THE SPATIO - TEMPORAL PATTERN OF URBAN SPRAWL IN ZARIA METROPOLIS, KADUNA STATE, NIGERIA

BY

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BEING A THESIS SUBMITTED TO THE POSTGRADUATE SCHOOL, AHMADU BELLO UNIVERSITY, ZARIA. IN PATIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER DEGREE OF SCIENCE IN ENVIRONMENTAL MANAGEMENT

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2015

DECLARATION

I declare that this thesis entitled ‘’ The spatio- Temporal Pattern of Urban Sparwl in Zaria Metropolis, Kaduna State Nigeria,’’ was conducted by me and it has not been presented in the department or anywhere for a degree. All quotations and source of information are duly acknowledged means of references.

…… **……** **……**

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CERTIFICATION

This thesis entitled ‘’ The spatio- Temporal Pattern of Urban Sparwl in Zaria Metropolis, Kaduna State Nigeria,’’ by Adamu Yahaya Kajuru meets the regulations governing the award of the degree of Master of Science in Environmental Management of Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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ABSTRACT

Cities and towns all over the world are rapidly growing. Population increase and economic booming is one of the leading factors of urbanization in Nigeria. Zaria is among the major Nigerian cities which have been experiencing rapid structural and functional changes which need to be understood, studied and measured for development control and proper planning for the growth. The study examined the spatio-temporal pattern of urban sprawl in Zaria Metropolis. LandSat ETM Satellite imageries of 1980,1990,2000 and 2013, as well as Questionnaire and field observation were used. The results of this study shows that within the periods of 33years, Zaria built-up area gradually expanded from 123.72km^2 in 1980 to about 260.79 km^2 in 2013 representing 29.10 percent. The growth of Zaria is associated with some socio-economic, environmental and planning problems. The result of the findings shows that, if the current rates of population increase and physical expansion continued, Zaria metropolis is likely to double its size in spatial extent in 50years. The researcher recommended that the Planning of infrastructure and Urban Services Delivery, Growth Management and Stakeholders Mobilization for Development through Advocacy should be maintained.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Urban sprawl may be defined as the scattering of new development on isolated tracts, separated from other areas by vacant land (Lata, 2001). It has also been described as leapfrog development (Jothimani, 1997; Torrens and Albert, 2000). The need for monitoring urban development has become imperative to help curb the problems of this type of growth. Monitoring urban development is mainly to find the type, amount and the location of land conversion for future planning (Shekhar, 2001). Urban sprawl varies in degrees between the developed and the developing world and subsequently they have differing consequences. In a developing country such as Nigeria, development in urban areas and miscellaneous land use types are isolated in the fringe areas followed by gradual filling of intervening spaces with similar uses. This is mainly due to rapid growth in population size which is usually uncontrolled.

The world's population is put at about 6.572 billion people out of whom the United Nations data indicated that about 3 billion people (50 percent) live in urban areas (UNCHS, 2007) , where as about 66 percent of the entire world's population lived in the countryside in the early 1950's (World Bank, 2000; IMF, 2006). Current estimates show that by 2030, about 61 percent of the total population of the world will be living in cities; and that all the world' increase in populations in the next three decades will occur in low and middle income countries (Peters, 2002 and 2007).

Glaeser, Kahn and Chu (2001) have analysed the impacts of sprawl in form of traffic congestion, environmental consequences, infrastructure costs and social consequences. They concluded that cars are producing externalities in form of congestion and pollution. However, because of the decentralisation of jobs, the pollution problem is reduced. As people move to edge cities, or is it commuting are getting shorter. Sprawl uses up formerly undeveloped land. But, on the other hand only a small portion of US landscape is built- up land, implying that there is no scarcity of land. Glaeser et.al further argues that externalities decreased over time per miles travelled. Moreover urban agglomeration economies may be reduced by sprawl and deter overall productivity.

In view of the implications of the increasing urban population for sustainable development in low and middle income countries, the 2002 Johannesburg World Summit on Sustainable Development (WSSD) called on all governments to address the overwhelming challenge of provision of urban basic services especially decent housing, water and sanitation for the teeming population in slums, where the quality of life is appalling. While continents like Europe and the America have stabilized their population growth and economy to a large extent, most countries in Africa, Asia and Latin America have in the last decades not been able to deliver on their promises of alleviating the precarious state of living environment of their citizens (UNHABITAT, 2003).

Generally speaking, growth in urban population worldwide is considered as the factor directly responsible for the unprecedented rate of urban sprawl being witnessed across the world. This is because as the population of an urban centre increases, its need for infrastructure such as transportation, water, sewage, etc. and facilities such as housing, commerce, health, schools,

recreation, etc. increases, consequently resulting to the phenomenon known as urban sprawl. Settlements represent the most profound human alteration of the natural environment through a spectrum of urban land use activities (Ifatimehin and Musa, 2008) which include farming, fishing, wildlife etc, but are not restricted to, transportation, commercial, industrial, residential, institutional, and recreational land uses. The expansion that ensues as a result of increase in the demand for these land uses explains the underlying and fundamental causes of urban sprawl.

The modern concept of urban sprawl in environmental management only really began to evolve in Britain during the second half of the nineteenth century as a reaction against industrialization which had created such great inequalities in living conditions by exploring for profit whatever did not have to be paid for directly, such as housing, air, water and workers health (Relph,1987:49). An urban form building process that transforms a former monocentric compact structure into a discontinuous, polycentric and disperse settlement structure (Galster, Hanson, Ratcliffe, Wolman, and Coleman, 2001, Torrens and Alberti, 2000). However, low-density, single-use, automobile dependent type of development has come to dominate the urban environment in the past fifty years, and was brought about by a combination of regulatory, economic, social and cultural factors (Arbury, 2005).

Glaeser and Kahn (2003) have shown that cheaper land and housing costs in the suburbs has lured many to settle in these areas. In addition to that, there has been an increase in public spending in the United State of America (U.S.A) for the development of infrastructure like roads, water and electricity in the suburbs than existing urban centres, thus adding benefit to life in the sprawl. Again, there has been an increase in commercial lending practices that favour suburban development; Increase in family income of an average American raised his living

standard. Owning a car and paying for gas to transit from suburb to the city is affordable for many Americans.

The fact that Sprawls are characterized by low density population and less traffic congestion gives it advantage to some people. Therefore, even in the absence of any federal policies that would encourage growth of sprawls, these centres have proliferated due to the willingness of a growing number of people to live in sprawls where they find life more calm and peaceful than in the cities. Higher property and business taxes in the cities have pushed businesses to the suburbs where taxes are generally low. Talking about positive effects of sprawl there have to be considered increased satisfaction of housing preferences, the convenience of car travel, the filling in of leapfrogging land, lower crime rates and better public schools in suburban local governments (Feng ,2009).

According to Wassmer (2005) a lot of negative urban consequences can be attributed to sprawl. The car and its polluting effects, a lack of functional open space, air and water pollution, a loss of farmland, tax dollars spent on duplicative infrastructure, concentrated poverty, racial and economic segregation, a lack of employment accessibility etc. Glaeser *et al.* (2003) have analysed the impacts of sprawl in form of traffic congestion, environmental consequences, infrastructure costs and social consequences. They concluded that cars are producing externalities in form of congestion and pollution. However, because of the decentralisation of jobs, the pollution problem is reduced. Sprawl uses up formerly undeveloped land. But, on the other hand, only a small portion of U.S landscape is built- up land, implying that there is no scarcity of land. He further argues that externalities decreased over time per miles travelled. Moreover, urban agglomerations economies may be reduced by sprawl and deter overall

productivity. However, this must not necessarily be the case. Sprawl cities differ substantially in productivity. The case of Detroit and Silicon Valley shows that the only true negative consequences of sprawl are social. The segregation processes that we have discussed above lead to a sharp social separation: Those who can afford cars live in the suburbs, those who can't in the inner city.

One other aspect of sprawl is the spatial configuration of built space in urban area. The spatial configuration gives more information than the size or geometry of cities. Euclidean geometry is not powerful enough to explain the highly complex spatial organization, whereas fractal analysis offers a different perspective on the urban landscape which takes into account urban spatial complexity (Batty and Longley, 1994; Batty and Xie, 1996; Bovill, 2000 Mehaffy and Salingaros, 2001). In these studies, it is argued that the urban development process is chaotic, it can be defined as complex structure, and such complex can be quantified through the spatial patterns which show the irregularity of their configuration.

1.2 STATEMENT OF THE RESEARCH PROBLEM

Rapid urban growth especially in the last two decades has put enormous pressure on land in Nigerian cities. The number of people living in Nigeria's towns and cities is expected to double to 80 million in the next 13 years and reach 100 million by 2010 (World Bank, 1996).The consequences especially for urban development and land management are many. The Federal Government of Nigeria (FGN)(2006) in a white paper observed that, "the uncontrolled nature of urban development is brought about by the tremendous difficulty experienced by individuals and corporate bodies in giving access to build" (FGN, 2002:45). Government has re-iterated that the main objective of its National Urban Development Policy is, "to ensure that land is

available for the purpose of controlled and orderly development in the urban areas (FGN, 2006:14).

There is no doubt that in recent times, sprawling activities have profoundly changed the pattern and environmental management in Zaria urban area. While comprehensive assessment and survey of urban sprawl and its management in the town and environs has yet been undertaken. Fragmentary information tends to suggest that a number of environmental problems such as congestion, pollution, sprawling along the adjoining country-side etc, within and around the city have increased in spatial extent and severity (Jaiyeoba, 2010).There is every indication that this trend would continue for a long time, if necessary actions are not taken. Zaria started as a nucleus settlement and gradually increased in to it multiple nucleus settlement. Presently, the rate of urban sprawl is increasing, more neighbourhood sub-settlement have emerged due to different factors.

In this regard, the assessment of the spatial pattern, factors responsible, rate of growth and management of urban sprawl remains unresolved over the years, particularly in the study area. The study explore these problems of urban sprawl in Zaria Metropolis, which is spurred on by population growth for proper environmental management, control and sustainability. Moreover, to the best of the researcher's knowledge, studies have not been carried out on this problem, hence this constitute the gap in knowledge that this study intends to fill. The search for solution to this problems has to begin with the examination of the causes, pattern and rate of urban sprawl in Zaria metropolis. Therefore, this research attempt to seek answers to the following research questions:

1. What is the pattern of urban sprawl in Zaria Metropolis?

2. What are the factors responsible for spatial pattern of urban sprawl?

3. What is the rate of urban sprawl in the study area?

4. What are the Challenges of urban sprawl in the study area?

1.3. AIM AND OBJECTIVES OF THE STUDY

The aim of this study is to analyze the spatio-temporal pattern of urban sprawl with a view to providing a basis for urban land management in Zaria Metropolis, Kaduna State Nigeria.

The specific objectives are to:

i. determine the pattern of urban sprawl in Zaria using GIS and remote sensing techniques,

ii. examine the factors responsible for the spatial pattern of urban sprawl in Zaria.,

iii. establish the rate of urban sprawl and its implications in Zaria Metropolis.,

iv. explain the socio-economic effects of the sprawl on the people of Zaria.

1.4. SCOPE OF THE STUDY

The spatial scope of this research covers Zaria Metropolis. That is, it covers Sabon-Gari, Zaria city, Samaru, Tudun-Wada, Kwangila and Dan-Magaji axies. The temporal extent of the study covers the period of 32 years. That is, from 1980 to 2013. The knowledge extent of this study was to analyze and determine the pattern and factors of urban sprawl in Zaria metropolis as well as its rate of growth for the management of the city. Some 20km radius around the town has been arbitrarily demarcated for the study with Tudun-Wada being the centre point.

1.5. JUSTIFICATION OF THE STUDY AREA

The study is envisaged to assist Kaduna State Urban Planning Development Authority (KASUPDA) and the State Ministry of land Survey and country Planning who are responsible for the supervision, monitoring, management, planning and maintaining the development control and ensuring the rules and regulations of their Board and Ministry are followed. The study also focuses on Zaria because it is one of the fast growing towns in the country, due to so many activities carried out in the City. The research is undertaken to bridge the knowledge gap,

via the use of Geographic Information System (GIS) and Remote Sensing technique. The study shall analyzed and examine the spatial pattern, rate and extent of growth and management of urban sprawl in the study area. The study would serve as a useful reference material to researchers in the field of urban environmental studies.

CHAPTER TWO

CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

2.1 INTRODUCTION

The chapter presents a literature review aimed at facilitating the understanding of the concept of urban sprawl and the debate surrounding the topic within the academic literature.

2.2 CONCEPTUAL FRAMEWORK

2.2.1 Urban sprawl

2.2.1.1 Definition of urban sprawl

Urban planning evolved throughout the twentieth century, leading to a great variety of urban forms which often had little regard for their impact upon the environment. In both developed and developing societies, this disregard is most evident in the rise of urban sprawl as the primary form of urban development, one of which come under increased criticism in recent years because of its negative environmental, social and economic effects (Newman and Kenworthy, 1989).

The various definition of urban sprawl in the planning literature have been summarized to create a working definition of the concept as: unplanned, uncontrolled single use development that does not provide for a functional mix of uses and is not functionally related to surrounding land uses and which variously appears as low- density, ribbon or strip, scattered, leapfrog, isolated development. This low-density, single-use, automobile dependent type of development has come to dominate the urban environment in the past fifty year, and was brought about by combination of regulatory, economic, social and cultural factors (Arbury, 2005).

However, urban management literature, frequently implicated as causing excessive land consumption due to under- valuation of open space, congestion due to increased commuting and socioeconomic segregation due to exclusionary housing market(Carruthers and Ulfarson, 2002: 315). Further more, sprawl development is now perceived as contributing to significant fiscal cost for infrastructure providers such as local governments (Burchell and Mukherji, 2003), and public health problems (Sturm and Cohen, 2004; Kelly-Schwartz et.al., 2004; Nozzi, 2003).

2.2.1.2 The evolution of urban sprawl

Before the industrial Revolution of the eighteenth and nineteenth centuries, people mainly lived in rural areas or small villages. Even though cities had existed for thousands of years, and had been planned, to some extent, right throughout this period, Only a tiny fraction of the world's population lived in urban areas (Elkin *et.al.*, 1991) . However, technological changes from the late 1700s onward not only encouraged greater numbers of people to live in urban areas as factory work replaced many former jobs, some of which later became mechanized, but also fundamentally altered the structure of the urban environment through a series of technological innovations such as trains and electric trams.

Newman (1992) has identified three distinct time periods shaping the development of urban areas, and how the periods are closely linked with the available technology of the time. Traditionally cities had been characterized by a small, dense environment, often walled and generally not being much more than kilometers from one end to the other. This form developed because of the need for all destinations to be within a reasonable walking distance, and can easily be seen in the design of most European cities, as well as the central parts of many older

cities in Europe, Africa, North America, Australia and Newzealand. The technological development of passenger trains and trams in the latter part the nineteenth century enabled cities to form a new style of development, characterized by an increasing push outwards. Trains generated sub-centers, with the train station at the heart of a number of pedestrian pockets with similar characteristics to that of the walking city; whilst trams created linear, grid-based development which followed the tram routes (Newman 1992). Cities could now spread up to twenty or thirty kilometres outwards depending on the technologies available, while where the rail lines met in the Central Business District (CBD) there was very dense activity. This technological development coincided with massive urbanization throughout much of Europe, North America and Australasia; as a result many of the cities in these areas have been strongly shaped by trains and trams, even if those transit system are no longer in use today.

The third stage of urban development, based on the technological development of the automobile, began before the Second World War, but did not become the dominant form of development until after the war, when the automobile progressively became the transport technology that shaped the city. Together with the bus it became possible to develop in any direction, first filling in between the train lines and then going out as far as fifty kilometres (Newman, 1992: 287). The automobile made low-density housing feasible, as people were no

longer forced to live either near their place of employment or a transit station to transport them there. City functions could be separated through exclusive zoning patterns, enabling people to escape the pollution and bustle associated with industrial or business areas.

The evolved form of many colonial and post-colonial African cities fit into these latter stages of urban evolution because contemporary urbanization in Africa started at a time coinciding with the period of the rising popularity and proliferation of the personal automobile. Nevertheless, it would be native to state that the rise in automobile ownership alone has led to the rise of urban sprawl, as there are many other important contributing factors. Duany *et.al* (2000:7) believe that above all else, suburban sprawl is the direct result of a number of policies or their absence and failures in the case of the developing world that conspired powerfully to encourage urban dispersal. The most significant contributing policies in the US have been identified as the Federal Housing Administration and Veterans Administration loan programs, which following the Second World War provided mortgages for over eleven million new homes. Intentionally or not, policies such as these discouraged the renovation of existing housing stock, and placed great emphasis on the construction of single-family, detached houses, the foundation of low-density development (Duany et. al., 2000). Working in combination with rapidly rising rates of home and automobile ownership to further entrench low-density, automobile –oriented development was federal investment in a 41,000 mile interstate highway program, which coupled with federal and local subsidies for road improvement and the neglect of mass transit, helped to make automotive commuting affordable and convenient for the average citizen (Duany *et.al.*, 2000:8).

