THE USE OF MULTI -TEMPORAL SATELITE DATA IN ASSESSING URBAN CHANGES IN ABUJA-NIGERIA

BY

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Being a project submitted to the Postgraduate School in partial fulfillment of the requirement for the award of Master of Technology degree in Remote Sensing Applications in the Department of Geography, Federal University of Technology, Minna, Nigeria.

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CERTIFICATION

This thesis titled: THE USE OF MULTI- TEMPORAL SATELLITE DATA IN ASSESSING URBAN CHANGES IN ABUJA – NIGERIA by: Aliyu, Yahanasu (M.Tech/SSSE/2003/916) meets the regulation governing the award of the degree of M.Tech of the federal University of Technology, Minna and is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

To my family, you are my world

DECLARATION

I Yahanasu Aliyu hereby declared that I wrote this project by myself.

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ACKNOWLEDGEMENT

Praises and eternal thanks to Allah almighty for HIS infinite mercy, blessing and protection bestowed me at this precious moment of my life, the strength with perseverance and all that is necessary to conquer the challenges for the attainment of my goal.

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ABSTRACT

Management and planning of urban space requires spatially accurate and timely information on land use and changing pattern monitoring provide planners and decision makers with required information about the current state of development and the nature of changes that have occurred. Remote sensing provides vital tools which can be applied in the analysis at the district and as well as the city level. Remote sensing becomes useful because it provides synoptic view and multi-temporal land uses/land cover data that are often required. Though often used only for identifying objects. This study evaluates the effectiveness of the use of remote sensing data (satellite images) in assessing the land use change dynamics within the study area (i.e. Abuja phase 1) from 1976 to 2001. This study attempts to determine urban change in Abuja FCC using satellite remote sensing data collected at three different times. The study area covers approximately 51.412km^2 of the Phase 1 consist of Wuse, Garki, Asokoro and Central Business Districts. The time series satellite images of urban changes used include; LandSat MSS acquired in 976, LandSat TM acquired in 1987, SPOT XS OF 1994 and LandSat ETM acquired in 2001. The data were classified into 'built-up' and 'non built-up' areas. This was reclassified in the GIS to show only those classes that represent urbanized land. Then make comparison of the years to show the extent of urban growth/change over the last twenty five years. The urban expansion were mapped within the GIS environment, and neighborhood statistics in order to show the to calculate the area of new growth were carried out. The quantitative results through GIS data collection and analysis, and visual detection of urban change have shown that urban change is a part of urbanization processes in Abuja. The increase in built-up landuse was visible and result shows increase in the percentage of urban land in 1976 - 2001 constituted approximately 0.29%, 29.16%, 74.33% and 95.15% of the total landuse change of the study area. The result of the time series analysis revealed that Abuja FCC has urbanised rapidly over the last twenty five years.

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

In recent years, cities all over the world have experienced rapid increase in population and the irreversible flow of people from rural to urban areas. Specifically, in the large towns and cities of the developing world the rate of population increase has been constant and nowadays many of them are facing uncontrolled and unplanned settlements at densely sites and fringes. It is almost true that the planets future is an urban one and that the largest and fastest growing cities are primarily in developing countries. Even in Africa, long though of as one of the least urbanized continents, it is expected that over half of the population will be urban by 2020 (UN, 1993). The largest cities serve simultaneously as national and regional engines of economic growth centre of technological and cultural activity, homes of poor and deprived, the sites of environmental pollution (Fuchs, 1994 p.2). As yet, our understanding of the dynamics of these cities and the urban systems of which they form part and our capacity to manage them effectively are limited.

A country is considered to be urbanized when over fifty percent of its population lives in urban areas. During the industrial revolution in 1985, the first countries to become urbanized were Great Britain and some other European countries.

The urbanization process in Abuja has traditionally been dominated by the housing sector. Recent discussions on spatial planning on national level tend to focus on the construction of one million residences for the coming decades, rather than considering our living environment as the departure point. The reasons for this rapid increase of population in the cites are:

i. Escape of people from the social structures of traditional rural life as they are attracted by the bright light of larger cites.

ii. High birth rate

A part of the urban migration could be channeled into a planned settlement structure but a significant part settled in an unstructured manner, which in most cases are illegal, spontaneous and without access to basic facilities such as drinking water, sewage disposal, electricity and roads.

Abuja like many cites of the developing countries has a problem with urban expansion and growth of population in the main cites, for example over the last decades Abuja, the capital city significantly expanded due to different development activities and migration of people from rural site. Urban areas are hereby defined as ; i)A continuous block of built-up land around the city which forms the urban core. ii)All enclaves of non built – up land within this core.iii)Apart from the built up areas, play grounds, parks and other amenity spaces were also defined as urban.

The words "towns, cities, and urban centres" have been used interchangeably. Cites is distinct from rural areas of innovation, provision of skilled specialized manpower, and above all, are the production centre for manufactured good and service. They are therefore the engine of growth and development.

Unfortunately there are no acceptable definitions of both towns and cities and no single description will cover their transformation. The various definitions vary with authors and widely with each country of the world. In simple terms however, a city is large town where people come together to live, work and Play. The Nigerian definition of a city is a place where people live with population of 20,000. Metropolitan: A metropolitan is the main city of a country or region. Urban change - is used in this study to mean the sprawling of cities into wider geographical areas.

Apart from dominant urban core, urban structure in most areas is mainly one of ribbon development with isolated cluster of more concentrated urban areas. The rate of expansion of the urban area averaged about 10% annually. The pattern of urbanization was influences mainly by small scale infilling of rural area and intensification of ribbon development along main and secondary roads.

Remote sensing provides a means for locating, identifying and mapping certain urban features and assessing the spatio-temporal changes and their environmental impact. Abuja F.C.T has experienced urban growth during the last decades. Extraction of land cover maps for mapping surface composition and assessment of changes in surface cover composition over time are requirements common to each investigation. Applied remote sensing became more and more inevitable technology tool contributing to human's progress toward sustainability by support solving environment-related tasks on local, regional and global level. Moreover, regularly acquired satellite data may be used for long-term. The project therefore assesses the urban change in Abuja using multi – temporal satellite data.

1.2 Statement of Problem

Most developing countries are faced with too little practical research, too few scientists and insufficient funds for technological development (IPTRID 1991). This shortage of research and development activities as affected many aspect of life in developing world including irrigation landuse and environmental factors. Of all the factors that determine the quality of our environment, the most important is the use we make of our land.

