cambridge, Cambridge University Press

World Bank, (2005). *The Dynamics of Global Expansion.* World Bank, Transport and Urban Development Department. Washington D.C.: The World Bank

Yang, L., Xian G., Jacqueline, M. K., & Deal, B., (2003). *Urban land-cover change detection through sub-pixel imperviousness mapping using remotely sensed data*. Photogrammetric Engineering & Remote Sensing Vol. 69, No. 9, September 2003, pp. 1003–1010.

Appendix I

UNIVERSITY FOR DEVELOPMENT STUDIES

Department of Environment and Resource Studies

Questionnaire for Section Chiefs/Heads

Topic: Urban Development of Wa since the 1986 to 2016: A GIS Perspective

Preamble: *This exercise is purely for an academic Purpose leading to the award of a Master of Philosophy Degree in Environment and Resource Management and any information given shall be treated with confidentiality and be used solely for academic work.*

SN Number: SH0…… Date: …….. Community: ……

Bio – Data

Sex: Male [ ] Female [Age …….. Status ……..

Main Questions

1. How long have you lived in Wa? ……
2. When was this settlement formed? ……..……..
3. Where did the people migrate from?

   ……...…….
4. What was the reason (s) for resettling/migrating here?

   ……..……

   ……

   …….
5. Has this settlement increased/expanded? A. Yes B. No

5.1 If yes, how did this settlement increase/expand?

……

…….

5.2 What caused the increase/expansion?

……

……

……...

6 Has there been any land use changes since you moved to this settlement? A. Yes B. No

6.1 if yes, What are they?

……..……

……

…….

7. What is the major land use change that has occurred?

……..…….

7.1 what is (are) the cause(s) of the major land use change?

……..……

……

8. Has the expansion presented any opportunity or chanllege(s) a) Yes [ ] b) No [ ]

9. What are the positive social attributions that has resulted from the settlement change in Wa?

a) Yes [ ] b) No [ ]

9.1 If yes, what are the opportunities

……

……

……

……

……

……

9.2 If yes what are the Challenges

……

……

……

……

……

……

10. What else do you have to say about urban expansion?

……

……

……

……

……

……

Appendix II

UNIVERSITY FOR DEVELOPMENT STUDIES

Department of Environment and Resource Studies

Questionnaire for Town and Country Planning Department (TnCPD)

Topic: Urban Development of Wa since the 1986 to 2016: A GIS Perspective

Preamble: *This exercise is purely for an academic Purpose leading to the award of a Master of Philosophy Degree in Environment and Resource Management and any information given shall be treated with confidentiality and be used solely for academic work.*

SN Number: TnCPD 0…….. *Date: ……..*

Data required:

A. Previous Land use maps or Zoning maps of Wa

B. Current land use map(s)

(Formats: hard copy/ image/ TIFF, arc coverage, Shapefile/ AutoCAD format etc)

1. When tncp came into being in Wa
2. What are the land Use changes that have been observed in Wa since the tncp existence in wa ?

   ……

3. What is the major land use change observed?

   ……

4. How has settlement developed over time?

……

……

5. Has the expansion imposed any challenges for use planning? ……..

6. What are the factors to consider when undertaking a Land Use/Zoning Activity?

……

……

7. What are the stakeholders involved in Land Use zoning?

……

……

8. What is the procedure for zoning?

……

…….

9. How do you ensure that the right use of land is being put to?

……

……

10. How do you correct a wrong land use?

……

……

11. What are the problems faced in land use planning?

……

……

Appendix III

UNIVERSITY FOR DEVELOPMENT STUDIES

Graduate School

Department of Environment and Resource Studies

Questionnaire of Valuation Officer

Topic: Urban Development of Wa since the 1986 to 2016: A GIS Perspective

Preamble: *This exercise is purely for an academic Purpose leading to the award of a Master of Philosophy Degree in Environment and Resource Management and any information given shall be treated with confidentiality and be used solely for academic work.*

1. What was the value of one plot of land in the following years?

Year/location	wa		Kpaguri	Bamahu	Degu	Kpongu	Sombo	kabanye	Danko
1986									
2001									
2014									
2016									

Appendix IV

Accuracy results for General Land Use/Land Cover Classification

					Accuracy		
Year	**Class Name**		**Classified**	**Number**	**Producer**	**User (%)**	**Kappa**
1986	Built	3	3	3	100	100	1
	Closed woodland	38	37	32	84.2	86.5	0.8
	Water	0	0	0	-	-	0
	Shrubs and grass	95	100	90	94.7	90	0.7
	Bare ground	12	9	9	75	100	1
	Totals	150	150	135			
	Overall Classification Accuracy = 90						
	Overall Kappa Statistics = 0.8039						
2001	Built	4	4	4	100	100	1
	Closed woodland	31	26	22	70.9	84.6	0.8
	Water	0	0	0	-	-	0
	Shrub and grass	111	119	107	96.4	89.9	0.6
	Bare ground	4	1	1	25	100	1
	Totals	150	150	134			
	Overall Classification Accuracy = 89.3						
	Overall Kappa Statistics = 0.7						
2014	Built	6	6	6	100	100.00%	1
	Closed woodland	28	23	22	78.5	95.6	0.9
	Water	0	0	0	-	-	0
	Shrub and grass	114	119	113	99.1	94.9	0.7
	Bare ground	2	2	2	100	100	1
	Totals	150	150	143			
	Overall Classification Accuracy = 95.3						
	Overall Kappa Statistics = 0.8						
2016	Built	7	7	7	100	100	1
	Closed woodland	37	37	35	94.5	94.5	0.
	Water	1	0	0	-	-	0
	Shrubs and grass	103	104	101	98.1	97.1	0.9
	Bare ground	2	2	2	100	100	1
	Totals	150	150	145			
	Overall Classification Accuracy = 96.6						
	Overall Kappa Statistics = 0.9						

Source: Authors' construct