In conjunction with these regulatory activities, which encouraged the decentralization of metropolitan areas, the emergence of 'zoning' over the past 80 year has contributed to the creation of single-use developments and the spatial separation of the home from almost all other activities which people are required to undertake on a daily basis. This is clearly another element of today's urban sprawl. In Nigeria, one can safely infer that it is in fact the absence of

workable urban development policies of the failures of existing ones that has resulted in the present sprawled form of most of our urban areas.

2.2.1.3 Characteristics of sprawl

There are many characteristics that can be associated with urban sprawl although there remains debate in the planning literature with regards to the development of an exact definition for the term, and disagreement whether particular urban forms should be categorized as urban sprawl or not. According to Gilllham (2002) there are four main characteristics of sprawl, which mirror the earlier definition given. These characteristics are commercial strip development, leapfrog or scattered development, low density, and large expanses of single-use development.

(a) Commercial Strip Development

Commercial strip development is characterized by huge arterial roads lined with shopping centers, gas stations, fast food restaurants, drive-through banks, parking lots and many large signs'(Gillham, 2002:5). 'Strip development' is very low density and automobile dependent, with retail configured in long, low boxes (portakabins /containers) or in a small pavilions which are always surrounded by large parking lots. Trips between the different retail outlet are almost

always made by car, due to the ‘ spread out’ nature of the strip, and there is little if any emphasis placed on the needs of pedestrians.

(b) Leapfrog or Scattered Development

Leapfrog and scattered development go beyond the urban fringe to create built-up communities that are isolated from the city by areas of undeveloped land. In many ways these can be seen as the most extreme examples of urban sprawl, with a highly inefficient use of land, and a greater

need to build highways and other infrastructure to service the outlying areas. Leapfrog development can be distinguish from ‘satellite town’ a similar type of development beyond urban fringe, by the former’s much lower density and once again the almost exclusive reliance on the automobile as the method of transport for those living in such areas. The result is a haphazard patchwork, widely spread apart and seeming to consume far more land than contiguous development (Gillham, 2002:4), and even though the open tracts of land are usually filled in eventually, leapfrog development remains an inefficient use of land.

(c) Low Density and Single Use Development

The third, and perhaps most commonly recognized aspect of urban sprawl, is its low density. Gillham (2002) describes the density of urban sprawl as lying between that of the crowded urban core and open countryside, but being much lower than order towns and cities. Buildings

in ‘sprawl’ developments are generally single-story, widely spaced and with intervening parking lots and roadways. Density is normally measured in terms of population density, or dwelling unit per area. The mixed-use, higher-density developments of early twentieth century cities, which facilitated both walking and the use of public transport, have been usurped by spatially

dispersed cities and ‘bedroom communities’ of exclusive residential development, realistically accessible only by car.

(d) Absence of Public Space

In addition to those elements of sprawl mentioned above, the absence of public space is a characteristic that truly identifies a ‘sprawled’ community from one that is not. As Gillham (2002:7) elaborates, urban sprawl is distinguished by an unbroken fabric of privately owned land divided only by public roads. The major civic open spaces, parks and commons that grace

many older urban-core areas can be few to nonexistent in much of the sprawl areas of today’s cities. Clearly urban sprawl is a complex phenomenon, involving the four aspects listed above.

2.2.1.4 Spatial concept of urban sprawl

The analysis of spatial structures and pattern are central to geographic research. Spatial primitives such as location, direction, orientation, linkage and pattern have been discussed as general spatial concepts in Geography (Golledge 1995). In Geography these concepts have been implemented in a variety of different ways. In this study, the basic spatial concepts and the

analysis of spatial structure and pattern will be approached from the perspective of spatial metrics (Herold et.al., 2005). Under the name of landscape metrics, spatial metrics are already commonly used to quantity the shape and pattern of vegetation and natural/anthropogenic landscapes (O’neill et.al., 1988; Gustaftan, 1998; Hargis et.al., 1998; and Mc Ganigal *et.al.*, 2002).

Landscape metric was developed in the late 1980s and incorporated measures from data information theory and factual geometry (Man-Delbrot, 1983). Based on a categorical patch based representation of a landscape. Patches are defined as homogeneous regions for a specific landscape property of interest, such as ‘’industrial land ‘’park’’ or ‘’high density residential zone’’. Landscape metrics are used to quantity the spatial heterogeneity of individual patches, of all patches belonging to a common class of the landscape as a collection of patches Shannon and Wave (1964).

2.2.1.5 Spatio-temporal approach of urban sprawl

Different disciplines look at urban sprawl approach from different viewpoints. This approach is based on scientific research techniques of deductive and inductive approach.

2.2.5.1 Deductive approach: this is traditional approach in which the urban sprawl pattern can be examined from general to specific (i.e. top-bottom approach). In this regards the urban sprawl can said to be an outcome of pre-specified process of urban change. Therefore according to this view point a structure of an urban system can be determined by the process of the sprawl (Herold *et.al.,* 2002). Geography. Economics and Urban planning are major disciplines, which commonly view spatio-temporal pattern of urban sprawl from this angle (approach). This perspective is criticized of being on only marginal representative of spatio-temporal complexities of urban change (Batty and Howes, 2001). This approach answers questions of, how urban structure form overtime? By examine the drivers, and factor of urban sprawl process. According to Herold *et.al.,* (2003) the factors that determine the spatio-temporal dynamic of

urban sprawl process are growth rate, terrain, facilities attraction, growth constrains, and deliberate factors such as business cycles, and planning efforts.

The approach focus more on isolating the drivers of growth rather than solely the emerging geography patterns. This several urban models have provided weight to which a deeper understanding of urban dynamic (can be based) upon, but limitations of availability of suitable data that can be compatible to the theory in still a constraint (Longley and Mesev 2000).

2.2.5.2 Inductive approach: this approach is based on bottom up perspective from which an evolution of urban structure or pattern is examined from drivers or factors change (i.e. al.,2003). Therefore this approach is an empirical observation that link temporal dynamic to specific hypothesis about the process involved. This empirical observation of urban sprawl pattern can be derived from time series observation of remotely sensed data. An integration of spatial analysis, Remote Sensing and spatial Metrics in understanding geographic phenomena, have recently attached the attention of researchers. Several studies have been carried out to link empirical observation with urban theory. Sudhira (2004) has integrated agent-based and cellular automata model in simulating urban sprawl. Abghani *et.al* (2011) established that deterministic approach can be used to model urban sprawl, by considering the change of pixels in a temporal imagery data, the growth of built-up area can be detected based on its neighbourhoods dynamics as similar to cellular automata theory.

2.2.2 Gis and remote sensing techniques in urban sprawl studies

One of the most important paradigms in Geography and related disciplines that manage or use spatial data, associated with methodological changes is the advancement in satellite Remote Sensing and Computer aided Geographical Information System and the availability of satellite imageries. Remote sensing technology has been the subject of research in a variety of contexts and situations and has been successfully introduced as sole, complementary or corroborative source of data for many applications (Batty, 2000).

Remote Sensing technology has great potential for acquisition of detailed and accurate land use information for management and planning of urban regions. However, the determination of land use data with high geometric and thematic accuracy is generally limited by the availability

of adequate Remote Sensing data in terms of spatial and temporal resolution and digital image analysis techniques (Herold *et. al.,* 2002). The technique of Remote Sensing provides a powerful tool for studying urban issues, like land use/cover changes, urban growth modelling, urban sprawl etc. Remote Sensing image classification is one of the important application aspects for Remote Sensing technique, through computer processing with specific software, like ERDAS, the results of the classification of land use can be auto-patted (Feng, 2009).

For decades the visual interpretation of areal photography of urban area has been based on the hierarchical relationships of basic image elements. The spatial arrangement and configuration of the basic elements (tone and colour) combine to give higher order interpretation features of quarters complexities such as size, shape and texture or pattern and association, that are

significant and characteristics for urban areas and urban land use (Bowden, 1975). Much of the expert knowledge of the human image interpretations was lost in the transition from air photo interpretation to digital analysis of satellite imagery. The great strength of Remote Sensing is that it can provide spatially consistent data sets that cover large areas with both high detail and high temporal frequency, including historical time series. Mapping of urban areas has been accomplished at different spatial scales e.g. with different spatial resolutions, varying coverage or extent of mapping area and varying definitions of thematic mapping objects (Herold *et. al.*, 2005). Global and regional scale studies are often focussed on mapping just the extent of urban area (Schnnides *et.al.,* 2001). One of the basic difficulties of mapping urban area from remotely sensed data is that of indistinct demarcation between urban and rural areas on the edges of city. Remote Sensing provides an additional information that closely respects the actual physical extent of a city still remains problematic and individual studies must determine this own rules for differentiating urban from rural land (Clarkset.al.,1998).

2.3 LITERATURE REVIEW

Ujoh, Kwabe and Ifatimehin (2009) in their research, on urban sprawl in the Federal Capital City, Abuja: Used Geographic Information System, Remote Sensing and Global Positioning System (GPS) and discovered that as a result of fast rate of urbanization, rapid urban sprawl occurred. Aliyu (2011) also analyzed the pattern of urban sprawl and its Management Implications in Kaduna metropolis. This research work, however concentrated on the use of Shannon's Entropy, GIS and Remote Sensing in measuring and quantifying sprawl and its implication for management in the study area. Jinadu (2004) carried out a research on urban expansion and physical Development Problems in Abuja using a statistical method of analyzing sprawl. From the findings, it was clear that there has been a considerable degree of urban sprawl

within the study area, to the extent that more than eight (8) settlement outskirt the study area were formed.

As a bold attempt in management and controlling such effect by the Nigerian Government, the Federal Environmental Protection Agency (FEPA) (1989) was established as a National Policy on Environment. Micheal, (2009) in his research ‘’Urban sprawl pattern and measurement in Lokoja, Nigeria. He finds out that Lokoja has been experiencing a large influx of population from its surrounding regions, which has led to rapid growth and expansion that had left profound changes on the landscape in terms of land use and land cover. Ndabula etal. (2013), in their journal on environmental protection ‘The analysis of spatio-temporal dynamics of land use land cover structures in the Kaduna inner core city region, Nigeria. They however, critically analyse the extent, rate, as well as the magnitude of change among various land use land cover in the study area, provides a basis for comparisms with other places and also explain the nature

of spatio-temporal dynamics of land use land cover as an index of land degradation. Adedeji (2010), in his journal of sustainable development in Africa, ‘The urban environmental problems in Nigeria; Examine the causes and implications of increasing environmental deterioration for sustainable development in the country and also identified colonial antecedents of Nigerian cities, rapid urbanization and poor psychological orientation of residents as being for the current situation. Ajibua (2013), examines the pattern and techniques for municipal waste disposal and the consequent on the health of population. Fatih and Serdar (2008), in their research work ‘ Analyzing urban sprawl patterns through fractal geometry’ attempts to measure urban sprawl using sprawl index and analyses urban form through fractal analysis for characterizing urban sprawl in Istanbul.

2.3.1 SRTATEGIES FOR THE CONTAINMENT OF SPRAWL

2.3.1.1 The compact City

Much of the planning literature from 1990 onwards focuses on the compact city: a concept designed to implement sustainable development within the urban environment and to counteract the perceived negative social, economic and environmental impacts of urban sprawl. There have been many attempt to define exactly what a compact city is, ‘ but in general it is taken to mean a relatively high-density, mixed-use city, based on an efficient public transport system and dimensions that encourage walking and cycling’ (Burton, 2000: 1970). Through intensification of development within the city, many problems related to urban sprawl have the potential to overcome, reversing the unsustainability of sprawl-type developments. Compact city policies have often been designed primarily to reduced the use of private cars and to

minimized the loss of open country-side. However, proponents of the concept claim more than just environmental benefit can be gained from intensifying urban areas: In fact ‘high density settlements are argued to be more socially sustainable because local facilities and services can be maintained, due to high population densities, and therefore accessibility to goods and services is more equitably distributed’ (Williams, 1999: 168).

Furthermore, high density urban living is seen as a prerequisite for vitality, vibrancy cultural activities and social interaction (Williams, 1999:168). The rejuvenation of local economies, particularly in downtown areas neglected by urban decentralisation and sprawl, can potentially

also be achieved through intensification. Therefore, at least theoretically, it appeared that a solution to the sustainable city problem had indeed been discovered in planning literature by the mid 1990s, although with scepticism from some such as Breheny (1992, 1996), Gordon and Richardson (1997).

Contention over exactly what a compact city is, and how a great variety of of urban forms have been promoted as being 'compact' has proliferated throughout the literature concerned with urban sustainability over the past fifteen-years .According to Thomas Cousins (1996:54), initial impressions of the compact city invoke an intense medieval city, whose limits are clearly visible, and where the hub of activity is confined within the city walls. While it is highly unlikely that urban planners advocate rebuilding walled cities, it is a confinement of urban activity that appears to be most desired by the supporters of the compact city theory. Indeed, Locks (1995:173) definition of compact city as:' the process of ensuring that we make the fullest use of land is already urbanised, before taking green fields or Neass' (1993: 309)

definition of encouraging development to where ' technical encroachments on nature have already taken place' typify the approach of the compact city advocate.

However, although there may be consensus that the compact city is clearly distinct from urban sprawl, there still remain many questions surrounding exactly *how compact* the compact city should be, and to what extent it extends beyond a simple population density increase in the urban environment. Scoffham and Vale (1996) argue that is highly important to ask these questions about what the compact city is; whether buildings should be brought closer together;

whether the number of people living in buildings should be increased; whether dwelling density or activity density that need to be 'compacted'; and what role a mix of urban uses has in the compact city debate. According to Pratt and Larkham (1996: 279) 'One of the key problems with the compact city hypothesis is that it brings very diverse concepts together under a potentially misleading banner'.

Generally three aspects of the compact city are identified: a high-density city, a mixed-use city, and an intensified city (Burton, 2002). The first two aspects are related to the form of the compact city, while the third focuses on the process of making the city more compact. This third point is critical because there are few opportunities for a compact city to be created from the scratch, which in many case would appear highly contradictory given the aims of urban compaction. Thus more compact cities can only be achieved through a process of making existing cities denser, of encouraging more people to live in urban areas and of building at higher densities (Williams *et.al.*,1996:83).

Therefore, there is general agreement that the 'compact city model' is based around an increase in density from current levels. Given that the main goal of the compact city model is to reduce the impact of urban development upon the countryside, most future urban growth will need to occur within existing city boundaries (Williams, 1999). In an attempt to replicate the 'supposedly desirable' densely developed cores of old European cities, many different methods of intensification have been proposed, such as 'the development of previously undeveloped urban land; redevelopment at higher densities of existing buildings or previously developed sites; sub-division and conversions; as well as additions and extension' (Williams 1999:168).

However, the nature of this density increase, the role of 'mixed-use' development, and the wide variety of international interpretations of the compact city concept are still contentious issues in the urban development literature. Lock (1995) claims that there is no technical or professional agreement on how best to measure density and that few planners are comfortable in distinguishing between net and gross residential density or overall town density. This

disagreement makes it difficult to draw out the component of urban intensification and to identify what types of intensification should be encouraged, and what should be avoided. The nature of urban compaction has been deemed very important (Burton, 2002; Breheny, 1996) because certain types of development are generally thought of as being more desirable than others-high-rise apartment building are often associated with crime, overcrowding and the 'failure of tower-block living' (Williams, 1999,; McLaren, 1992): while high-density that is not characterized by high-rise is often thought of as 'town-cramming' (Williams *et.al.,* 1996).

The environmental arguments for the compact city, notably that it 'save' the countryside from Greenfield development and the number of car trips per person are reduced, have been questioned by empirical evidence. Williams (1999: 172) states that 'recent research in three London Boroughs which had been intensified over a ten year period showed no reductions in car use. Travel patterns were so complex, due to lifestyle shift such as cross-London commuting and increased journeys for leisure, that no relationship could be found'. Furthermore, the environmental gains made from not developing beyond the urban fringe are often negated by 'the subsequent loss of urban open space that may mean a reduction in ecological important land, and a loss of space for tree and other greenery' (Williams, 1999: 172).