The present, past and future juxtaposition of urban change has been an issue of much concern to a number of discipline, including agriculture, economics and geography, planning and sociology. Data on landuse are relevant to understanding the process and formulate operational model. They also provide the federal, state and local government officials an up to date for decision making as well as a means of monitoring the outcome of past decision.

Abuja, being centrally located with respect to the other part of the country, has her landed property scramble for development purposes. It is therefore necessary to investigate the growth of this town since the time of its inception as the Federal Capital to date. This work therefore is set to tackle the questions what was the landuse/landcover of Abuja in terms of physical development before and how has these been changing over time? How have these changes affected the urban system and the physical environment?

1.3 Aims and Objectives

1.3.1 Aims

The aim of the project is to examine the growth of Abuja FCC with regard to the patterns and direction of growth, with a view to make recommendation for effective development control of the town.

1.3.2 Objectives

The specific objectives to achieve the stated aim are as follows:

1. To measure urban growth within the study area based on urban land use change between 1988 and 2004.
2. To assess the cause of such changes over the period
3. To make recommendation towards effective developmental control of the city.

1.4 Research Questions

As a basis for the development of policies and decision making accurate and timely data about the extent, distribution and changing conditions of the various landuse is important. The questions that readily come to mind include:

i. What changes have occurred and to what extent?

ii. Where have the changes taken place?

iii. Why this changes?

Answers to these questions afford planners good foundations for proper planning. This study intends to present a method of acquisition of reliable data from satellite images, using simple equipments and readily available data from which answers to the above questions would be correctly deduced.

1.5 Justification of Study

As postulated by Adeniyi (1972), the economic status of any nation is always a direct formulation of the use it makes of the available natural resources regarding resource quantity, quality and economic productivity. The knowledge of the current landuse patterns is a pre-requisite to monitoring changes in the over all use of land or developing plans for improved landuse. Therefore, the land administrators and the planner need a comprehensive and current information if they are to control orderly use of the land. Information on the changes in the landuse is essential to the proper planning, management and regulation of development of the city.

Furthermore, since a particular landuse generally has an 'unnatural' expression in the landscape, landuse is especially susceptible to study by remote sensing techniques (Nunnaly 1974). In different situations the study of man environment interaction as a cultural theme of geography is achieved through landuse investigations (Lintz and Simoneth 1976). Physical development inventories provide and vehicle for the rapid collection of current detailed physical development inventories for variety of planning and management purposes.

1.6 Scope of the Study

The study area was selected with consideration to the availability of time series data (satellite imagery). The study is limited to phase 1 of the Federal Capital Territory development (Fig.1.1) comprising Maitama district, Wuse, Asokoro, Garki, the Central Area and three Arm Zone, for the period between 1987, and 2001.This area was chosen because of its intense development and completion.

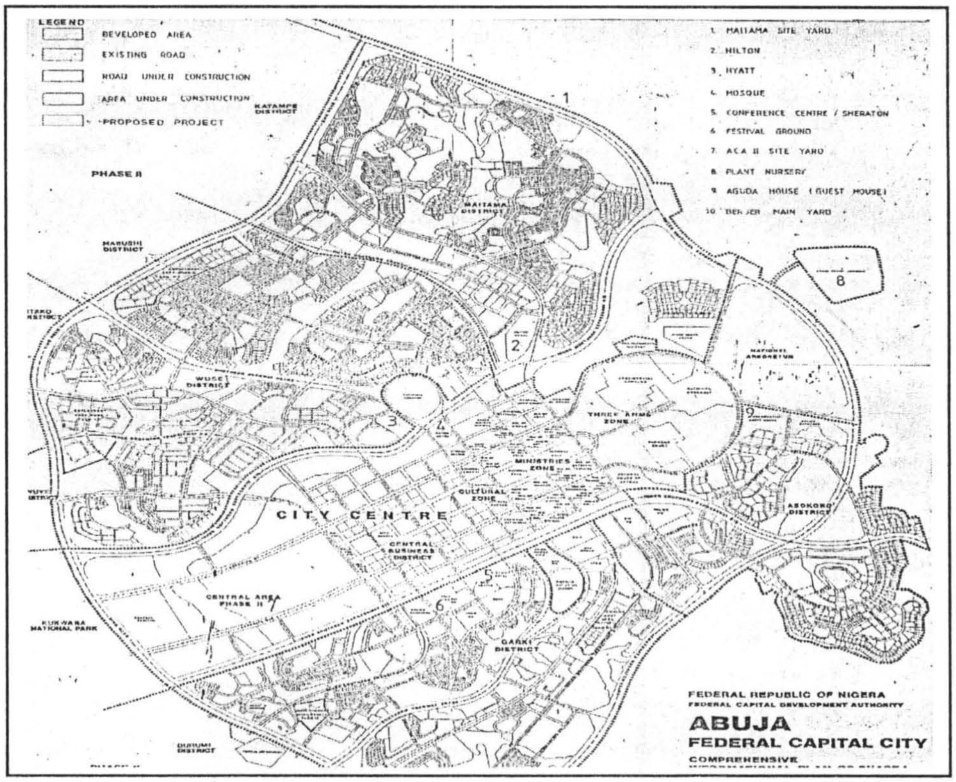


Figure 1.1: Map Showing the phase I (FCC), the Extent of the study area

1.7 Study Area

Abuja the new Federal Capital came into existence by decree No.6 of 1976. Until it creation in 5th, February 1976, Lagos had been the capital of Nigeria since the amalgamation in 1914. With time the increase tempo of economic activities and the influx of people into Lagos were not matched with corresponding increase in the level of infrastructural facilities, spaces and service. The result was that Lagos was over burdened and its facilities stretched to breaking point and it was incapable of housing both the federal and State Government. Available land was insufficient for development commensurate with the status of a capital. This not withstanding, Lagos as the capital of Nigeria had remained a contentious issue right from the time of lord Laggard, who himself had recommended Kaduna to the British government upon the amalgamation because of its central location, invigorating climate and its accessibility by rail to the East, West, the far North and the middle belt.

To examine and advice on this national predicament, the federal military government under the late General Murtala Mohammed in August 9, 1975 set a seven man committee headed by an eminent jurist Dr. Timothy Akinola Aguda was inaugurated to handle the assignment. Part of the Kwara, Kogi, Nassarawa, Plateau and Niger States was marked out and recommended as the federal capital territory. The federal government accepted the recommended and by the decree No.6 of 1976, the governance of the territory was vested in the federal capital development authority (FCDA), as the government agency responsible for the design, construction, administration and management of the new capital territory.