The economic benefits of urban intensification frequently fail according to Gordon and Richardson, (1997) while there has been little empirical evidence to show that higher population densities lead to economic growth. However, a recent study by Carruthers and Ulfrasson (2003: 506) across 283 metropolitan areas in the US 'suggests that per capita spending on infrastructure declines at greater densities and increases with the spatial extent of urbanised land area'. Therefore, while some efficiency gains may be possible for the provision of services through increasing population density, the complexity of the whole compact city concepts means that in many cases no direct parallel can be easily drawn between economic growth and intensification. Closely link to whether urban compaction can be implemented are doubts over whether this will be acceptable to local residents.

Perceptions of 'over-development' have led to communities feeling that their neighbourhoods are being over –crowded, and losing amenity. This leads to battles to stave off development,

usually on back land sites, or well-loved amenity space such as playing fields or sports grounds (Williams et.al., 1996: 86) Thus, even if urban compaction policies are implemented successfully, they may not be acceptable to large tracts of the population, resulting in the reversal of such policies by locally elected councillors keen to retain their jobs. Breheny (1997: 213) clams that generally, marketing surveys carried out by house-builders reveal a strong preference for houses with gardens and as much space in both as possible, an urban form that contradicts compaction.

Moreover, development s requiring shared driveways, smaller units, multiple extensions turning detached houses into terraced housing, and other methods used to increase the density of

use among the urban environment, have led to a perceived reduction in quality of building stock, especially in the UK (Williams *et.al.*, (1996). Fillion *et. al.*, (1999: 1319) summarise many of these problems by stating that: 'One cannot escape noticing that policies inspired by such criticism of urban sprawl have had little influence on urban development which remains predominantly low density and car dependent. Proposed corrective measures have been stonewalled by a deep-seated consumer taste for low-density living and by vigorous anti-

intensification (Not In My back Yard) sentiments. Furthermore, even massive transit investment, suburban downtowns, and urban regeneration projects have failed to alter the heavy car reliance typical of suburban forms of urbanisation. (Duany *et al* 2000). Clearly, valid questions have been raised in the literature over the past eight to nine years about the veracity, feasibility and acceptability of the compact city as a tool for promoting urban sustainability. Not only has the literature focused on the shortcoming s of certain types of urban compaction, but the whole concept of increasing urban sustainability through intensifying activity within a more confined area has been questioned and found wanting.

As a result, many researchers have begun to look at new approaches to promoting urban sustainability: if urban sprawl is clearly unsustainable, but urban intensification is only questionable sustainable and riddled with issues and complexities, what methods should be used in the search for a sustainable urban form? (Jenks *et.al*., 1996). The burning question in most urban sustainability researchers' minds has become whether to focus on finding the best way to implement urban intensification policies, and to monitor their progress with utmost care or whether to abandon the whole 'compact city' concept and instead move towards developing new methods of attaining a more sustainable urban future.

2.3.1.2 Growth Management

Growth management is generally defined as the regulation of the amount timing, location and character of development (Levy 2009). Growth management programs are often heavily motivated by environmental considerations. A related consideration may be ensuring a desirable pattern of land development in future years. Preserving an existing lifestyle and community ambiance are common motivatgions as is ensuring that community facilities such as schools, roads, utilities and recreation will be adequate for future needs. In some cases, a major goal of growth management will be fiscal, ensuring that the community will not be swamped by development imposed cost. Lastly, growth management may have an exclusionary or 'keeping the good thing to ourselves motivation' (Levy, 2009).

In general, growth management plans or systems are made up of elements that have been well known to planners for years (Levy, 2009). However, Growth management systems differ from

traditional comprehensive planning not in the elements that compose them but in the synthesis of those elements. Specifically, growth management systems are generally characterized by every close and long-term coordination between land-use controls on the one hand and capital investment on the other. They are often also characterized by the use of more modern approaches to land-use control and often, by a great sensitivity to environmental issues. When growth management appeared in the late 1960s and early 1970s several different terms with overlapping meanings came in to being. 'A review of scholarly article published on the field in the 1970s carried, the title management and control of growth. In addition to the terms growth management and growth control, the term no growth also came in to use' (Levy, 2009).

Growth management might be taken to mean management without any implication, of limiting growth. Growth control carries the implication that growth is not only to be managed or guided but also to be limited. The term no growth carries the obvious implication of an intent to step growth entirely. With time, growth management became the standard term covering programs that fit all three senses of the terms just noted (Levy, 2009). The motivation and approach to growth management for any municipality needless to say it highly dependent on the prevailing political, social and economic clime.

2.3.1.3 Smart Growth

In the middle of the 1990s, the term smart growth appeared on the planning scene and rapidly became the buzz word of the day. The term was first used in connection with the Maryland state plan in 1996.Whether smart growth is inherently different from growth management as just described in earlier above or it is basically growth management under a more attractive name. 'who could be in favour of stupid growth is arguable' (Levy, 2009). Much of the concern

with smart growth has been driven by a concern with suburban sprawl., a condition that derives directly from population growth.

The biggest force behind smart growth in the US has been citizen concern over one aspect of sprawl, namely traffic congestion. The suburban resident who finds that his or her commuting time is increasing because of growth traffic congestion on major roadways and who finds the trips to shopping, to visit friends and to entertainment and recreation are making him or her feels as if the car is becoming a second home is likely to feel that something need to be done.

Often that something is planning for smart growth. Other forces behind the push for smart growth have been concern over preservation of the natural environment and concern with what some suburban residents may regard as excessive urbanization of their environs (Levy, 2009).

Because smart growth does not have a precise definition, the term means the method used was clearance and rebuilding directed by local agencies and supported by large Federal subsidies. It was and still stand as the largest Federal urban program in US history, and it reshaped parts of hundred of communities. Congress intended urban Renewal as a housing program, as the goals listed earlier indicated but as time went by, commercial and even industrial development were included as a way of revitalizing and modernizing the economies of cities where renewal was executed.

A critical concern in any urban Renewal program is the fragmented nature of land holding in urban areas. As response to this, quite a number of models and strategies have evolved over the

years to deal with this concern. These include various land readjustment models like the one used in Japan which Morales (2010) refers to as instigated property exchange. Locally, the overriding public interest clause in the Land Use Act provides a good alternative for overcoming this challenge.

2.3.2 The Effects of Sprawl: Sustainability and Sprawl

The term *sustainable*, in reference to human development patterns, first appears to have been used in the 1972 study of global resource use: The limit to growth (Meadows *et.al.*, 1972). The

authors of this work believed that the catastrophic collapse of global systems would occur midway through the twenty-first century if current growth rates and resource consumption continued, and that the only alternative was 'to alter these growth trends and to establish a condition of ecological and economic stability that is sustainable far in to the future' (Meadows *et.al.,* 1972: 24). At the time, such thinking was quite radical as the 'environmental movement' had barely emerged.

However, events around this time including the 1972 UN conference on the Human Environment and the 1973 oil crisis forced many academics and policy makers to accept that current trends could not be maintained forever, and that drastic measures may be required to conserve natural resources for future generations (Arbury, 2005). During the late 1980s and early 1990s WCED report Our Common future and the 1992 Earth Summit in Rio de Janeiro (WECD, 1987). The most commonly used definition of sustainable development, the recommendation of both the WCED report and the Earth Summit, is 'development that meets the needs of the present without compromising the ability of future generations tom meet their own needs (WCED, 1987: 43). The definition recognizes the importance of ensuring that the

needs of the world's population at the moment should be met, with consideration for the needs of people in the future.

Therefore, the concept of sustainability development, which has formed the basis of environmental law in many countries around the world over the past fifteen years is strongly related to the ethical norms of welfare, distribution, and democracy while recognizing that nature's ability to absorb human-made encroachments and pollution is limited (Naess, 2001). Haughton and Hunter (1994) have identified three basic principles of sustainable development:

The principle of inter-generational equity; the principle of social justice; and the principle of trans-frontier responsibility. Each of these principles is seen as equally important in achieving sustainable development, especially when attempting to apply the concept in a situation such as designing more sustainable cities. The principle of inter-generational equity, or futurity, is what most people concentrate on when talking about sustainable development: the need to consider the effects on future generations' needs and aspirations when undertaking any human activity (Haughton and Hunter, 1994).

However, equally important in the eyes of the Brundtland Commission was the principle of social justice,(also known as 'intra-generational equity'): that poverty needs to be tackled in present generation as it is a prime cause environmental degradation, Sustainability according to the generally accepted definition, means a more even distribution of resources, wider participation in environmental strategies and policies, and always taking in to account basic needs and common aspirations. Finally, Haughton and Hunter (1994) refer to the principle of trans-frontier responsibility, as the need for people to take stewardship of the global environment at a global level, which is necessary because many of the environmental problems

(such as global warming) transcend national borders. The principle also requires developed countries to refrain from the exploitation of resources in other areas, which can distort regional economies and ecosystems.

However, there are major potential problems for those attempting to implement sustainability throughout the world cities, as the concept appears to conflicts with urbanism as the fundamental level. Indeed, Elkin *et.al.,* (1991: 6) state that cities have never been sustainable;

rather ‘ the process of urbanism in antiquity has been frequently link with desertification in the hinterland, Cities have always exploited the surplus food and materials produced in the hinterland, and thus interfered with previously more cyclical ecological system. ‘This fundamental conflict between sustainability and urbanism becomes clear when one analyses the environmental impact of urban areas. Cities house a concentration of polluters, from industry to cars, which contribute to the disruption of the earth’s carbon cycle and could leads to global warming. Moreover, the vast food and energy use of the city creates what has been termed an enormous ‘ecological footprint’; the amount of land needed to support the modern city (Naess, 2001).

Furthermore, not only are today’s cities unsustainable, but they are becoming more unsustainable all the time, as there is no doubt that the pre-industrial dense European city would have consumed far less than cities today which are characterised by urban sprawl. Nevertheless, it is clear that while cities may never be able to actually achieved ‘sustainability’, they can become more ‘sustainable’. Haughton and Hunter (1994) have calculated that on average each city of one million people consumes 625,000 tonnes of water, 2000 tonnes of food and 9500 tonnes of fuel, and generates 500,000 tonnes of waste water, 2000 tonnes of waste solids and 950 tonnes of air pollutants on a daily basis. While this level of resource consumption is clearly unsustainable, it remains very difficult to device ways to reduce the levels of resource consumption while maintaining the relatively high standard of living that people enjoy in cities.

Although cities in the developing world are growing at a much faster rate than those in developed countries, the amount of resources used in these countries pales in comparison to the unsustainable use of resources in every large developed-world city. This means that increasing the sustainability of the world’s developed and developing cities must be a priority for policy makers, as there is both potential for great improvement and available resources to help implement necessary changes.

Furthermore, as intra-generational equity is a key element to Brundtland's definition of sustainability, it is important to analyse the wider impacts of urban sprawl on today's communities, as well as how these impacts are set to develop in to the future. Environmentally,

there are two main concerns related to urban sprawl: the rate at which it is consuming the landscape, and the air pollution that such a high level of automobile reliance is causing (Williams, 1999; Newman and Kenworthy, 1989; Guiliano and Narayan, 2003; Garcia and Riera, 2003; Anderson et.al., 1996; Kenworthy and Neman, 1990; Keyes, 1982; Owens, 1986). As already mentioned, the great irony of urban sprawl is its attractiveness at the individual level, in particular the spacious sections and large houses of recent development, but its destructiveness communally.

According to Burchell and Mukherji (2003), 742 out of the 3091 counties in the USA are affected by urban sprawl, and 13.1 million of the 23.5 million projected households for the period 2000 to 2025 will be constructed in areas characterised by sprawl. Therefore, at least in the USA, urban sprawl is a widespread problem affecting much of the urban development that has occurred in the past fifty years. This ubiquity means that any negative environmental impacts of sprawl are very significant, not just affecting a small proportion of the environment. It also means that the loss of land due to development is significant, with the American Farmland Trust believing that about 400,000 acres of prime farmland is being lost to sprawl each year in the USA alone (Gillham, 2002: 75).

This also leads to the destruction of natural habitat for many species, which as a result have become endangered or are on the brink of becoming so. Sprawl consumes land with particular ferocity, due to its highly inefficient form. This generally includes a surprisingly high

percentage of land in sprawled urban areas being devoted to the needs of the automobile, with many American cities having close to half their land area occupied by either roads, highways, parking lots or other automotive-serving facilities (Duany *et.al.,* 2000).This compares with about ten per cent of more compact cities being devoted to the automobile, which would lead to a far smaller loss of productive land (Duany *et.al.,* 2000). Here one can begin to draw a parallel between American cities and Nigerian cities especially the capital, Abuja.

Economically, urban sprawl has been shown to be highly inefficient, especially in the provision of services and infrastructure by local governments. However, once again there is a strong mismatch between individual economic effect of sprawl, and those on society. Deal and Schunk (in Duany *et.al.,* 2000) summarise this conflict by stating that: ‘ current low density sprawl development patterns are preferred because they are relatively cheaper for the developer and individual purchaser at the expense of the broader community and society as whole.’ Water and sewer infrastructure cost are one particular aspect of urban sprawl which can prove to be prohibitively expensive for local governments. Burchell and Mukhherji (2003) stata that under conventional (sprawl) development in the US between 2000 and 2025 there is a projected expenditure of about 190 billion dollars in providing necessary water and sewerage infrastructure expansion to primarily single-family detached subdivisions.

Although much of this investment would still need to occur under a more compact-type development, multi-family units require fewer laterals, fewer outdoor sprinklers and generally use less water than single family homes. Road infrastructure is another area where significant

cost saving could be made by focusing development in a more compact manner. ‘Under conventional development’ the US is projected to spend more than 927 billion dollars during the period 2000-2005 to provide necessary road infrastructure, amounting to an additional two million lanes- miles of local roads (Burchell and Mukherji, 2003: 1537). While there would still need to be significant investment under a ‘managed growth’ policy, the difference over the time period could be around 110 billion dollars, or an 11.8 percent saving in local road costs.

As well as basic infrastructure costs. Sprawl is also economically inefficient with regards to the cost of local public services. As development does not usually pay for itself, and required services includes schools, hospital and other government services, Costs are generally lower in denser areas close to urban centers as economies of scale and absorption of existing excess capacity can reduce the need for expensive new developments (Burchell and Mukherji. 2003; Auckland Regional Growth Forum, 1999).

While social impacts such as a ‘loss of community’ or ‘a sense of exclusion ‘ can be critiqued as being very vague, the health impacts of the ‘sprawled society’ clearly reveal a significant

social cost, in addition to the economic costs already mentioned. The effect of automobiles, the overwhelming dominant mode of transportation when urban sprawl exists, on health and well

being, leads to some very sobering figures. As Nozz (2003: 4) notes: ‘ The number of people who die on US high ways every year is the equivalent of a fully loaded Boeing 747 air craft crashing every three days, killing everyone aboard. In 2000, almost 6.5 million motor vehicle crashes killed 41,821 people and injured more than three million.’ Due to these figures, motor

vehicle accidents are the leading cause of death for people in the US of every age between four and 33. In Nigeria, even though there is no reliable data on the frequency and casualty figures arising from automobile accidents, estimated statistics show a high rate of accident leading to injuries and fatalities on the Nation's high- ways especially within the urban environment. Furthermore, it is claimed that the physical structure of sprawl development, through it greater reliance on the automobile as the primary method of transportation, discourages walking and other physical activities, therefore increasing the possibility of many physical ailments such as hypertension heart disease and type-two diabetes (Kelly-Schwarz et.al., 2004; Badland and Schofield, 2005).

As outlined above, the negative environmental, economic and social effect of urban sprawl are widespread, divers and clearly at odds the concept sustainability. This is not particularly surprising, given Elkins *et. al.*'s (1991) assertion that urbanism fundamentally conflicts with sustainability. However, what is clear from the above analysis of the urban sprawl literature is that improvements can be made with regard to sustainability of our cities Jenks *et. al*.,(1996: 4) expand on this, stating that ' with such a large proportion of the population, the concentration of environmental problems, and consumption of resources, cities clearly appear to be the most important location for action to help the goals of sustainable development.'Therefore, achieving

urban sustainability has been identified as a key part of any shift towards achieving sustainable development on a global scale. Due to this challenges, much of the planning literature throughout the 1990s has concentrated on the question of to design the urban environment in a more sustainable way, and to look for alternative to the ubiquitous sprawl that has dominated most urban development since the Second World War.

Firstly, there is the need to identify what urban outcomes can be said to contribute to sustainable development. In response to this need, Neass (2001: 506) has identified five elements of urban development and spatial planning deemed necessary for sustainable development to occur. They are:

A reduction of the energy use and the emission per capita in the city to a level compatible with the ecological and distributional criteria for sustainable development in the global level;

1) A minimising of the conversion of and encroachments of natural areas, ecosystems and soil resources for food production.