By 3rd, February 1976, Abuja was proclaimed as the new federal capital territory by late General Murtala Mohammed based on the reasons that

> "*the site recommended satisfied the panel criteria of centrality, good and tolerable climate, land availability and use, adequate water supply, low population density physical planning convenience,*

security and multi access possibility. The area is not within the control of any major ethnic group in the country".

By 12th December, 1991 seat of the Federal Government finally moved to Abuja the new Federal Capital Territory.

1.7.1 **Location**

The Federal Capital is located in the geographical centre of the national. It lies between latitude 8^0 25'N and 9^0 20' and longitude 6^0 45'N and 7^0 30'. It is bounded to the north by Kaduna State, Nassarawa State to the east and south – east Kogi to the south – west and Niger to the west. The total landmass is an area spanning 8,000 sq km (Fig.1.2 and 1.3).

1.7.2 **Climate**

The climate of the FCT is determined by the alternating dominance in the region of either the dry continental air mass from the north or the marine air mass from the south.

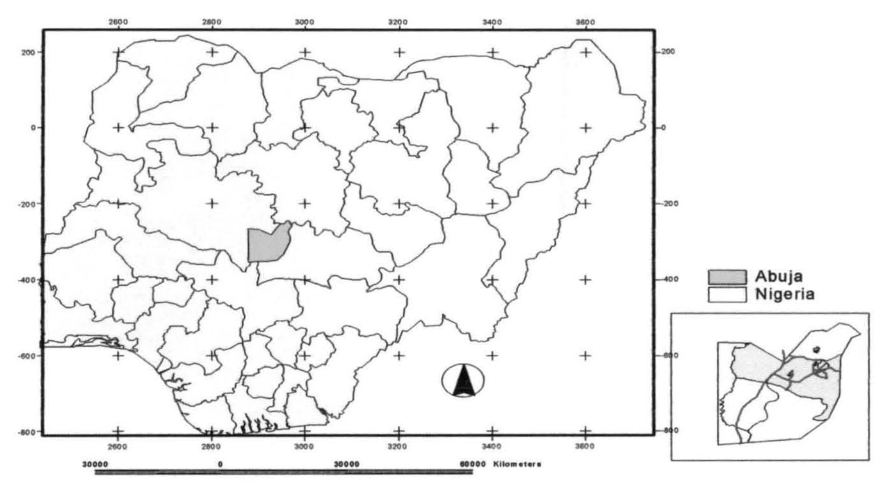


Figure 1.2: Map of Nigeria Showing Abuja and the location of the study area

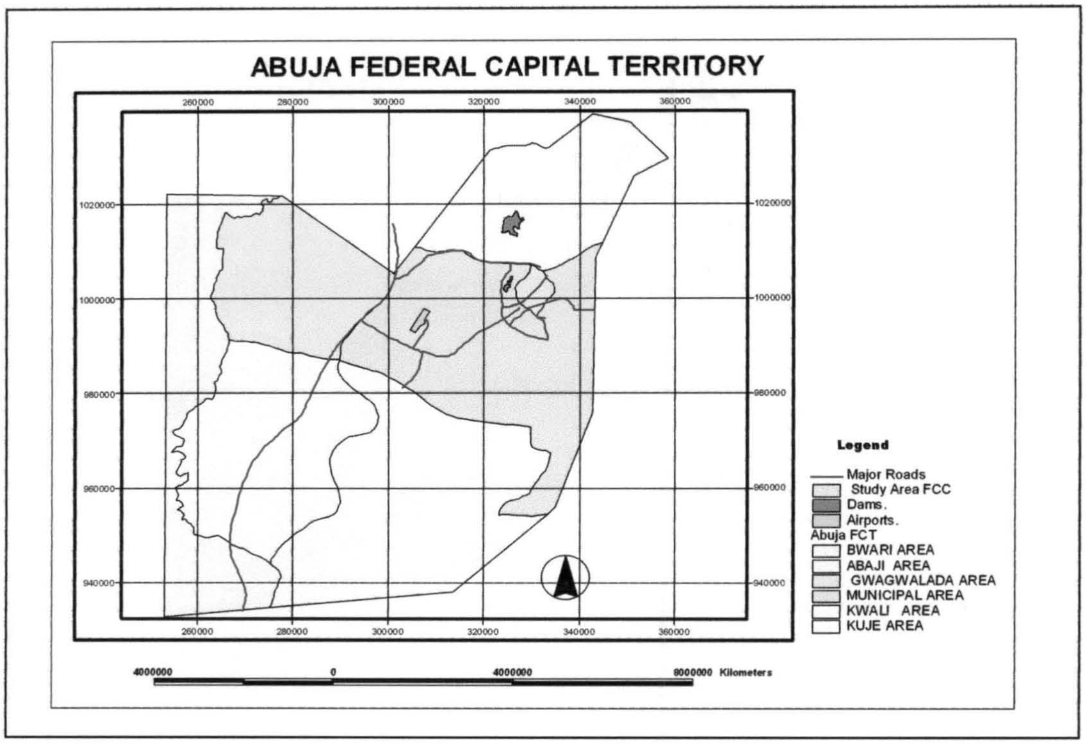


Figure 1.3 Map of Abuja Showing the location of the study area

The oscillation between these two air masses produces the highly seasonal characteristics of weather conditions in the country. The tropical continental air mass is associated with dry season and the tropical maritime mass creates the wet season. Rainy season starts in April and ends in October. The mean annual rainfall in the vicinity of the FCT ranges between 1,145.55mm and 1,631.7mm. However, extreme concentration of rainfall during two or three months, generally occur in July through September. Daily maximum temperatures in the vicinity of the FCT are strongly influenced by elevation and the extent of cloud cover, associated with the dry and wet season of the year. The highest temperatures and greatest diurnal ranges occur during the months of the dry season (November – April) during which maximum temperatures range between 27.5^{0}C and 37^{0}C. The diurnal ranges can be as much as 17^{0}C during the dry season. During the rainy season (May – October) maximum temperature range from 23.5^{0}C – 36^{0}C. Wind in the vicinity of the FCT is also influenced by the seasonal migration of the dry and moist air masses through the region. As the dry air mass descends from the north, the regions are dominated by the north easterly winds. These winds predominate from October through March and are frequently dust laden as they descend from the interiors of the continent.

1.7.3 **Vegetation**

The vegetation in the FCT includes two types of forest and three types of savanna. These five plants communities include rain forest, Riparian forest, savanna woodland, park savanna, and shrub savanna. The rain forest vegetation occurs through out the FCT at present it is more prevalent on the Gwagwa plains in the east, the southeastern portion of the Agwai-karu hills and on the Rubochi plains in the southeast of the FCT. The riparian forest vegetation type consists of a complex of diverse physiognomic and floristic units covering about 1000sq km, or about 12.5% of the territory. It contains the typical rain forest vegetation, as well as woodland and thickets. The common feature of the riparian vegetation complex is its close proximity to a riverside water supply. Savanna woodland occurs primarily in hilly terrain such as ridge tops hill clusters. The most extensive occurrence of this assemblage in FCT is found in the Sukulu hills, forming the southern fringe of the Iku plains. Savanna woodland is also found in the upper basins of the Robo and Afara-Bokwoi Rivers (Robo plains), the awai-karu hills and along the eastern portion of the Iku plains. Savannah woodland covers approximately 1,030sq km or 12.8% of the FCT. The park savannah vegetation covers over half of the FCT (4,200 sq km) it composed of a thick of the assemblage. Shrub savannah is the last major vegetation type found in the FCT. It is most frequently found below high wooded ridges and low ridges covering about 1,030 sq km or 12.8%. Regions within the FCT, when shrub savannah is most frequently found include the middle Gurara river valley, the Usuma River valley and the undulating terrain of the Robo plains between the Robo and Afara bokowoi Rivers. A continuous belt of shrub savanna occurs around the range of hills to the north of the Gwagwa plains.

1.7.4 Soil

The majority of the soils in the FCT have developed from crystalline rock of the basement complex. To a laser extent. Sedimentary rock mainly sand stone have served as the parent materials. The common characteristics of FCT soils include stoniness, a generally acidic reaction, a sandy texture and shallow schist of the Gwagwa plains. These soils are deeper less stony and of finer texture e.g. clay loans and sandy clay loams.

1.7.5 **Geology**

The major rock units underlying the FCT are metamorphic rock including Biotite muscovite schist; migmatite porphyritic Gneiss, and granites, igneous rock includes biotic granite, large intrusive masses commonly elliptical in shape forming dissected zones of the Zuma-Bwari-Aso hillsand outcrops of the Gwagwa plains.

1.7.6 **Population**

The projected estimated population (from the 1963 census by Dioxides) put the population of the entire territory at 124,678.00 people in 1977, and arising to about 132,816.00 at the onset of the physical development in 1980. This gives an overall positive change of 6.5% over the 3 years period, about 2.2% per annum. On The other hand, data acquired from FCDA recognizes the new element of migration in the demography of the FCT suggest that the overall population had increased to 492,300.00 in 1980 then 516,900.00 in 1987 and 555,668.00 in 1988 (FCDA 1988 b). These indicated an overall growth rate of 5.0% per annum between 1998 and 1987 7.5% between 1987 and 1988 (see table 1.1). Hence a case of an increasing rate. How ever the 1991 census provisional figure put the population of FCT as a whole at 378,671.00 and 212,854.00 for the municipal area council. The 1995 population of the FCT was put at 423,391.

Table 1.1Estimated population of FCT by LGA 1986 – 1988

LGA	1986 (a)	1987 (b)	1988 (c)	(a – b)	(b – a)
Abaji	62,300	65,400.00	71,305.00	4.98	7.50
Abuja Municipal Council	178,500.00	208,400.00	224,030.00	4.98	7.50
Gwagwalada Kuje	121,200.00	127,400.00	136,955.00	5.02	7.50
Kuje	110,200.00	115,700.00	124,878.00	4.99	7.50
Total	**492,300.00**	**516,900.00**	**555,668.00**	**5.00**	**7.50**

Source; 1988 federal capital digest of statistics

2.2 Urbanization as an Environmental Issue

The expansion of urbanized areas does impact on the quality of the environment. It often degrades the environment in the forms of inefficient land use and air and/or water pollution. When lands are not efficiently used, growth of urbanized areas often became uncontrolled and often penetrated into environmentally sensitive areas such as floodplains, wetlands, steep slope areas, and others. This type of inefficient growth of urbanized areas often proceeds in a leap-frogging fashion that skips usable lands in between new developments, thus creating sometimes smaller patches or vacant lands that are difficult to use. Growth of urbanized areas no doubt increases the amount of air and water pollutions that eventually impact on the quality of our environment. (Urban Growth Modeling and Environmental Impact Analysis, Jay Lee et al. 1999).

Even though pollution and environmental degradation do not just happen in urbanized areas, they are usually the most intense and evident in cities and their immediate surroundings. Furthermore, certain types of problems such as the extreme concentrations of wastes that cannot be degraded through natural processes, and congestion resulting from high population densities, are distinctly urban in origin.

2.3 Review of Relevant Urban Theories

2.3.1 Urban Land Use Theories

Various factors help to explain the distribution of activities in the urban centres. The central business district (CBD) is taken as the centre of urban settlements from various use. This concept helps in explaining the distribution of activities in the urban centres.

Generally two factors can be used to explain why there is a concentration of activities in the urban centres. The forces in operation are responsible for the internal structuring and restructuring of the urban centres. They are:

(i) The centrifugal force otherwise called the push factors i.e. forces that discourages the concentration of population and inward movement of people into the core of the town. Examples are traffic congestion, delays, and shortages of parking spaces, noise, environmental pollution and accidents. Others are, the decrease of land value from CBD towards urban fringes high cost of rent and poor housing condition.

(ii) The centripetal forces otherwise call the pull factors that encourage the inward movement and consequently the concentration of population activities in the core of urban centres. Examples are: sire attraction, accessibility, functional magnetism and linkage locational prestige and human/cultural attraction.

Three basic structures of intra-urban land use pattern can be identified. These are: the concentric land use theory, sectoral land use theory and the multi-nucleic land use pattern.

2.3.1 Concentric Zone Theory

E.W Burgess developed the concentric zone theory of urban land use in the mid-1920s based on an examination of the historical development of Chicago through the 1890s. It contrasts from the von Thunen approach in being descriptive rather than analytical (Harvey, 1996). The concentric zone theory of urban land use is based on the assumption that a city grows by expanding outwards from a central area, radially, in concentric rings of development. Burgess classified the city into five broad zones (Figure 2.1):

1. The Central Business District (CBD): The focus for urban activity and the confluence of the city's transportation infrastructures
2. The zone of transition: generally a manufacturing district with some residential dwellings
3. The zone of factories and working men's homes: this zone was characterized by a predominantly working class population living in older houses and areas that were generally lacking in amenities
4. The residential zone: this band comprised newer and more spacious housing for the middle classes
5. The outer commuter zone: this land use ring was dominated by better quality housing for upper class residents and boasted an environment of higher amenity.