2) A minimising of the use of environmentally harmful construction materials;

3) A replacement of open-ended flows, where natural resources are transformed in to waste, with closed loops relying to a greater extent on local resources; and

4) A sound environment for the city habitants' health , and with sufficient green areas to give opportunities for the population to experience and become emotionally relate to nature.

Clearly, a fundamentally shift in the form and function of the city will be required to meet any of these criteria for sustainability. Urban sprawl clearly conflicts with most, if not all, of the elements of sustainable development listed above. The UN's Agenda 21 and habitat Agenda

both suggest that the objective of urban sustainability should include: 'a compact urban form; the preservation of open space sensitive ecosystem; reduced auto-mobile use; reduced waste and pollution; the creation of liveable and community- oriented human environment; decent, affordable, and appropriately located housing; improved social equity and opportunities for the least advantage, and the development of restorative local economy' (Cited in Wheeler, 2000: 134).

The concept of sustainability itself has been widely critiqued on the notion that it is too popular hence impossible to disagree with and also difficult to define. Traditionally, many North Americans, Asians, and even Africans have define success in terms of a big house on a big lot. Such cultural attitudes about landscapes, privacy, and leisure may inhabit the willingness to adopt sustainable practices that require social responsibility, and that entail significant spatial and behavioural changes. A sustainable society operates differently from the one we know now.' For sustainability to be successfully implemented in future urban development, either these cultural attitudes will need to dramatically change (Which appears unlikely in the near future), or development will need to be carefully designed to be more environmentally, economically and socially sustainable, but at the same time appeal to consumers as attractive places to live. The compact city concepts attempts to provide a more sustainable alternative style of urban development to sprawl.

2.3.3 INSIGHTS AND CONCLUSION

This chapter has provided an insights into the review of the related literatures, concept as well as the effect of urban sprawl. It clearly established that sprawl as an urban phenomenon is not necessarily engendered by lack of planning but actually in most cases a direct product of

planning and urban management intervention and policies making it a rather controversial subject among environmental managers and planning professionals and policy makers. The causes of sprawl however vary from region to region, country to country and city to city. Today, there are three facets of concern as relate to the effects of sprawl and they are; environmental, economic and social concerns. The scale of these concerns however is dependent on local

priorities and policies that vary from city to city. Added to concerns is also the fact that sprawl has its proponents just like it has its opponents.

CHAPTER THREE

STUDY AREA AND METHODOLOGY

3.1 INTRODUCTION

This chapter intends to bring out an overview of how Zaria Metropolis was based on weather and climate, population, vegetation etc, and how the types and sources of research method was applied in the study area

3.2 THE STUDY AREA

3.2.1 Location and Extent

The study area is located in Zaria which is situated between latitudes 11^{O} 00' to 11^{O}10'N of the equator and longitudes 7^{O} 36' to 7^{O} 45'E of the Greenwich meridian, as shown in Figure 3.1 below. It is situated in Kaduna State of Nigeria. The area covers Zaria and Sabon Gari Local Governmenst. It is bounded to the North by Giwa Local Government, to the West by Birnin Gwari Local Government Area, while to the East and South –East by Soba Local Government area of Kaduna State respectively. The area include Sabon-Gari, Zaria city, Gaskiya, Samaru, Tudun-Wada, Kwangila and Dan-Magaji. It is located in the central plain of northern Nigeria, about 950km from the sea.

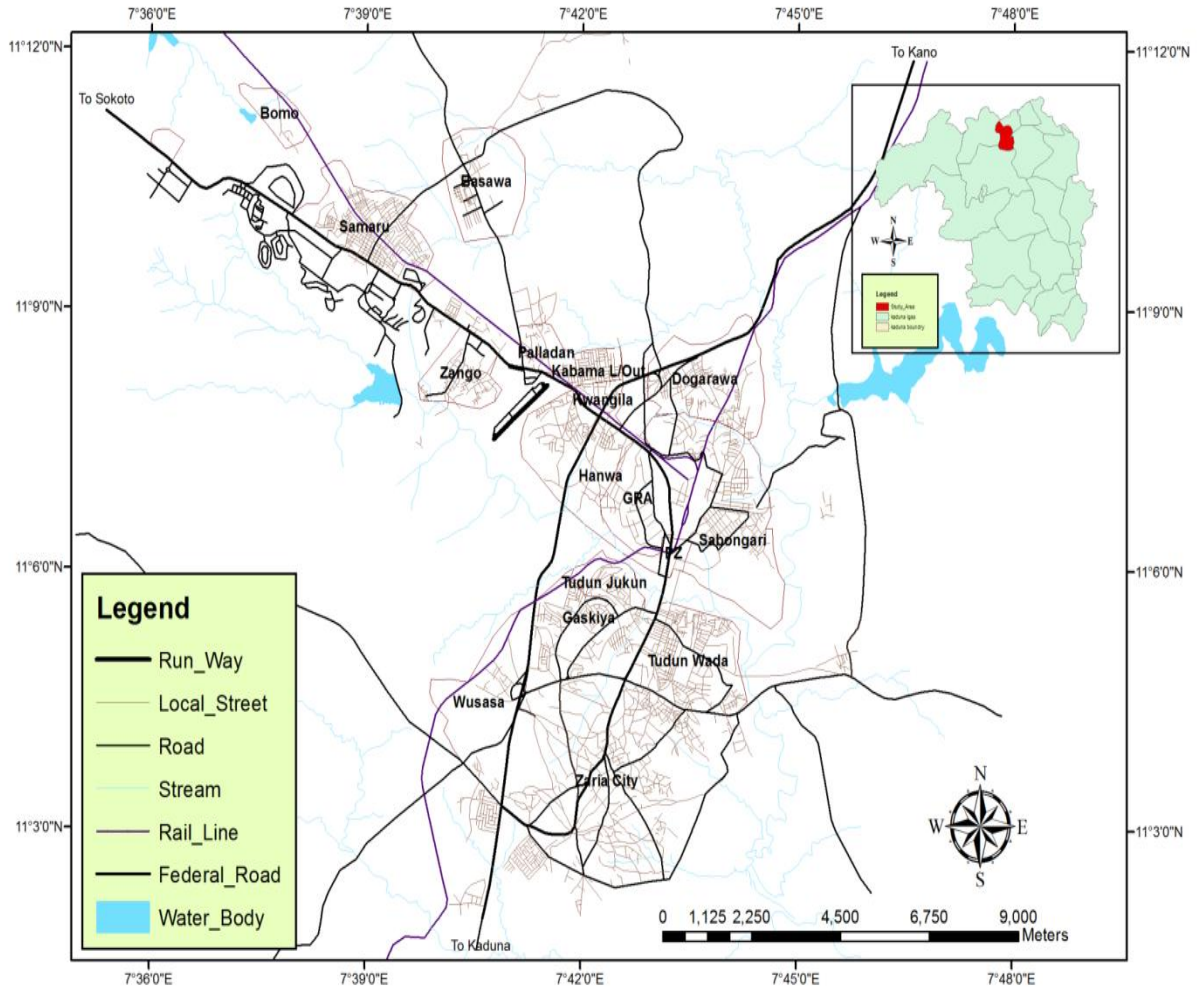


Fig. 3.1: Zaria Urban area

Source: 2013 Satellite Image

3.2.2 Weather and Climate

Zaria possesses a tropical continental climate with a pronounced dry season, lasting up to seven months (October - May). During the dry season, a cool period is usually experienced between November and February.' This emanates from the influence of the North-easterly winds (the Harmattan) which control the tropical continental air mass coming from the Sahara. This weather prevails over most parts of the country. The NE winds are characterized by hazy to dusty conditions and low temperatures, as low as 10o C at night. In the afternoons, up to 402C is sometimes recorded. The humidity also drops to less than 15% in December/January. Zaria experiences a brief period of hot but dry weather in March and April, followed by a progressive incursion of tropical maritime air mass from the Atlantic Ocean which displaces the NE (Harmattan) winds. During this short period, the mean daily maximum temperatures are fairly stable, and they range from 38QC to 422C. After that, the South Westerly Monsoon winds laden with moisture bring the rain in thunderstorms and squalls with heavy fall of high intensities. The rainy season lasts from May to September/October with long-term annual rainfall of c.1040mm in about 90 rain days, (Mortimore,1970**).** .

3.2.3 Vegetation

The relatively deep tropical ferruginous soils and climate conditions of Zaria are suitable for and sustain a good cover of savanna woodland (Northern Guinea Savanna) with a variety of grasses, woody shrubs and tall trees. However, increase in human population with its concomitant demands for grazing, subsistent cultivation, fuel-wood, and poor land management have had great impact on the natural vegetation. Consequently, new plant communities are developing

around the townships and the densely nested villages of Zaria. The present vegetation may thus be described as parkland with annual grasses/shrubby cover interspersed

with trees of special food and economic values such as *Parkia biglobossa Tamarindus indica* and shea butter trees.

3.2.4 Drainage

The River Galma forms the main focus of the drainage systems in Zaria. Although the Galma carries water throughout the year, most of its tributaries such as the River Samaru dry up between January and June. The valleys of the streams to the North of Zaria are generally wide, shallow and not incised. To the west and north-west, the valley bottoms are alleviated and are singularly flat, wide and level. The soil in Samaru is made up of accumulated clay lying in a depth of between 36cm and 119cm, (Mortimore,1970**)**.

3.2.5 Human background of zaria metropolis

3.2.5.1 Economic Development of Zaria metropolis

Agriculture is basic and oldest economic activity in Zaria, which involves the cultivation and production of grains, legumes and some root crops. These crops are use for food and as cash crops. Other crops produce also include tobacco, sugarcane and cotton. The rearing of livestock is also an important economic activity and it is a means of livelihood to some people. There are many other modern economic activities in Zaria due to increase urbanization. These ranges from small scale industries to many more like metal work, mechanic works, tailoring, printing press, trading shops etc. These activities develop as a result of individual pursuing returns for family upkeep, (Mortimore1970**)**.

3.2.5.2 Population of Zaria metropolis

Zaria is the second largest town in Kaduna state capital, Kaduna. According to the 2006 population census, the two LGAs that make up the Zaria metropolis have a combined population of 698,348 (with S/Gari having 291,358 and Zaria 406,990) Mortimore,1970**)**.

3.2.5.3 Social Development

Urban Zaria being the study area comprises mainly the Hausa/Fulani as indigenes and many other ethnic groups. The indigenes predominantly practice Islam as their religion. However, cultural practices can hardly be separated from religious practices such as seclusion or purdah. This is a practice of restricting women at home and can only move out with their husbands' permission and mostly at night. Family settling in the area are of two types, a simple unit (nuclear family) consisting of married adult, his wife or wives and children, and a composite unit (extended family) also known as economic unit consisting of two or more male adults usually married staying together in a compound setting. In some cases they cooperate to secure income from the farm. In this complex unit which is also known as sociological unit, members are ranked in order of decision making power and the subordinate having minor rights while basic decisions are taken by the head of unit (Nwachukwu, 1990).

3.3 METHODOLOGY

3.3.1. Reconnaissance survey

(i) Consultations with the relevant communities in the study area has been carried out with a view to intimating them of the objectives of the study and to seek for their permission and cooperation.

(ii) General overview of the environment has been carried out.

3.3.2 Data types and sources

3.3.2.1Types of data required.

The data required for the study are:

i. Satellite imageries of Zaria Urban Area.

i. Normalised Different pattern of sprawl in Zaria.

iii. Changes and characteristics of sprawl.

iv. Groundthruth of the study area.

v. Map of Zaria Metropolis showing approved layouts and development plans.

vi. Population Data.

vii. Google Earth scenes of Zaria at 32m resolution for the year 2013.

3.3.2.2 Sources of data for the study,

Two methods were use to obtain data for this study. The primary and secondary methods. **The primary sources are -**

(i) Land Sat image of 1980, 1990, 2000 and 2013 from National Centre for Remote Sensing, Jos Plateau state

(ii). Google earth Inc.

(iii) National Population Commission.

(iv) Questionnaire

The secondary sources: The data to be was derive from the following sources.

(i)Using Detailed field Observation/Survey.

(ii) Review of related literatures from journals, texts books, internet materials, conference papers, thesis and dissertations.

3.3.3 Sampling Technique and Size

Since it will not be possible to get the population data covering the wards/layouts as the National Population Commission does not render figures at ward level, the population of the two local government area that comprises the metropolis was used. Random sampling was adopted because of the large size in population. Two hundreds copies of the questionnaire were administered to collect relevant information that assisted in achieving the specific aim and objectives of this study. To achieve this, Zaria city,Tudun-Wada, Sabon-Gari, Samaru, Kwangila and Dan-magaji were adopted as strata. Because population is not evenly distributed within the study area, 20 averagely served as damage and not returned.

3.3.4 Data processing

This will involve the processing, analysis and extraction of relevant spatial information about the study area from sources such as satellites images, and maps. This shall involve the following:

a. Subset: Satelite imageries covering Zaria metropolis were extracted from scene of satellite images of 1980,1990,2000 and 2013.

b.Geo-referencing

All the maps that were used for this study were geo-registered to their true geographic coordinates by creating a common geographical coordinate system for them using zone 32minna datum to facilitate geo-spatial processing and analysis. These will be carried out using ArcGIS version 9.3 by Environment System Research Institute (ESRI)

c. Image processing of remotely sensed data

Because the satellite images to be used usually comes in bands and in large area coverage, appropriate bands combination relevant for this study was determine to produce a composite band for all images, and subsets from all the images was created using geometry of Zaria to

obtain the exact images of the study area. All these were carried out using the raster processing application in the ArcGIS 9.3. After obtaining the exact images of the study area for all the time series, image classification was carried out for all the images using supervised classification method, and be supported by ground truthing to determine the extent of urban built up and other land cover classes observed in all images. This was done first by carrying out image visual analysis, which was involve digitally studying the spectral characteristics of features on the images and their relative's importance to this study.

3.3.5 Data analysis

To analyze the rate as well as the pattern of urban sprawl from 1980 to 2013, GIS software (ILWIS 3.7) was used to classify (supervised classification) imageries of 1983,1993,2003 and 2013. To measure the spatial growth, based on two classes: developed and undeveloped area, ArcGIS 9.3 was used for GIS analysis. The area measurement of each class was measured in

square kilometres. The period of change analysis was divided in to three (3) epochs based on data available and changes scenarios that took place 33years ago (10years) interval. The change analysis and change detection was carried out using supervised classified image statistics to differentiate changes.

While the urban areal extent was measured by digitizing build up urban land and also converted vector GIS data for precise area measurement. The change detection result of the three (3) epochs was used in analyzing the temporal changes within the study period. In determining the growth pattern of the developed and undeveloped land or area, i.e built-up extent and the non-developed area through direct visual interpretation. However, the information's or data collected through this study was quantified and analyzed using descriptive statistical analysis.

3.3.6 The Method of Analyzing Sprawl

3.3.6.1 The Impervious Metric

This aims to measure sprawl by calculating the change in the amount of built surface per capita, compares impervious change estimates derived from satellite imagery to population change derived from census information. This approach is anchored on the assumption that urban sprawl is fundamentally define as the relationship between population and the built-up environment. Human development typically converts native vegetation to impervious surfaces. Growth intended to minimize sprawl would limit the amount of impervious surface created with the influx of new residents to any given region. A principle challenge to this method is the difficulty in measuring impervious surface using Remote Sensing Techniques. The method is also limited because it is not suitable for pattern analysis (Aliyu, 2011).

3.3.6.2 The Permit Metric

This works by way of evaluating the annual number of residential building permit for new construction. Specifically, it monitors the percentage of those occurring outside established urban growth boundaries as a way gauging whether growth is leading to sprawl, or the infill of existing developed lands. It evaluates the trends in permitted building activities in and outside of areas designated for development. A key challenge of this approach is the non-availability of the data on building permits because even in the developed societies of the United State and Western Europe where the data is available, it is on record that obtaining and analyzing it is quite expensive. Like all the other techniques, this is also limited in these sense that it fails to take in to account the spatial dynamics of sprawl as represented by resultant patterns (Aliyu, 2011).

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 INTRODUCTION

This chapter deals with presentation, interpretation and discussion of results. In recent years, a lot of thrust in this field has been to understand and analyze urban sprawl pattern. The common approach is to consider the behaviour of built-up area and population density over the spatial and temporal changes taking place and in most cases the pattern of such sprawl is identified by visual interpretation. However, in order to achieve sprawl pattern identification visually, the area under study has to be observed at different spatial and temporal scales. This is made possible by the availability of dated and recent satellite imageries at relatively good resolutions that enable visual analysis and interpretation. In this chapter, satellite images at

different temporal scales were used to facilitate a time series analysis of the spatial and morphological transformation of the city of Zaria between 1980 and 2013.

4.2 Pattern of Urban Sprawl

The results of the analysis are presented below in explanations, tables and figures.

Table 4.1 The Pattern of Urban Sprawl in Zaria

Year	Built- up Area(km^2)	(Growth km^2)	Percentage %	Rate(yr)
1980	123.72	20.19	12.08	1.28
1990	195.66	71.94	20.26	2.03
2000	224.17	28.51	23.22	2.32
2013	260.76	36.62	29.10	2.91

Source: Field survey 2013

4.2.1 Sprawl Pattern 1970-1980

The main objective of the spatio-temporal analysis was to establish the growth of dynamics of Zaria Metropolis based on sprawl indices computation between 1980 to 2013. Zaria Metropolis which comprises both Zaria Local Government and Sabon-Gari Local Government Area respectively, as at 1980 had a population of 349,164 and a total land area of 965.46km^2. From table 4.1 above, the total built-up area of the city as at then was approximately 123.72km^2 representing 12.81% and based on the GIS and Remote Sensing analysis, it shows that the areas with highest growth and development is South-East (SE), South-South-East (SSE) like Tudun-Wada, Cikin- Ganuwa, U/Alkali etc and North-East (NE) , North-North-East (NNE) such as Sabon-Gari, Cikaji, Hayin- Ojo axies etc of Zaria.

While the area with dispersed or less development that followed by South-West (SW) like Kufena and Wusasa and North-West (NW) Kwangila and Samaru axies.

This suggests that the rate of urban sprawl in Zaria city at this period occurred in the South-East (SE) e.g Kofar Doka and Dembo, South-South-East (SSE) such as Fada and Babban Dodo, North-East (NE) like Hayin/Ojo and Marmara and North- North- East (NNE) Sabon Gari and Jushi axies. By then, Zaria urban area could be said to be a city comprising of essentially six sub-towns and the other to the South-West (SW) Tukur-Tukur, Kofar Kibo and Dan-magaji and North-West (NW) Kwangila and Samaru. This created an easily identifiable pattern of leap-frog patches of development that defined the city's built form (see figure 4.1).

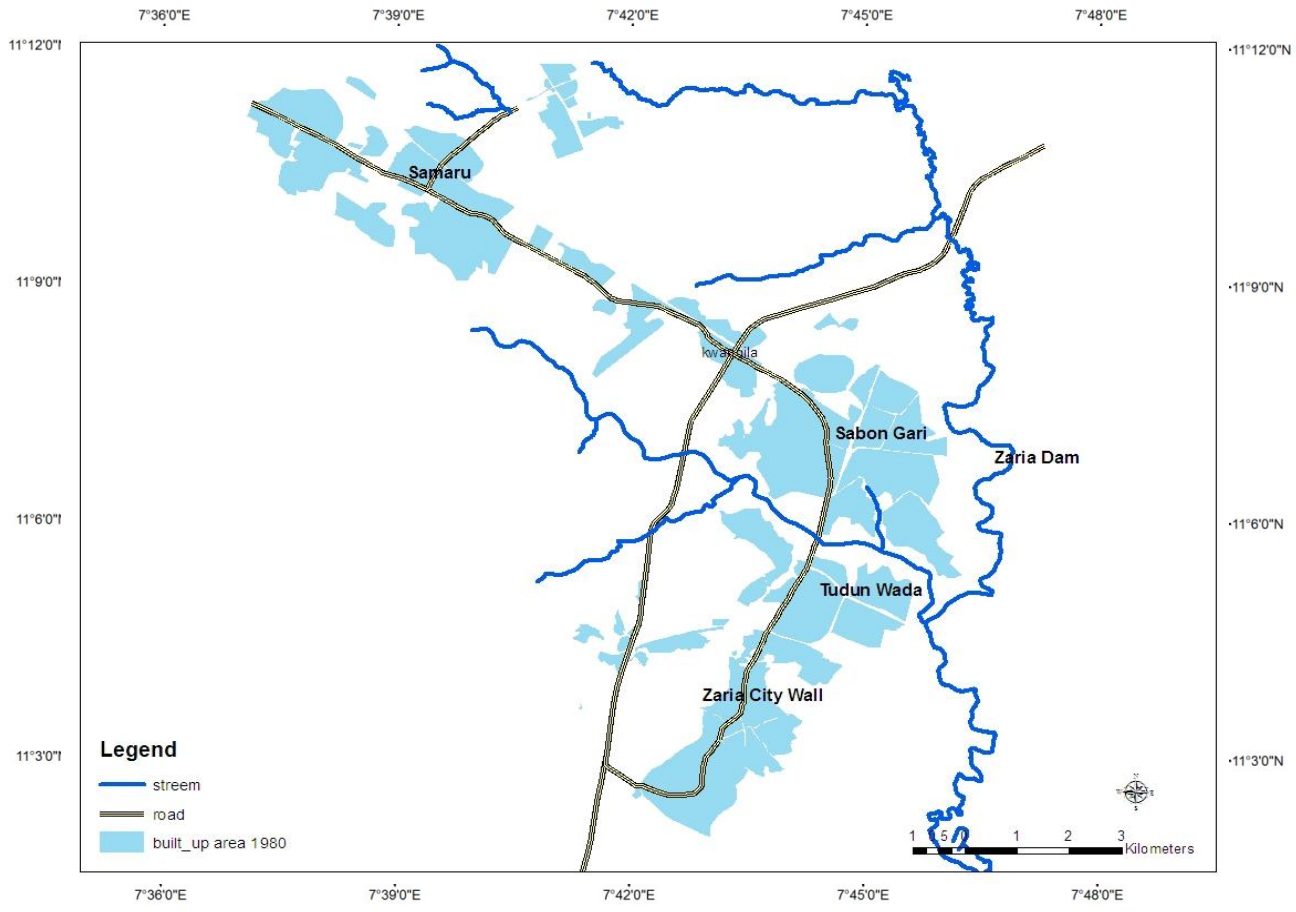


Fig. 4.1: Zaria 1980 Built Extent

Source: Field Survey 2013

The leap-frog pattern of development at this early stage of the city's development is attributable to the early history of the city. These settlements were in existence by the transition period between the Stone Age and Iron Age like Kofar Doka, Kusfa, Fada, U/Alkali e.t.c. In addition to these early settlements, there are also a number of communities that were formed during the Zazzau expansion of the seventeenth and eighteenth centuries. Both contributed to the realization of the larger Zazzau that was only overrun during the Jihad of Uthman Bin Fodio (Suleiman, 2007).

This radical growth in the population of settlements in the area seems to owe much to the development of Islam and scholarships, where itinerant Muslim scholars and intellectuals who were also engaged in pastoral activities spread all over the territory with *Birnin* Zaria as their centre. Thus, the emergence of *Birnin* Zaria as the seat of power for Zazzau was born out of necessity for the various Birni types of settlement earlier laying claim to Zazzau ruler ship to come together and organize the area under a strong power (Suleiman, 2007). The European area housing the government offices and residences for the colonial officers; the Tudun-Wada originally a labour camp meant for the natives of northern origin; and Sabon-Gari which was designated for the southern natives that had come along with the British Military or migrated after wards. Later on, the railway stations as well as the industrial developments of Tobaco company in the area of Sabon-Gari axis were added to the urban landscape. These are all detached masses of development.

4.2.2 Sprawl pattern 1980-1990

Between 1980 and 1990, the population of Zaria Metropolis increased by 41.43% changes from 349,164 persons to 500,424 persons (NPC, 1991). This astronomical rise in population translated into accelerated and unprecedented urban expansion during this decade and the city's built fabric expanded to a much greater size around 1990 to (195.66 km^2) representing 20.26% than it was in 1980 as shown in table 4.1 above. However, the GIS analysis showed that between this 10years, development and growth continued to occur in addition to the existing development, South- West (SW) such as Unguwan Dankali and Gwargwaje, North – East (NE) like Chikaji and Jushin Waje , South-East (SE) e.g Kofar Gayan and Banzazzau and North- West (NW) such as Dogarawa and Hanwa respectively continued to expand from all angles of the city.

This suggests that more settlement have emerge as an increase to the existing ones in the year 1980. Settlements like Gaskiya, Gwargwaje, Unguwan Dan-Kali,Tudun-Jukun, Extension of

Kusfa Low Cost to the South –West and Banzazzau, Jushi, Dembo, Dakace continued to expand to the South- East of Zaria urban area. While more settlements such as Muchia, Chikaji, Hayin –Ojo, Jushin Waje, Zabi and Shika Dam to the North –East, while Dogarawa, Hanwa low-cost, Unguwan Nashuka, Hayin Mallam, Zango, Hayin-Danyaro, Unguwan Gwaiba, Samaru New-Extension to the North-West axies. These increases are easily explained by the sprawl pattern analysis on the digitized built extent of the city shown in fig.4.2 below as derived from the classified satellite.

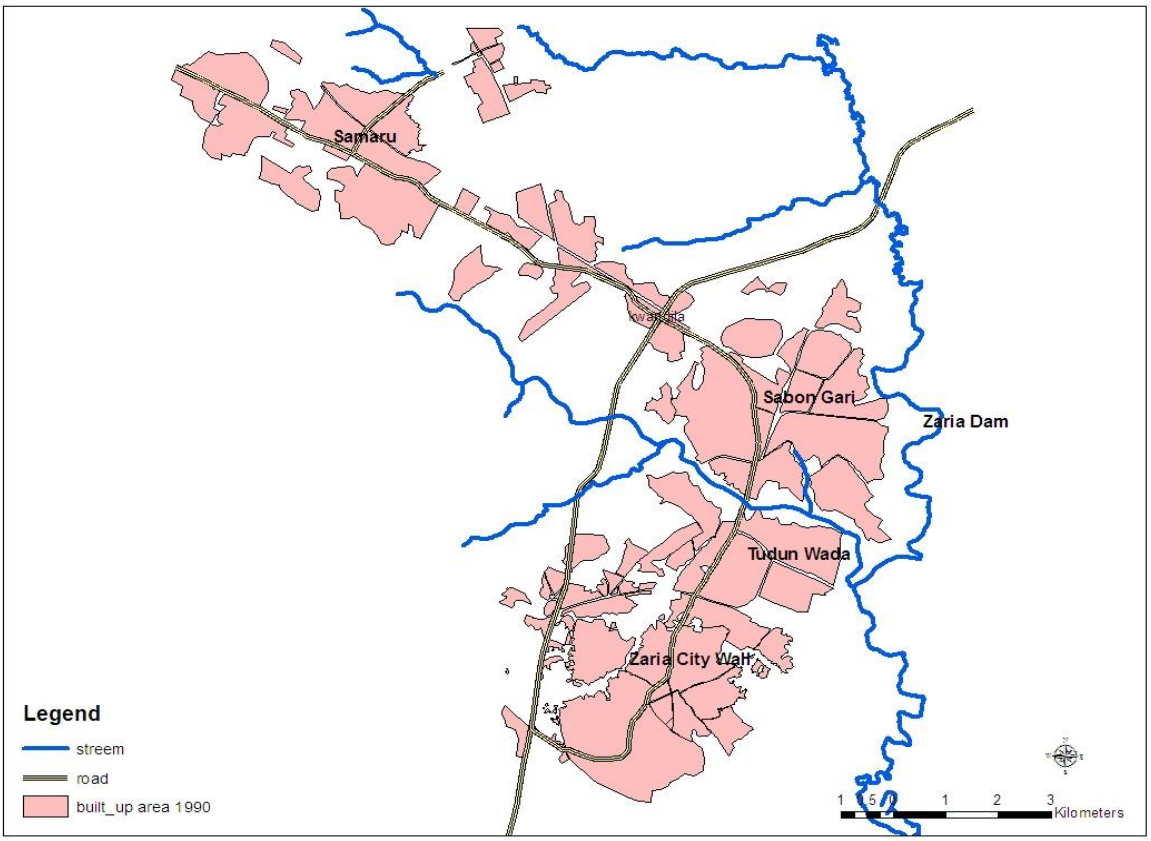


Fig. 4.2: Zaria 1990 Built Extent

Source: Field Survey 2013

Most of this expansion was as a result of the different factors responsible for the emergence of the sprawl such as the higher Institutions within the Metropolis, Commercial activities Industrial activities, Transportation activities, Health etc.

4.2.3 Sprawl Pattern 1990-2000

By the year 2000, the population of Zaria urban area increased by 36.17% changes from 500,424 persons to 650,582 persons (NPC 1991) Population projection. Table 4.1 above shows that, the total built- up of the city was approximately 224.17 km^2 representing 23.22%. The growth pattern analysis of the digitized built extent of Zaria shown in fig. 4.3 below (as derived from the satellite image) shows that most of the urban growth in Zaria Metropolis during this period of (10) years was limited to infilling of spaces between the hitherto distinctly identifiable urban districts in both Northern and Southern sectors of the city. Some peripheral expansion however continued to occur.

In the South-East (SE) New Banzazzau, New Dakace, Nagoyi, New kusfa extension, Sabon-Unguwan kofar Gayan, Unguwan Kaya, Filin Mallawa, and Gaskiya Layout. To the North-East (NE) Unguwan Kanawa, Kwantaresha, New Hanwa GRA, Kabama layout, New Dogarawa, Grace Land and Unguwan Fulani. But to the North-West (NW) development continued in Hayin Liman, Unguwan Gwaiba, Unguwan Dakarkari and New Basawa Extension. While to the South- West (SW) some gradual expansion occured in Unguwan Saye, Madaci, Sayen Goburawa and Gwargwaje Extension.

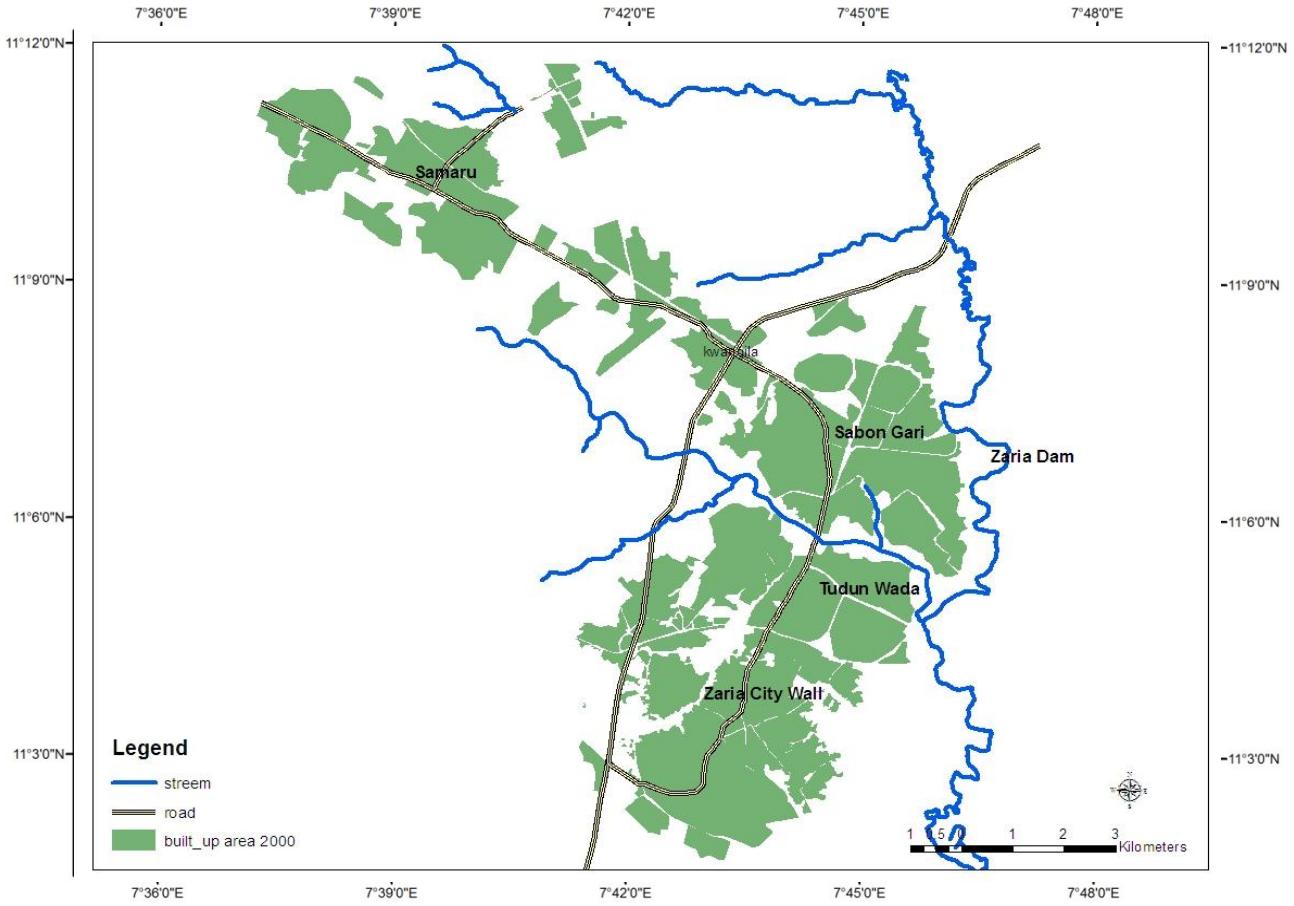

7°36'0"E
7°39'0"E
7°42'0"E
7°45'0"E
7°48'0"E
11°12'0"N
11°9'0"N
11°6'0"N
11°3'0"N
Samaru
Sabon Gari
Zaria Dam
Tudun Wada
Zaria City Wall
Legend
streem
road
built_up area 2000
1 0.5 0 1 2 3
Kilometers

Fig.4.3: Zaria 2000 Built Extent

Source: Field Survey 2013

4.2.4 Sprawl Pattern 2000-2010

More also, between 2000 and 2010, the population of Zaria Metropolis increased by 40.10% jumping from 650,582 persons to 730,192 persons (NPC, 2006) population projection. Significant increases were recorded in terms of growth and development in areal expansion and the total built-up extent of the city as shown in table 4.1 above. It can be seen in the GIS and Remote Sensing analysis that laep-frog and ribbon pattern of sprawl had fully developed North-South with the city spanning approximately 25 km on the North-South axis along Sokoto-Kaduna-Kano and Jos regional arterial road as compared to the 16 km on the East-West axis.