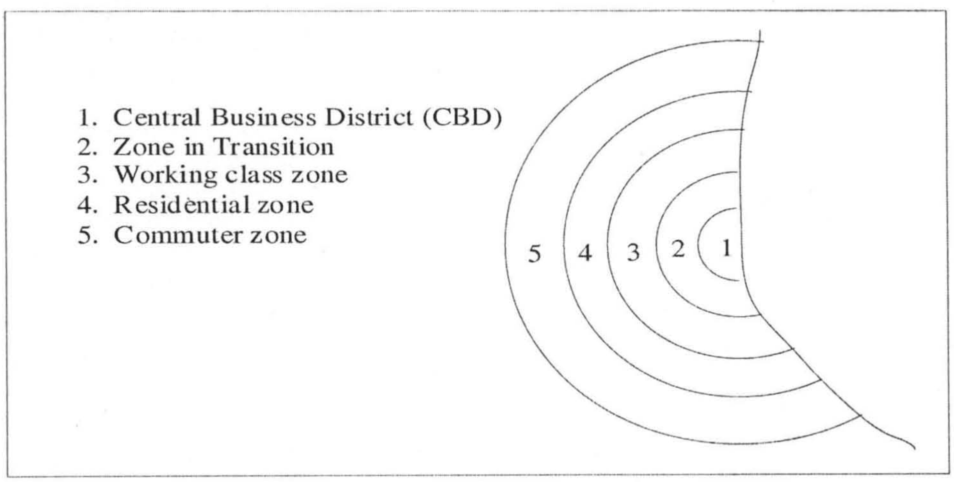


Fig.2.1: Concentric Landuse Theory as Conceived by Burgess (after EW Burgess, 1925; Carter, 1981)

2.3.2 **Wedge or Radial Sector Theory**

Development of the wedge or radial theory of urban land use is generally attributed to the work of Hoyt (1939). Hoyt's model concerns itself primarily with the location of residential uses across urban areas; it refers to business location only in an indirect fashion. The model seeks to explain the tendency for various socio-economic groups to segregate in terms of their residential location decisions. In appearance, Hoyt's model owes a great deal to Burgess's concentric zone model: Hoyt presents wedge-like sector of dominant urban land use, within which he identifies concentric zones of differential rent. The model suggests that, over time, high quality housing tends to expand outward from an urban centre along the fastest travel routes. In this way, Hoyt transforms Burgess's concentric zones into radial or sectoral wedges of land use (Figure 2.2).

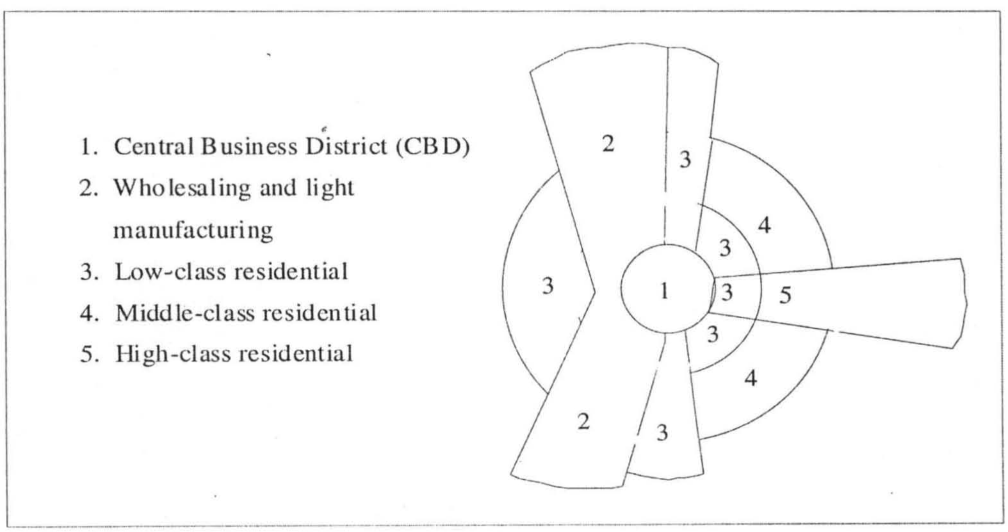


Figure 2.2. Hoyt's sector model (after H. Hoyt, 1939; Carter, 1981).

The innovative element in Hoyt's model was in considering direction, as well as distance, as a factor shaping the spatial distribution of urban activity. Hoyt's model also goes further than its predecessors in recognizing that the CBD is not the sole focus of urban activity (Kivell, 1993). One major criticism, however, is that the model overlooks the location of employment, which itself is the major determinant of residential location (Harvey, 1996).

2.3.3 The Multi-Nuclei Landuse Theory

The work of Harris and Ullmann (1945) in developing a multiple-nuclei theory of urban land use is amongst the most innovative descriptive of analytical urban models. Their model is based on the premise that large cities have a spatial structure that is predominantly *cellular*. This, they explain, is a consequence of cities' tendencies to develop as a myriad of nuclei that serve as the focal point for agglomerative tendencies. Harris and Ullmann propose that around these cellular nuclei, dominant land use and specialized centres may develop over time.

The novelty in multiple-nuclei theory lies in its acknowledgement of several factors that strongly influence the spatial distribution of urban activity: factor such as topography, historical influences, and special accessibility. The theory is also innovative in its recognition of the city as polycentric (figure 2.3). In this sense, it moves closer to explaining why urban spatial patterns emerge.