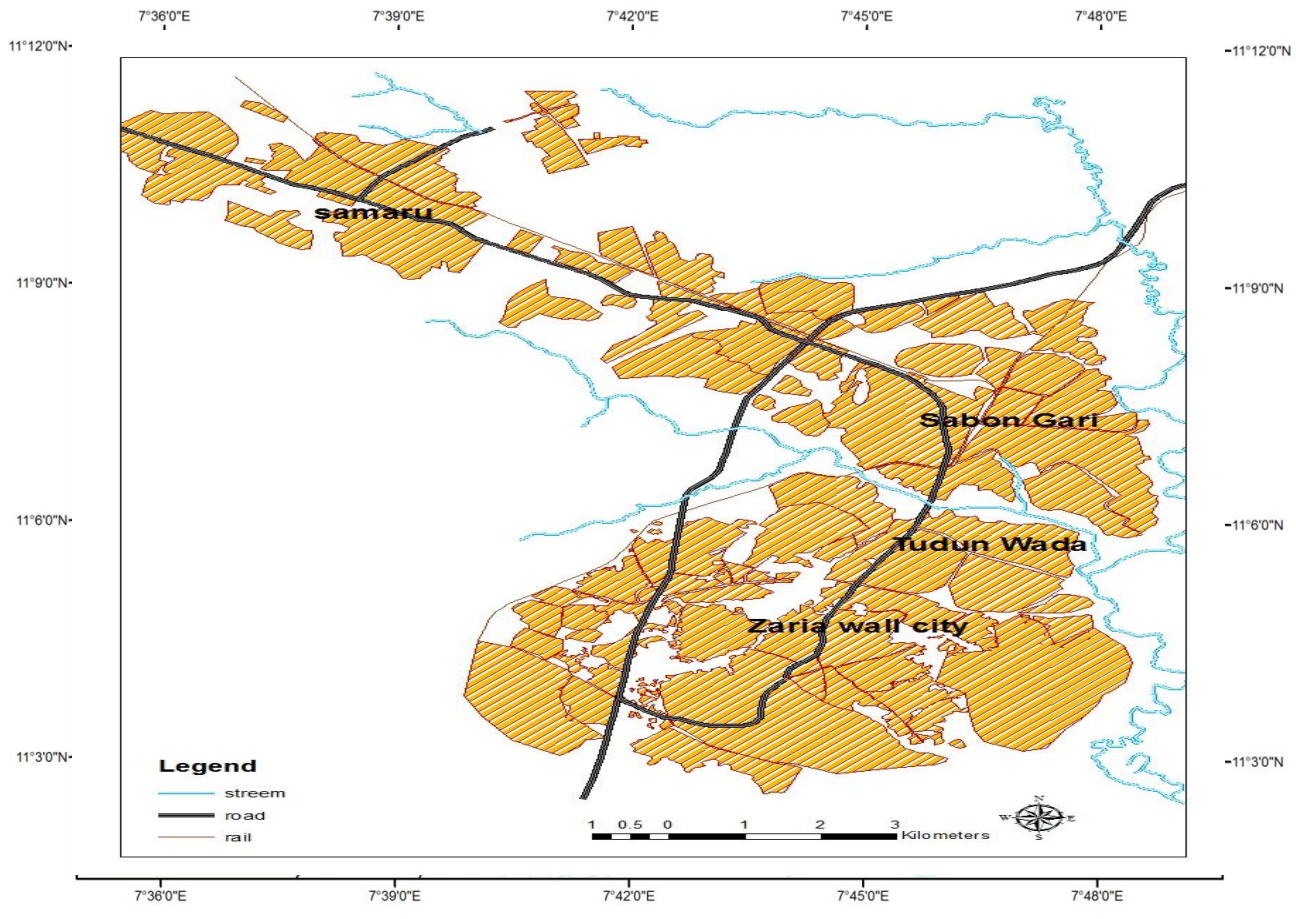


Fig.44: Zaria 2010 Built Extent

Source: Field Survey 2013

This form suggests a continuous dispersal of development but at the same time infilling of the spaces between the scattered patches of development especially along the roads linking them. A further outwards expansion is also seen as isolated masses of development along almost all the major roads that link the city such as Zaria – Kaduna Express road, Zaria – Kano Express road, Zaria – Sokoto road, and Zaria – Jos road.

4.3 FACTORS RESPONSIBLE FOR THE EMERGENCE OF URBAN SPRAWL PATTERN IN ZARIA METROPOLIS.

Table 4.2 Factors of Urban Sprawl

Factors Responsible	Frequency	Percentage
Rapid population growth	60	33
Economic growth	28	15
Institutional formation	42	23
Weak planning authority	23	12
Commercial activities	27	15
Total	**180**	**100**

The factors that determine the spatio-temporal variation of urban sprawl in Zaria metropolis:

(1) **Rapid urban population growth**- From Table 4.2, sixty (60) respondents representing 33% are of the opinion that rapid urban population growth is one of the major factor of sprawl in the study area. In this regard, the influx of people and the increase in the birth rate in Zaria urban area due to polygamous marriage as well as employment opportunities around are responsible. However, the people of Zaria originally live as homogenous and majority of them practice Islam as their religion, which gave them the right to marry up to four (4) wives. This is why Zaria is booming every day.

(2) **Economic growth**- Twenty eight (28) respondents representing 16% of the questionnaire are of the view that economic growth contributed to sprawl in the study area. Zaria originally have fertile land, which makes their agricultural farm produce to grow better yield and in large quantity. The people of Zaria do produce both food and cash crops such as maize,

guinea –corn, millet, rice, sugar-cane, ground-nut, vegetables etc. Moreover, the formation of small, medium and large scale industries in the study area has boost the economy.

(3) Institutional formation- The formation of several higher institutions of learning in the study area such as the Ahmadu Bello University, Zaria., Federal College of education, Zaria., Nigerian College of Aviation Technology, Zaria., Nigerian Institute of Transport Technology, Zaria., Nuhu Bamalli Polytechnic, Zaria.,etc., happens to be one of the factor responsible for sprawl in Zaria. It can also be seen from Table 4.1 that forty two (42) people representing 23% of the respondents do support the argument. This however, contributes immensely to the influx of people in to Zaria to form a base for their living.

(4) Weak institutional urban planning and monitoring mechanism- As a result of negligence and improper planning, management and development control from the side of Planning Authorities, Planning Agencies, Planning Board etc as it can be seen from Table 4.2 that twenty three (23) respondents representing 12% of the questionnaire in the study area that poor planning have contributed to the emergence of sprawl activities in Zaria Metropolis.

(5) Commercial activities- The population of Zaria metropolis is increasing every day, the demands, human wants and their needs however increases, as it can be seen from Table 4.1 twenty seven (27) respondents representing 15% of the questionnaire are of the view that buying and selling of goods and services, which boost the commercial activities of the study area have resulted to sprawling activities.

4.4 THE SOCIO-ECONOMIC EFFECT OF URBAN SPRAWL IN ZARIA

Table 4.3 Response on Socio-Economic aspect of Sprawl

Parameters	Frequency	Percentage
Higher Institutions	51	28
Telecommunication	25	14
Employment opportunities	48	26
Water supply	56	31
Total	**180**	**100**

From Table 4.3, fifty one (51) people representing 28% of the respondents are of the opinion that as a result of the formation of several higher institutions of learning such as A.B.U., Zaria, F.C.E., Zaria, Nuhu Bamalli Polytechnic, Zaria e.t.c. contribute immensely to the socio-economic activities of urban sprawl in Zaria Metropolis. Also, as the population of Zaria Metropolis increases every day, the economy of the area is booming, therefore there are so many employment opportunities around, as people do engage in different trading and business within and around the city. Table 4.2 above shows that 48 respondents representing 26% of the questionnaire are of the view that due to so many Small and Medium scale industries such as bread bakeries, Metal-works, tailoring, Foot-ball viewing centres, Barbing saloon and lots of them socio-economic activities continued to emerge.

However the spatial pattern and nature of Zaria urban landscape, is fully connected with electricity and G.S.M. communication networks, twenty five (25) people representing 14% of the questionnaire are of the opinion that telecommunications play a vital role in the socio-economic aspect of Zaria sprawl. Good roads, drainages, culvert and pipe born waters which

is the most serious problem, with the exception of few developed housing unit like G.R.A Zaria, some part of Tudun-Wada and Hanwa new G.R.A.. Most of the Zaria urban area residence doesn't have access to pipe born water fifty six (56) respondents representing 31% of depends on near -by boreholes and water vendors for their waters supply.

Sudhila (2004) is of the view that functional and structural changes and growth of urban areas has an impact on urban socio-economic activities and ecosystem. According to WUF 6 (2010), spatial areal expansion and urban sprawl increase travelling distance within the city. The GIS map above in fig.4.8 shows the distance of some outskirt residential areas to some strategic important places and it can also be seen that within a spatial radius of 22sqkm with a built-up area density, some residences are travelling a distance of more than 15 kilometers to their various places of work e.g the residence of Dakace area, working or schooling in Ahmadu Bello University, A.B.U Zaria and A.B.U. Teaching Hospital respectively, travelled a distance of over 15 km before getting to the destination. However, a serious hold-up and go slow along Agoro round- about junction, PZ side, Kwangila/Fly-over axis, cause both staff and students to reach their place of work and school late.

Table 4.4: Some of Socio-Economic Indicators of Change

Socio-economic parameters	1980	1990	2000	2013
Higher institution of learning	7	7	7	7
Hospital (Government owned)	2	2	2	2
Electricity	yes	yes	yes	yes
Banks	4	6	14	18
Filling Station	7	12	17	29
Telecommunication	yes	yes	yes	yes
Recreational area/Hotels	4	7	7	9
Market/Shopping complex	5	7	8	14
Approved Layout	1	2	3	3

Source: Field Survey 2014

Before 1980, Zaria Metropolis underwent a serious socio-economic functional transformation as shown on the Table above. Seven higher institutions of learning were already established since before 1980, these however contributed greatly to the population increase of Zaria. Higher institutions such as A.B.U.,Zaria, F.C.E., Zaria, Nuhu Bamalli

Polytechnic, Zaria, Nigerian College of Aviation Technology, NCAT Zaria, CHELTECH, Samaru, NARICT, Basawa, and NITT, Zaria. There is only three (3) government hospital in the study area, one belongs to the Federal Government which is A.B.U.T.H Tudun-Wada but now at Shika, the Gambo Sawaba General Hospital kofar gayan Zaria and Major Ibrahim Hospital Sabon- Gari Zaria belongs to Kaduna State Government respectively. But in the case of private clinic/hospital, there are so many of them within the city. There were only four (4) commercial banks as at 1980, with the increase in population and commercial activities in 2013 Zaria now has about eighteen (18) commercial banks. There were five (5) market/shopping complex and four (4) recreational area/hotels in 1980, but to this moment Zaria has about fourteen (14) market/shopping complex and nine (9) recreational area/hotels in the study area respectively.

4.5 URBAN SPRAWL AND ITS IMPLICATIONS IN ZARIA URBAN GROWTH

The rates of Zaria urban area begins as far back 1980 as the population continued to increase every day with few settlements/communities expansion as earlier mentioned in our discussion on pattern of urban sprawl in Zaria. The Zaria wall or settlement area within the the city known as (Cikin Ganuwa) in hausa, had continued to expand which leads to the emergence of it neighbouring communities such as Tudun-Wada, Sabon-Gari, Tudun-Jukun, Kwangila, Dan-Magaji, Hanwa, Samaru to mention but a few. These settlements were formed mostly in a leapfrog, linear and single use development pattern.

4.5.1 RESPONDENTS VIEW ON URBAN SPRAWL IMPLICATIONS IN THE STUDY AREA.

The urbanization process of third world countries is associated with problems of environmental degradation. The environmental degradation of Zaria urban area is still less

when compared with other Nigerian cities/town; there are more than urban environmental issues/problems in the traditional settlement. Table 4.4 shows that sixty seven (67) respondents representing 82% from the traditional settlement reported the problems air pollution especially in the evening of the day, where as in the new extension only 31 people representing 37% of the questionnaire make the same complain. Others include waste disposal 63 respondents representing 78% in the traditional settings, 31people representing 37% of the questionnaire, flooding, and mosquitoes breeding the same thing.

The field survey reveals that, residential areas at Sabon-Gari, Zaria-wall, Tudun-Wada, Kwangila and Samaru axies encroached the water logs, while the constructed central drainage channel is not draining the water, the water logs blocked of road side drainage channels become a suitable mosquito breeding ground. The attitude of residence of disposing refuse in the drainage channels and water logs, in core traditional settlement apart from polluting the water, breeding mosquitoes it also created a serious unpleasant odours, capable of affecting the health of inhabitants.

Table **4.5: Urban environmental problems**

	TRADITIONAL AREAS		NEW LAYOUT/EXTENSION		
	FRQ	**%**	**FRQ**	**%**	**TFRQ**
Waste disposal	63	78.30	31	37.6	94

Flooding	52	59.38	18	21.45	70
Air pollution	67	82	21	25.06	88
Mosquitoes	70	84.44	20	24	90

Source: Field Survey 2014

The housing structures of the core-traditional settlement are mostly made from clay where Table 4.5 below shows that 63 people representing 76% of the questionnaire are of the view that, from inner Zaria city wall, Tudun-Wada, old Sabon-Gari and some part of Wusasa axies, their houses are made from clay and tar mixture, while 85 of the respondents representing 98% of new layout/extension make use of cement bricks in their buildings. While 72 people representing 84% of traditional settlement use pit latrine toilet system. The respondents also

reported that poverty, poor planning and peoples attitude of dumping refuse in drainage channels and water logs are the major cause of environmental problems.

Table 4.6 The type of building materials and toilet facilities

	TRADITIONAL AREAS		NEW LAYOUT/EXTENSION		
	FRQ	**%**	**FRQ**	**%**	**TFRQ**
Cement bricks	36	42	85	98.34	121

Clay bricks	63	76.8	5	7	68
Water system toilet	18	24.27	88	102	120
Pit latrine	72	84.44	32	39	104

Source: Field Survey 2014

The growth of Zaria Metropolis is associated with socio-economic problems in which Table 4.6 below indicated that about 72 people representing 87% of the respondents are of the view that poverty, especially at organic traditional settlement contribute to sprawl implication and in new layout/extension 31 respondents representing 36% are of the same opinion. Crime and social vices where 62 people representing 75% of the questionnaire are of the view that as a result of increase number of political thugs so many socio-economic implication occur. Others include diffusion of social cultures and pressure on infrastructural facilities. The city is fast becoming heterogeneous as 71 respondents from traditional settlement representing 86% report diffusion of social cultures as one of the social problems.

Table 4.7 Socio-economic problems

	TRADITIONAL AREAS	NEW LAYOUT/EXTENSION

	FRQ	%	FRQ	%	TFRQ
Poverty	72	87.08	31	36.05	103
Pressure on facilities	69	84.11	43	50.06	112
Crime and social vices	62	75.16	42	50.22	104
Difussion of social culture	71	86.36	87	96.33	158

Source: Field Survey 2014

It is an established fact that a settlement spatial dimension has an impact on allocation of basic amenities and increased risk to life and property in the face of disaster (Verzosa and Gonzalez 2010). Omar (2009) observed that poor services in term of lack of good drinking water, inefficient waste disposal systems, poor healthcare and inadequate housing, schools and recreational facilities etc are norms rather than exception in most of Nigerian cities.

Table 4.7 contain response on access to amenities in the study area, where 67 people representing 80% of the respondents are of the opinion that electricity is available but in very low voltage due lack of enough transformers most especially in traditional areas, but in the case of new layout/extension 86 people representing 95% of the respondents where of the view that electricity is available with some few areas not connected to the high cable wire.

In terms of housing delivery, a part from the Kusfa Low cost at Zaria city and Hanwa low cost at Kwangila axis constructed over 30 years ago by the Kaduna State government of that time, then group of Rimin-Tsiwa and Danraka Housing estate which belongs to the private individuals. Though our field survey revealed that the present Governor of Kaduna State has awarded the contract of constructing about 2000 housing unit at the outskirt of the city along Zaria-Jos road.

Table **4.8 Access to amenities in the neighbourhood**

	TRADITIONAL AREAS		NEW LAYOUT/EXTENSION		
	FRQ.	**%**	**FRQ.**	**%**	**TFRQ.**
Electricity	67	80.24	86	95	153
Pipe born water	30	38.32	10	12.06	40
Tarred road and drainage	56	60	45	51.43	101
Waste disposal	22	30.17	38	44.12	60

Source: Field Survey 2014

About 40 of the respondents representing 51% of the questionnaire in the traditional areas did not appreciate the planning policies and effort of planning authorities, but in the new extension /layout, 38 people representing 47% of the questionnaire however did not appreciate the effort of the planning authority. Field survey revealed that the roads reserves

are converted to commercial layouts, in contrary to provision of developmental plan and layout plan. The access roads in most of residential areas are not up to standard as

observation has shown that the sizes of access roads in traditional wards are even more standard and larger than that of some new extension/ layouts within the city.

In addition, 53 of the respondents, representing 64% of the questionnaire in the traditional settlement, and 74 people representing 90 % in the new extension/layout reported that Zaria urban growth is lacking some infrastructural facilities and services, especially manufacturing industries, new modern market, more government hospital, more tarred road etc. Inadequate facilities and services are to some extent limiting the rate of structural and functional growth of Zaria Metropolis.

Table 4.9 Perception on urban sprawl pattern in Zaria Metropolis

	TRADITIONAL AREAS		NEW LAYOUT/EXTENSION		
	FRQ	**%**	**FRQ**	**%**	**TFRQ**
Good(assessment)	40	51.06	38	47.32	78
Poor(assessment)	37	45.01	65	81.42	102
Inadequate amenities	53	64.26	74	90.06	137

Insecurity	47	55.17	67	78.36	114

Source: Field Survey 2014

About 66% of the respondents did not appreciate the planning policies and effort of planning authorities. Field survey revealed that the roads reserves are converted to commercial layouts, in contrary to provision of developmental plan layout plan. The access road in most of residential areas are not up to standard as observation has shown that the sizes of access raods

in traditional wards are even more standard and larger than that of some new extension/layout within the city. In addition, 87% of the respondents reported that Zaria urban growth is lacking some infrastructural facilities and services, especially manufacturing industries, new modern market, more government hospital, more tarred road etc. Inadequate facilities and services are to some extent limiting the rate of structural and functional growth of Zaria Metropolis.

4.6 INSIGHTS AND CONCLUSION

The application of the GIS and Remote sensing techniques in computing the rate of urban sprawl for Zaria metropolis was achieved in this study. This was done by employing the mapping, measure area as well as land use land cover expansion of the built extent of the city. These excessive physical growth rate is most likely to result in further sprawl with all its attendant implications as there is no reason to suggest that growth will be in any form or pattern. Finally, if the current rates of population increase and physical expansion are sustained, Zaria metropolis is likely to double its size in spatial extent in the next 50years.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 SUMMARY OF FINDINGS

This study is generally aimed at analyzing the spatio-temporal pattern of urban sprawl in Zaria metropolis, using GIS and remote sensing technique. The study adopted the concept of urban growth, as the spatial expansion of town and cities with respect to increase in the size of a built-up areas and socio-economic functional changes. The face at which third world or developing countries urban areas are growing reveals distinctive spatial and temporal variation of land use/ land covers in locally urbanized environment. Therefore, in achieving

the aim of the study both physical and social surveys were used for both physical and social measurement of urban sprawl. The study used high and low resolution imageries of Zaria urban areas for years of 1980, 1992, 2003 and 2011 and high resolution imagery of 2013, based on the data available and scope of the study period.

Field survey and social survey were used in capturing the socio-economic functional changes as well as the impact of the changes, the residence of traditional core historical existence-settlement of Zaria city, new settlements and sub-settlement all around the Zaria metropolis, the formation of newly developed layout base of time variation were also used as sample interview. Others include planning and management information which was obtained from interviews with various stake holders, Kaduna State Urban Planning Development Authority (KASUPDA), as well as the planning authorities of Kaduna State Ministry of Land Survey and Country Planning.

The findings of this study revealed that, Zaria urban area since before 1980, was a typical rural and urban settlement. Every day, Zaria is experiencing rapid influx of people which resulted to increase in urban land use, spatial expansion from 123.72 Sqkm in 1980 to 195.66 sqkm in 1990, while the population increase within this period of only 349,164 persons, to 500,424 persons in 1990 according to 1991 census figures. Zaria experience more growth both in population and built-up area since before 1980, all as a result of the establishment of Tertiary Institutions within the Metropolis. Such as the establishment of Ahmadu Bello University, (A.B.U) Zaria, Nigerian College of Aviation Technology (NCAT), Nuhu Bamalli Polytechnic Zaria, Nigeria Institute of Transport Technology (NITT), Federal College of

Education (F.C.E) Zaria etc. However, these growth continues rapidly most especially from 1980 to 2014.

The areal extent of Zaria is increasing in geometrical rate, while built-up area are increasing in arithmetical rate. Also in relation to population growth, the population is also increase in an arithmetically, while the built-up areas increase geometrically. The sprawl pattern commonly occurred in the study area is the, linear, leapfrog or scattered development and low density single used development urban sprawl. The spatial dimension of Zaria urban area increase the travelling distance, as proximity to place of work is determining the people choice of place of residence, as some travelled over 10km to their place of work. The result of urban area overlay analysis revealed that the major sprawl pattern occur along the major roads to Kaduna, Jos, Zaria-Sokoto road, along Dogarawa Kano road.

These four major roads that cross Zaria from all the four cardinal direction became the major growth poles. The growth within this period (1980 to 2014) forming the bottle neck growth pattern from all the four cardinal directions. The decisions of Kaduna State Government under the supervision of planning authorities within (1999 to 2005) of creating two (2) government approved layout in Kabama and New Gaskiya layout at some kilometer from the traditional settlement, determine the growth pattern. Subsequently, within that same period range, dualization of Zaria Wall road to PZ down to Samaru road took place as well as expansion and renovation of Sabon Gari and Zaria market respectively.

The establishment of Dadi Kwangila Motor park and so many of them took place within same period. Zaria linear,leapfrog and Low density single use development structural growth process already engulfed so many settlement within and around Zaria metropolis from that 1980 to 2013. Which include : Banzazzau, Jushi, Dembo, New Dakace, Nagoyi, etc around Zaria wall axies, Pampon Gwaiba, Gangaren kwadi, U/kaya, Filin Mallawa,etc around T/Wada axies, Chikaji, Shika Dam, Zabi, Jushin Waje, U/kanawa,Kwantaresha etc around S/gari axies, Dogarawa, Hanwa low cost, Palladan, Grace land etc aound Kwangila axies, Zangon shanu, H/danyaro, U/gwaiba, H/mallam, U/dakarkari, Samaru New Extension,etc around Samaru axies, U/dankali,Gwargwaje,U/saye,Sayen gobirawa etc around Dan-magaji axies.

Within the period under study, Zaria Metropolis experienced substantial growth in Socio-economic functions, the growth almost touches all the sectors of the economy, include education, commerce, recreation, transportation, health, infrastructural development, etc .As the third world urban centers growth cannot disassociated with environmental and socio-

economic problems, the problem of Zaria urban area are more visible in organic traditional settlement, as most of the people residing in the sprawl areas outskirt the old Zaria wall are mainly high and medium income civil servants. This study identified several environmental problems ranging from air pollution in evening of the day mostly in traditional wards, others including waste disposal system, mosquitoes, bad roads with their street, pollutants at water logs in the center of town, as well as poor drainage systems etc.

5.2 CONCLUSION

The examination of the findings of the research along with other general observations supports the advancement of the two general conclusions. The first conclusion is that the sprawl analysis as conceived in the early and initial stages of the research is workable and viable. Second, that its application in the mapping and analysis of sprawl in Zaria has demonstrated that urban planners and managers alike can utilize it as a cost effective, convenient and accurate means of monitoring urban growth, analyzing varying resultant patterns, examine factors responsible and explaining the socio-economic effect of urban growth and development. This then offers tremendous opportunities for effective monitoring and management of development control which currently is lacking in the study area and most other urban areas in Nigeria.

5.3 GENERAL RECOMMENDATIONS

Because of its versatility, it is recommended that urban planners and managers interface Remote Sensing and Geographic Information System GIS in the mapping of growth, sprawl pattern, the rate of the sprawl and the socio-economic effect of sprawl activities. As shown from the study, not only will there be value from the precision of the tool , but the saving of time in the analysis allows proactive response to urban management issues. To draw value from the methodology, the basic constraints to its adoption need to be removed. In most planning offices, the equipment and personnel base to utilize the method is lacking. The constraint of lack of capacity can be removed through training and education. Secondly, there is an urgent need for government as represented by its agencies to improve mapping at suitable spatial scales and also improve the generation and archiving of other data types. This will facilitate effective research and formulation of robust urban management and development control strategies.

5.4 RECOMMENDATIONS FOR ZARIA METROPOLIS

It is recommended that the Kaduna State Urban Planning and Development Authority (KASUPDA) leads the adoption of the tool in Zaria by creating an urban growth analysis and monitoring unit within the existing structures of the Board. This unit will engage departments and units within the board and other ministries in carrying out the periodic analysis of urban growth and the dissemination of the information gathered to public and private organisations that have use for it. Examples of organizations with need for such information include utility providers, property developers, telecommunication providers, security agencies, fire department, the Health Ministry, and the Education Ministry. From the outcomes of the research, the tool will be beneficial to Zaria in the following ways.

(a) Planning of infrastructure and Urban Services Delivery

The ability of the cost of providing urban services and infrastructure can be very useful in the process of infrastructure planning, budgeting and priotization of interventions based on the objective identification of the areas of greatest need within the city. The rapid assessment of the dynamics of urbanization will also assist the development of proactive measures for providing infrastructure and services rather than the usual reactive approach of waiting until there is a gap to be filled which has been shown to be extremely inefficient.

(b) Planning and Growth Management

In Zaria Metropolis, planning and development control is greatly hampered by the dearth of data especially up to date maps seen as cardinal requirements that determine the effectiveness and success of activities. The tool will provide fast and convenient access to updated mapped data and will also facilitate regular updates that will enable concerned authorities keep up with the pace of urban growth and development. This will have a positive impact on planning and growth management efforts.

(c) Stakeholder Mobilization for Development through Advocacy

Urban planning and management decision –making process in Zaria is very diffuse. It is spread widely among various government agencies, field practitioners and policy makers and is not easily captured in a single decision –making platform. This makes it pertinent to devise a model where all stakeholders will work under a common jurisdiction. For all these actors to be carried along, an efficient system that is capable of collecting accurate and reliable data and at the same time communicating it to those involved in decision making through an efficient medium is required. The rapid mapping, update and visualization capabilities of the tool will help achieve the noble objective of engendering participatory planning and improve the quality of decisions in governing the city. The constraints and limitations to the adoption of the tool are three: lack of technical know-how, lack of equipment and lack of managerial support. To address these issues, the following are suggested:

(a) Skill and Education

Staff require training and education to enable them attain the minimum level of expertise and competence needed for the effective deployment of the GIS and Remote sensing in Zaria .Suitable candidates for this type of training are highly motivated middle cadre staff with Degree level education in Urban and Regional Planning, Cartography and Land Surveying.

(b) Equipment (Computer Hardware and Software)

The necessary hardware and software need to be acquired. Two properly calibrated computer workstations, one handle GPS unit, ArcGIS 9.2 software, Google Earth Software, other

conventional software needed for proper functioning of the workstations and a reliable internet link are required as the initial investment.

(c) Managerial support and Goodwill

The management of KASUPDA needs to be adequately sensitized on the inherent benefits of the adoption of sprawl study in Zaria Metropolis. This is because its goodwill and support is a pre-requisite to the successful and sustainable utilization of the tool within the framework of the day to day operations of the authority.

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Appendices

DEPARTMENT OF GEOGRAPHY,

AHMADU BELLO UNIVERSITY, ZARIA, NIGERIA

QUESTIONAIRE

Dear Respondent,

I am a postgraduate student of the above named institution, conducting a research titled Analysis of Spatio-Temporal pattern of urban sprawl in Zaria Metropolis using GIS and Remote Sensing techniques. I am soliciting for your kind co-operation in completing the questions below. All information provided shall be treated with full confidentiality and will only be used for academic purposes.

Thank you.

Adamu Yahaya Kajuru.

Definition of sprawl-: Urban sprawl is considered to be the expansion of low-density accompanied by a series of environmental and socio-economic issues.(scattered urban growth)

Section A: Socio-Economic characteristics

1. Sex: (a) Male ( ), (b) Female ( ).

2. Age (a) 15-24years ( ), (b) 25-34years ( ), (c) 35-44years ( ), (d) 45-60years ( ), (e) 60 and above.

3. Marital status: (a) Married ( ), (b) Single ( ).

4. Educational status: (a) Non formal Education ( ), (b) Primary Education ( ),

(c) Secondary Education ( ), (d) Tertiary Education ( ), (e) Others, please specify……..

5. Occupational status: (a) Civil servant ( ), (b) Business (trading, contractor) ( ), (c) Farming ( ), (d) Artisan (mechanic, carpenter, welder etc), (e) Unemployed ( )

6. Do you work for any organisation: (a) Yes ( ), (b) No ( ).

7. If yes, Name of organisation……

8. How long have you been working? (a) 1-5years ( ), (b) 6-10years ( ),

(c) 11-15years ( ), (d) 16-20years ( ), (e) 21-25years ( ), (f) 26-30years ( ).

9. Income per month (a) ₦10,000-30,000 ( ), (b) ₦30,000-50,000 ( ),

(c) ₦50,000-80,000 ( ), (d) ₦80,000-100,000 ( ), (e) ₦100,000 and above.

Section B. Urban Sprawl information.

10. Ward/layout (Address)……..

11. House ownership: (a) Rented apartment ( ), (b) Owned (c) Others, pls. specify……

12. Nature/source of ownership: (a) Traditional authorities allocation ( ),

(b) Government allocation ( ), (c) Estate/ land vendor ( ), (d) Inheritance ( )

13. Nature of building materials used: (a) mud ( ), (b) bricks ( ), (c) zinc ( ), (d) thatch ( ).

14. Types of toilet facilities; (a) water system ( ), (b) pit ( ), (c) others, pls. specify……..

15. For how long have you been living in Zaria metropolis…….

16. Is your own area affected by sprawl (scattered urban growth) : (a) Yes ( ),

(b) No ( ).

17. If yes, what is the pattern of the sprawl (scattered urban growth): (a) Leapfrog or scattered development ( ), (b) Commercial strip development ( ), (c) Low density development ( ), (d) Absence of public space ( ),(e) None of the above( ).

18. Are you satisfied with the pattern and forms of sprawl (scattered urban growth) in Zaria :(a) yes ( ), (b) No ( ).

19. If yes reason…….....

…….

20. If no reason……

…….

21. Can you estimate the year of the sprawl (scattered urban growth)……

22. What common environmental problems are you facing within Zaria urban area?

(a) Air pollution ( ), (b) Flooding ( ), (c) Refuse disposal ( ), (d) Lack of drainages ( ), (e) Others specify……. .