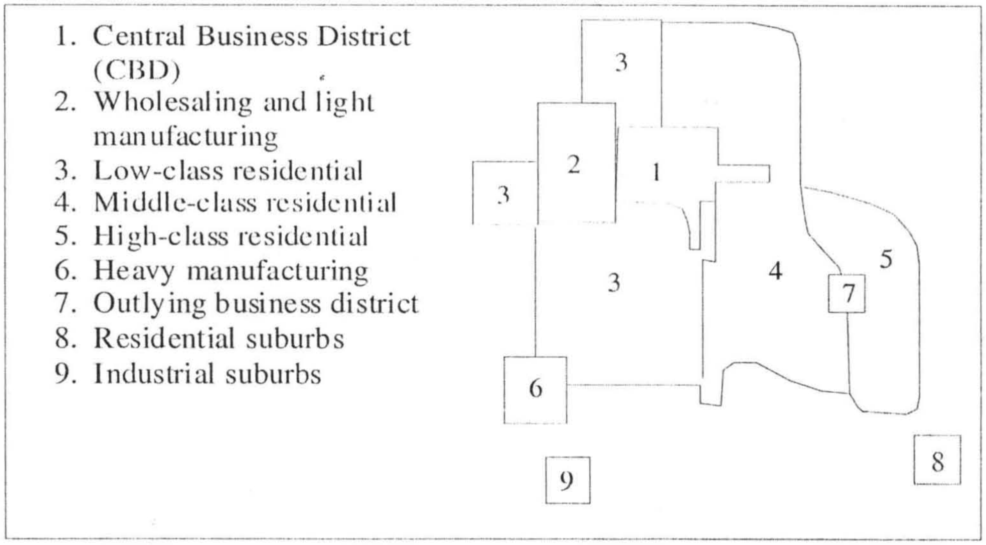


Figure 2.3. Diagram illustrating Harris and Ullman's multiple nuclei model (after CD Harris and EL Ullman, 1945; Carter, 1981)

2.4 Landuse Change

The subject of urban change may be partitioned into changes in the physical, social and economical subsystems of the city. Remote sensing provides a means of discerning physical changes in the distribution of activities, which in turn are related to social and economic changes within the system.

While, knowledge of what currently exist is often a necessary condition for answering question relating to the use of land. It is rarely a sufficient one. To know how a particular parcel of land come to have its present use through time (Rhind and Hudson op. cit). In order to understand why landuse changes as well as how the changes occur. It is necessary to have information on the landuse and landcover over different time. Thus it is necessary to understand the past and the present landuse to be able to predict the future role of the land.

In the past the processing of overlay to produce changes has often been carried out by photographic means. When two different data sets have occurred on maps of similar scale, making negative film image of each, and super imposing these on a light table, they give the area of coincidence which can be measured using a planimeter (Rhind and Hudson 1991). However the use of computer has greatly eased such comparism.

2.5 Specific Application of Remote Sensing To Landuse Changes

Remote sensing has been used for urban survey purposes in studying landuse, residential pattern, population estimation and the spatial growth of urban centres. The studies which have been carried out mainly by academics and planning experts, have yielded marvelous results. The approach adopted for the monitoring of urban changes has been on the comparative analysis of satellite images and sequential photographs taken at different years.

Mahur and Marjon Galema (1991) used aerial photographs with spot images to monitor urban growth of the city in chiangmai in northern Thailand. Material used include black and white aerial photographs of 1976 (1:20,000), 1985 (1:20,000) and 1989 (1:10, 000) print of the 1989 panchromatic spot images also available in 1:20,000 and 1:50,000 sales. The study revealed some interesting growth pattern in Chiangmai between 1976 and 1989. The city has a built-up area of 9,302 hectares in 1989, of this area 62% was high density

28.6% was low density and 6% of open space, less than 1% was occupied by industries. The city expanded at a fast pace between 1976 and 1989, growing from a total boil-up areas of 4,689 hectares in 1976 to 7,550 hectares in 1985 and 9,302 hectares in 1989. The rate of growth in the two intervals remained between 6 and 7 percent per annum. A detailed comparison of the situation in 1976 and 1989 revealed that most changes occurred in "Agricultural fields" and "other non-built up" which actually indicates that less agricultural land was being sown. Agricultural fields becoming high density' while other non built-up becoming low density'. Also 148 hectares of open space and 2 hectares of water bodies were taken for development between 1976 and 1989.

Henderson, (1975) evaluated the usefulness of Side-looking Airborne Radar (SAR) for general land use mapping at a scale of 1:250,000 in a study covering parts of Midwest of United States. What he did was to first of all regionalize using physical and cultural features of the environment interpreted from the radar imagery of scale 1:80,000 which facilitated the description of the area to detect changes. The criterion used for the regionalization was that that land use region should fall witan on which the physical and cultural characteristics are similar. With this, he will able to detect five major and fourteen subcomponents of a landuse region at levels one and two classes respectively. The level one composes of field pattern and size, settlement pattern, natural vegetation, transportation and communication network and surface configuration.

Each of these regions was delineated on a separate transparent overlay and finally composited to determine the boundaries of the level of the land us region. His study reveled that much of the land use region conformed to the existing classification, indicating that radar imagery is better than using traditional approach. Besides, the research shows that it is possible to revise an existing land use map with radar imagery. From this however, it is possible that the transparent overlay will not give the actual aerial extent of each land use category due to double counting.

Welch at al, (1975) made use of LANDSAT MSS data of scale 1:600:000 to produce a colour land use map. He used a false colour composite of each scene of the study area at a scale of 1:500,000 projected on to a viewing screen. A transparent overlay by 5mm grids was then placed on top of the colour composite of cell-by-cell interpretation of the land use. Eight categories of land use were employed as a result of the restriction by low spatial resolution of LANDSAT data. These categories which were equivalent to level one of the United State Geological Survey (USGS) scheme are; intensive market garden, intensive field cropland new agricultural land, rivers streams and lakes, bog and marshland and urban or built-up area. It could then conclude that one could obtain some insight into the urban structure of cities using this methodology. In addition, the methodology permits mapping of areas where up-to-date spatial data difficult to obtain.

Brown, (1976) applied the thermal scanning imagery to study the land use classification in Taxas, using the USGS classification system. The scanner was an AAS-18 line scan infrared detecting set with a wavelength range of 8-15mm. Using the thermal infrared imagery of a scale of 1:24,000 and photographic map of a study area, with a scale of 1:25,840, the land use categories on the thermal infrared was delineated. Aeronautic carts and USGS topographic maps of scale 1:24,000 were also consulted. Ten landuse categories were delineated.

The study concluded that the interpretation of thermal infrared imagery requires and understanding of intensity of infrared energy emitted by an object according to its absolute temperature, thermal capacity, texture background and emissivity. The study therefore, reveals that the extraction of land use information from thermal infrared imagery requires more inference than the use of aerial photographs. The implication here is that aerial photographs are better use for land use information studies than thermal infrared imagery.

Collins et al (1971) studied the urban land use in the city of Leeds, U.k using three sets of serial photographs of scale 1:10,000. The aerial photographs covered an extensive area with a dominant land use of commercial, industrial and residential. Also a key of urban landuse was combined using these aerial photographs. A building unit was used as the unit of interpretation for the built-up the area, the function of which had to inferred. The three photographs were then carefully examined under stereoscope in order to become more familiar with the photo images of the various forms in the key of urban land use. They then delineated the land use categories on a transparent overlay from the photographs and details were then transferred directly from the overlay to the map. The research therefore, reveals a high degree of accuracy and achievement. However, greater details could have been revealed if they had made use of level iii classification scheme instead of the level ii they used.

Poulton et al, (1977) made a comparative analysis of 1944 and 1968 aerial photographs to detect land use change and asses causes as they relate to land management in a range and forest land environment in Sierra Nevada, California. Ground data were not available to verify the conditions in 1944 photographs. Therefore only that of 1968 was used. The changes detect were that most meadow site and riparian vegetation have disappeared from the photographs, while encroachment of sage bush and shrub as had occurred. It could therefore be noted that the study does not make use of ground data to verify conditions especially on the 1944 photographs. Besides, the use of only 1968 aerial photographs alone will not allow for a reliable comparison capable of revealing significant landuse change over time period.

Henderson, (1979) also tried to use radar imagery to map the northeastern part of the United States, in this study, the radar imagery used was the wasting house K band imagery at scale 1:225,000 He delineated the study area using the level 1 and 11 land use categories of the USGS system image and the land use of each cell was interpreted with the aid of Bausch and lomb 2407 stereoscope. Base on this interpretation, the land use regions for the study area were delineated. The following are his findings.

1. When his result was compared with the existing land use region classification of the same area, the agreement was poor, indicating

fragmented and complex landscapes of the Northeast United States. This reduces the level of land use details visible in the study area compared to that of Midwest United States. Finally, the forest stands found everywhere in the area – concealed drainage, relief transportation and settlement features.

2. Level 1 category of USGS system was delineated but the analysis of level 11 was difficult. From the study therefore, it can be deduced that he did not terry to delineate the land use region in the area in order to determine the aerial extent of the varouis land use categories.

Synder, (1981) used LANDSAT MSS imagery and other collateral materials to study laden use in part of the Union Soviet Socialist Republic (USSR). Black and white positive prints of LANDSAT imagery at scale 1:500,000 were used. He adopted the land scale approach in this study. in order to device a land scale scheme, a study area of 41 scenes located in USSR given a combined surface area of about 1.4 million square kilometers was used. From the study area, a landscape classification scheme consisting of 30 categories and sub categories of land sue approach delineated regions of uniform landscape elements. From the study, it was found out that much of the USSR was dominated by a single element such as woodland or cropland that is in very large aerial extent that could hardly allow for an effective co-ordination of land use categories and their aerial coverage.

Byrne et al (1980) used the transportation enhancement of multi-temporal data to study land use change detection of Atlanta, United States. They superimposed two LANDSAT data of different dates and treated them as a single-eight dimension data array.

A principal component analysis was carried out by this method; a new set of co-ordinate axis was fitted to imagery, choosing the first new axis as an orientation, wick will minimize the variance accounted for, by that axis. Subsequent ones would account for successive smaller portions of the remaining variance. In this study, the principal component analysis decomposed the four plus channels of correlated MSS data in to eight orthogonal axis. The first and second order component images resulted, which were believed to present on change.

Changes to be anticipated were of two types.

1. Those that would extend over a substantial part of the scene such as changes in atmosphere transmission and soil water states.
2. Those that was restricted to part of the scene such as clearing forest, construction of roads and erection of buildings.

It should therefore be noted that their method of studying land use change detection has been so tedious and requires many approaches.

Lo, (1981) mapped the land use of Hong Kong using the LANDSAT MSS digital computer-assisted approach. What he did was to first examine the LANDSAT MSS of the study are separately for each band analogue form. The study area was delineated on band 5 of the image with reference to the scanning number. The LANDSAT computer compatible tape (CCT) digital data acquired from Eros data center in United States was radiometrically corrected. The delineated study area was extracted from the original data tape and stored in a disc file. To checks if the study area is properly delineated; program called NMAP was run to show the overall pattern of the data at the desired number of bands. This provided the basis for the training data selected for a supervised classification. Landuse scheme of Hong Kong was determined with reference to existing landuse classes were found appropriate they are cropland, grassland and shrub, water features residential mangrove reclaimed land residential/commercial and woodland.

Next, a stat program computes the mean and standard deviations of the pixel values for each band in each training data set. Family "D" class program was run to classify the image of the study area.

This was then transferred to the base map by direct tracing. The study concludes that digital approach to land use change detection using LANDSAT can surely produce reasonable accurate result it should however be noted that the study does not specify the aerial extent covered by each the land use type even though the approach has been able to effectively the land use categories of the study area.

Roger et al (1985) conducted a study to assess quantitative change in the land surface occurring as result of man's activities. Time series analysis of LANDSAT MSS of 1970, 1976 and 1979 covering St. Lawrence valley in Quebec Canada were used to monitor seasonal and long –term variation in the land use and vegetation cover. Global Albedo was the land surface parameter studied three types of land cover were distinguished forest agriculture and allotropic areas. The result shows that deforestation has occurred and there is a significance decrease in farmland and a marked process of urbanization from the result of the research it could be deduce that the researchers did not indicate the method used in their classifications besides comprehensive analysis on land use and vegetation cover as seen on LANDSAT imagery has not been made Henderson (1982) used SEASAT SAR imagery to map the land use in an arid environment of Denver Colorado area of united states a general electric imagery of 100 *0/0* interactive processing system was used to contrast stretch and enlarge the original image data to three scales small (1.500,000) medium (1:131,000) and large (1:40,000) black and white images at all scales were interpreted an automated machine was also carried out the image at largest scale it was found that level I land use classes of the USGS classification system could be delineated from 1;500,000 image for the urban built up area the research therefore reveals that SAR imagery could be processed and use for land change detection effectively.

Hong et al (1982) used a post – classification comparison change detection to study the coastal change in Tokyo Bay of Japan. They used different LANDSAT imagery of 1972 1976 and 1980 what they did was to register the three sets of the imageries using ground controlled points read from 1;50000 scale of topographical map the approach was to classify independently each LANDSAT scene by applying standard procedure of classification the result were overlaid and compared so that area and type of change could be identified the LARSY software package was employed for the land use classification the resultant land use maps were later superimposed two by two to detect change which were indicated by distinctive color.

The study reveals the percentage changes have been for the specific class from one year to the next from the findings of research it could be deduced that no observation has been made in regard to the factors that gave rise to the changes noted however the study is explicit and easy to adopt.