23. What are the social problems of sprawl in Zaria metropolis? (a) Increasing housing congestion ( ), (b) Scarcity and pressure on facilities like roads, water, electricity,( ), (c) Increase in crimes and social vices ( ), (d) Diffusion of social culture ( ), (e) Others specify……..

24. What are the economic impacts of sprawl (scattered urban growth) in Zaria urban area? (a) Poverty ( ), (b) Increase in relative prices of commodities ( ),(c) Unemployment ( ), (e) Others specify……

25. What are the factors responsible for urban sprawl: (a) Cheaper land ( ), (b) Housing cost ( ), (c) Increase in public spending ( ), (d) Increase in commercial lending ( ), (e) Increase in family income ( ).

26. What was the condition of sprawl in Zaria: (a) Severe ( ), (b) Controlled ( ), (c) Not controlled ( ).

27.If severe, not controlled, controlled why……

……..

28. What informed your choice of residence here in Zaria? (a) Land is cheaper ( ), (b) proximity to my place of work/school ( ), (c) availability of infrastructural facilities ( ), (d) Ethno-religious consideration ( ), (e) Security of the area ( ).

29. What was your own contribution towards controlling and managing sprawl in Zaria……
……

30. Rate the following factors in terms of their influence on the development of scattered settlements around Zaria.

Factor	Strongly Agree	Agree	Undecided	Strongly disagree	Disagree
Ease of accessibility in the area.					
Absence of planning in the area.					
Cheaper lands.					

Ethno-religious affinity.					
High rental values in Zaria.					
Population growth.					

Thank you for your usual co-operation.

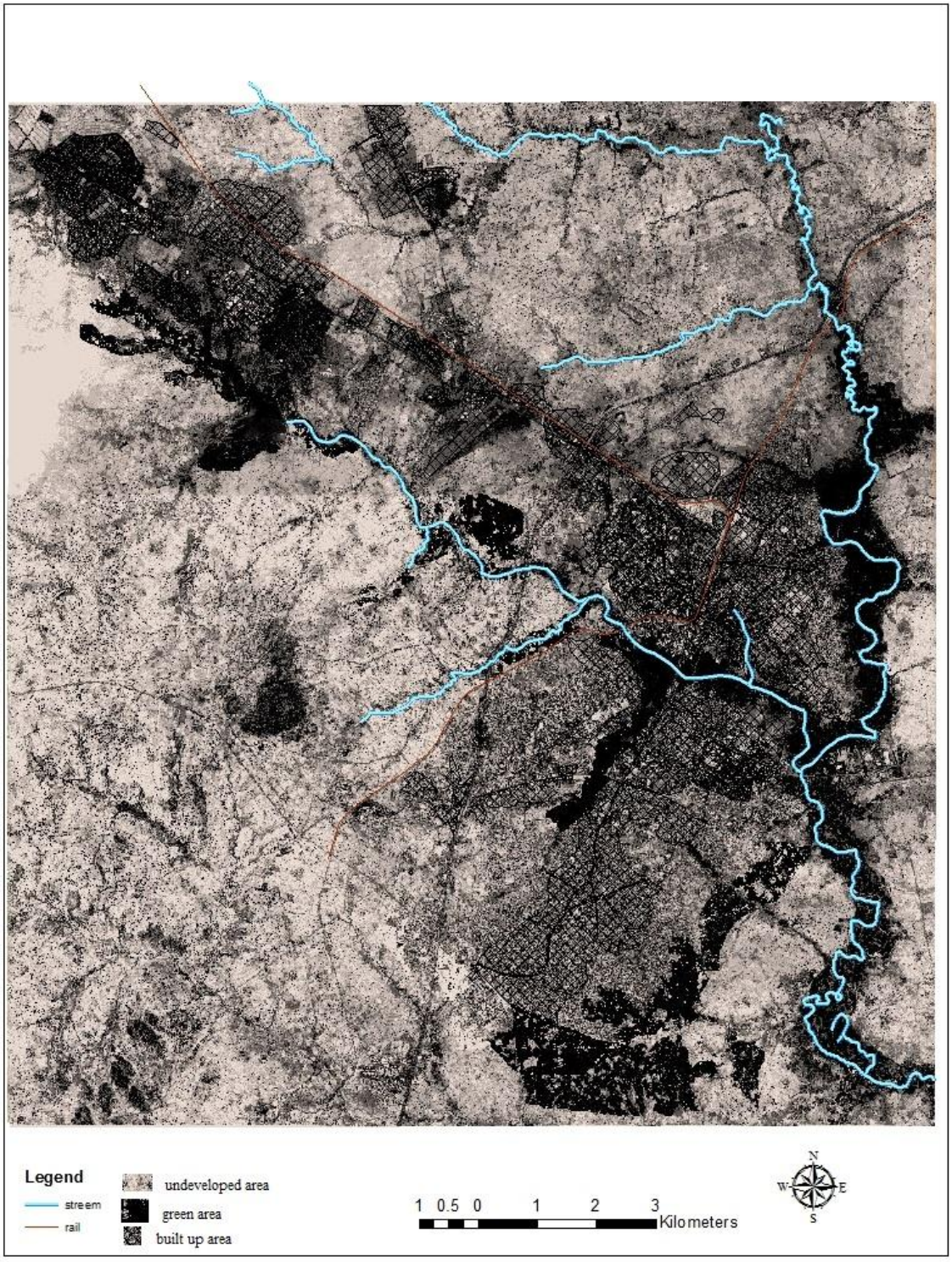


Fig. 4.5: 1980 Landsat Image Resolution of Zaria

Source: Field Survey 2013

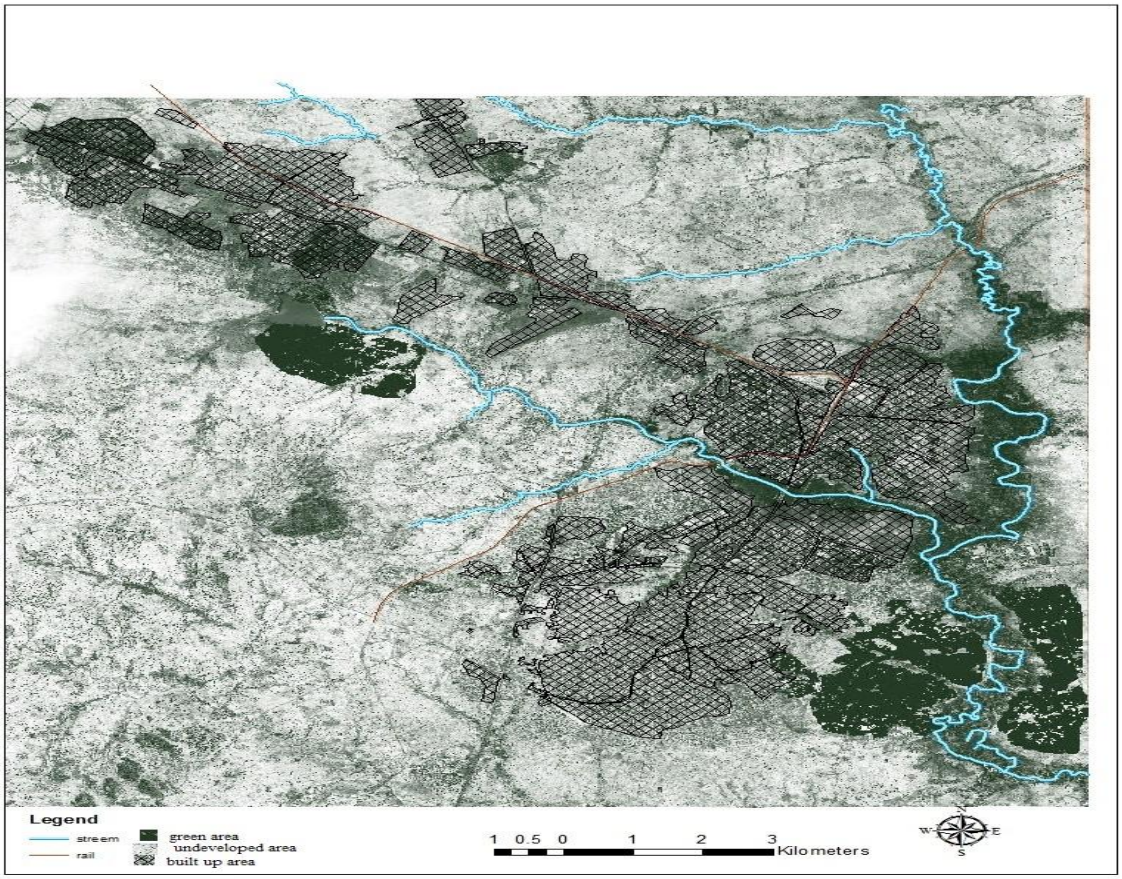


Fig. 4.6: 1990 Landsat image Resolution of Zaria Metropolis

Source: Field Survey 2013

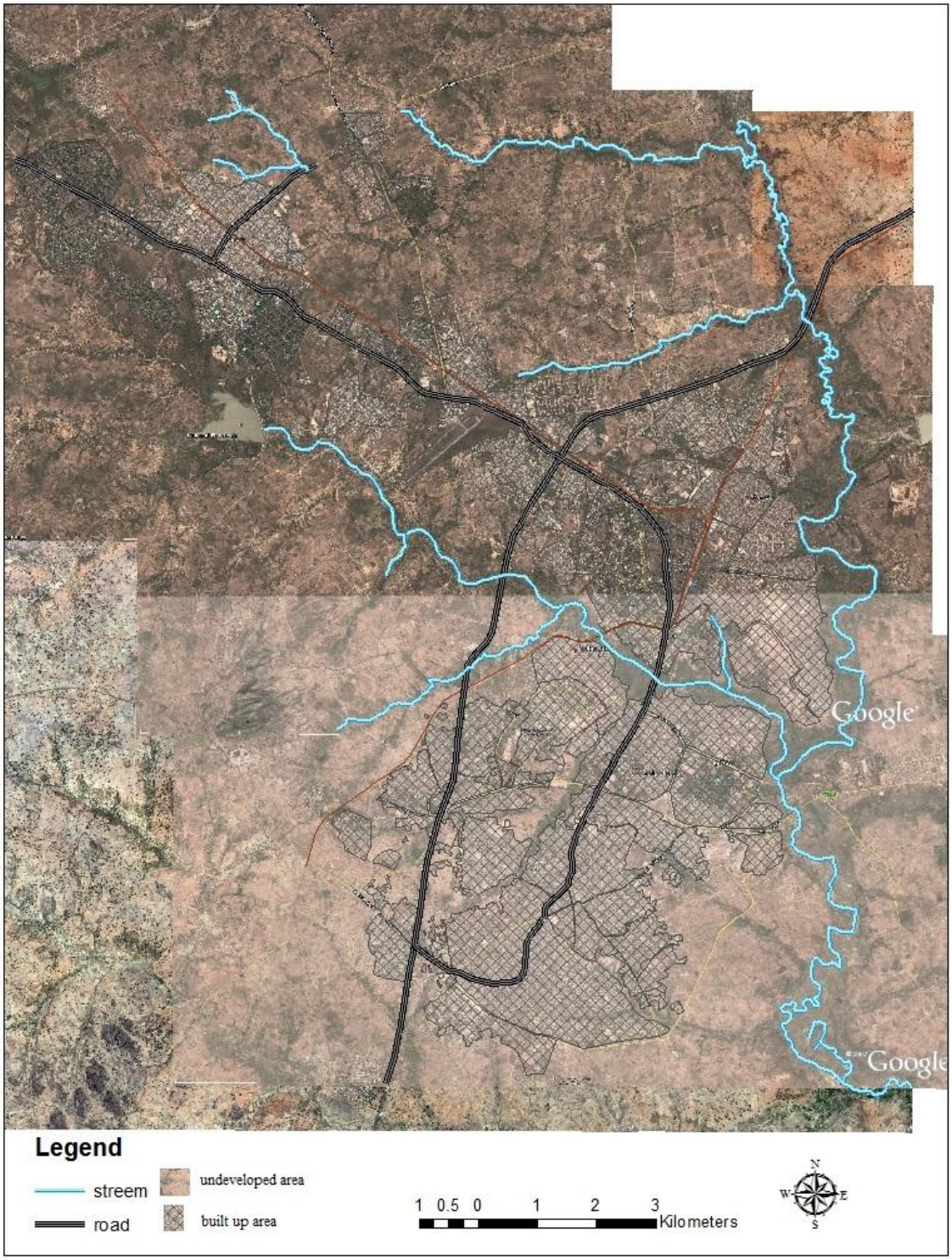


Fig.4.7: 2000 landsat Image Resolution of Zaria

Source: Field Survey 2013

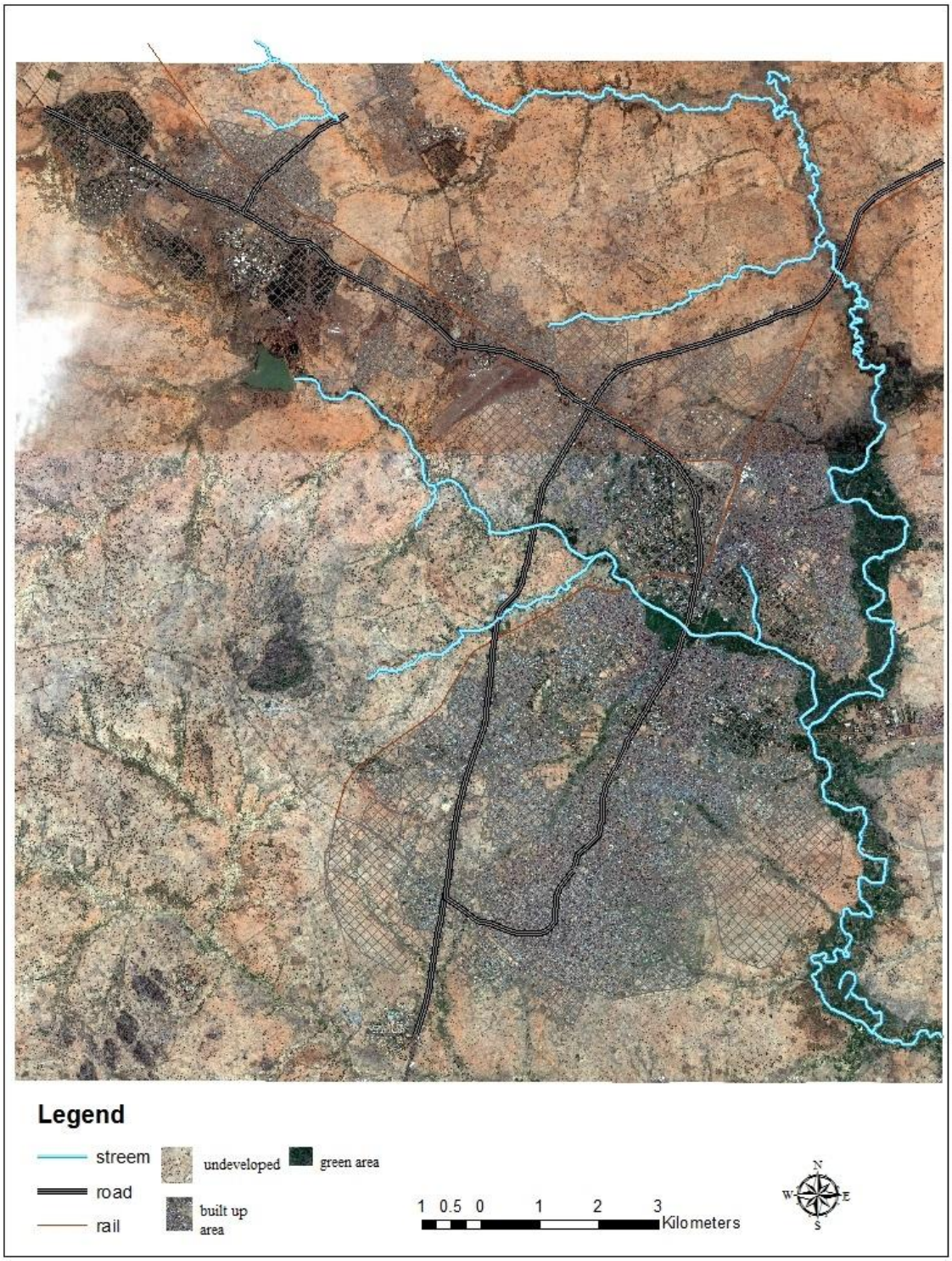


Fig.4.8: 2010 Landsat Image Resolution of Zari

Source: Field Survey 2013