At the local level remote sensing has been use to study land use changes by many interested researchers Adeniyi (1980) use two of aerials photographs of 1962 and 1974 with a scale of 1:400,000 and 1:20,000 respectively covering urban built area, urban open spaces and non-urban areas in Lagos. A landuse classification scheme of nine major landuse categories were residential, commercial, industrial institutional and utilities recreation and open space, non-urban land and water body. A minimum mapping unit of one hectare was used as a basis for interpretation and for subsequent storage into computer. On each model, the built up areas were identified and delineated first and followed by non-urban and open space landuse. The interpretation was done using mirror stereoscope. The interpretation and the field check data were transferred into a base map with the aid of a 200m transfer-scope. A clear acetate sheet with 100mm by 100m width was placed on the map and the data manually encoded and keypunched into a girt before they were transferred to computer tape for processing. A special computer program was written to:

(1) Compare two major land use categories for the two periods on a cell by cell basis.

(2) Produce a land use change map with the drawn plotter. A data band could easily be updated and integrated with other type of data.

(3) Provide information about the location, types and amount of changes.

He came up with the following findings:

(1) That the computer approach was adjudged to be more flexible and desirable for land use detection.

(2) The land use change revealed a rapid increase in the residential land use and a strong lateral expansion of the urban area of Lagos.

Ademola et al (1993). Used remote sensing and Geographic information system (GIS) techniques to map the landuse and the land cover around the Basin of Sokoto River in Northwestern Nigeria. A LANDSAT MSS imagery acquired in 1986 with a scale of 1,125,000 was used. The LANDSAT MSS positive image transparency was interpreted using the PROCOM 2 optical image transparency analysis equipment. 13 landuse and land cover classification categories were delineated. The study revealed that the grass occupied about 37.7% or 13,230.6 hectares of land, which was the largest while the forest wetland accounted for about 0.01% or 2.7 hectares of land and which was the smallest. The study concluded that the visual interpretation of the enhanced LANDSAT MSS data can provide adequate spectral information required for the mapping of landuse and land cover while the A/X sub-system can prove easy analysis and presentation of the maps generated through remote sensing techniques.

Adegbola, (1997) used aerial photographs to detect land use changes in of Kaduna South. He used black and white panchromatic aerials photographs to detect the changes within the study areas over a period of ten years of (1962 - 1972). The land use classification scheme used was the modified USGS land use classification scheme. Image interpretation and classification of the two aerial photographs using mirror stereoscope. The changes for the two periods were calculated from the statistical data generated from the techniques for the 10 years period. A land use change map was also produced on which eight categories of landuse were delineated. From the study, the result revealed a decline of 675 hectares agricultural land, while shrub land category has increased by 14.8%m built-up areas, transportations, wetland and open space also increased by 11.69%, 13.8% 7.3% and 3.8 respectively.

Pandy Nathawat (2006) carried out a study on land use cover mapping of panchkula, Ambala and yamunanger district, hangana state in India. They observed that the heterogenous climate and physiographic conditions in these districts has resulted in the development of different land use land cover in these districts, an evaluation by digital analysis of satellite data indicates that majority of areas in these districts are used for agricultural purpose. The hilly region exhibit fair development of reserved forests. It is inferred that land use land cover pattern in the area are generally controlled by agro climatic conditions, ground water potentials and a host of other factors.

It has been noted over time through series of studies that land sat thematic mapper is adequate for general extensive synoptic coverage of large areas. As a result, this reduses the need for expensive and time consuming ground surveys conducted for validation of data. Generally, satellite imagery is able to provide more frequent data collection on a regular basis unlike aerial photographs which although may provide more geometrically accurate maps, is limited in respect to its extent of coverage and expensive, which means, it is not often used.

Daniel et al. 2002 in their comparison of land use land cover change detection methods, made use of 5 methods viz; traditional post – classification cross tabulation cross correlation analysis, neutral networks, knowledge – based expert system and image segmentation and object – oriented classification.

A combination of direct T1 and T2 change detection as well as post classification analysis was employed. Nine land use land cover classes were selected for analysis. They observed that there are merits to each of the methods examined, and that, at the point of their research, no single approach can solve the land use land cover change defection problem.

Also, Adeniyi and Omojola (1999) in their land use cover change evaluation in Sokoto – Rima basin of North – Western Nigeria based on Archival remote sensing GIS techniques, used aerial photographs, land sat

MSS, SPOT XS/ panchromatic image transparency and Topographic map sheet to study changes in the two dams (Sokoto and Goronyo) between 1962 and 1986. The work revealed that land use land cover of both areas was unchanged before the construction while settlement alone covered most part of the area. How ever during the post-dam era, land use/land cover classes changed but with settlement still remaining the largest.

Authors such as Yang and Lo (2002), Mundia and Anyia (2005), haved conducted land cover classification using unsupervised ISODATA classification algorithm. In Nigeria supervised classification has been used to monitor land use dynamics in South/Western region (Akinyemi 2005), while Ojigi (2006) compared different supervised classification algorithm to monitor landscape changes in Abuja. His findings reveal that the Maximum likelihood algorithm performed better than the other methods used.

The aforementioned case studies have clearly shown that Remote sensing techniques are very effective and time saving for the purpose of monitoring the dynamics of human activities in our environment.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Description of Data

The study was carried out using LandSat ETM+ image acquired on 28TH December 2001(late wet season), LandSat TM acquired on 21st January 1987, SPOT XS image acquired on 3rd December 1994 and LandSat MSS image acquired on 29th January 1976 (dry season). Other ancillary data used includes: Maps (Topographic maps).

3.2 Data Collection Method and Description

Two forms of data would be collected for the course of the research, namely primary data collection and secondary data collection.

a) **Primary Data**: This data would include; Time based satellite images to be sourced for the spatial mapping of urban sprawl in the study area, as well as drafted field questionnaire to sample the opinion of the people on issues related to sprawl(i.e. extent of sprawl, characteristics and direction, and causal factor).

b) **Secondary Data:** This includes demographic data from primary census of 1991 and 2006. Other sources of secondary data will include internet, Journals, textbooks, seminar papers etc.

3.3 Data Analysis

The research methods adopted for this study is purely **quantitative methods:** This involved the usage of Geographic Information Systems data to produce maps of urbanization within the study area. Neighborhood statistic measurements were also used to quantify and display the density and connectivity of patches of new built-up land. The Geographic Information System allowed for reclassification of land cover data into categories appropriate for the purposes of this study: built-up and non-built-up.

3.4 Remote Sensing Data Analysis (Image Processing):

The procedures followed during the image processing phase are used as follows:

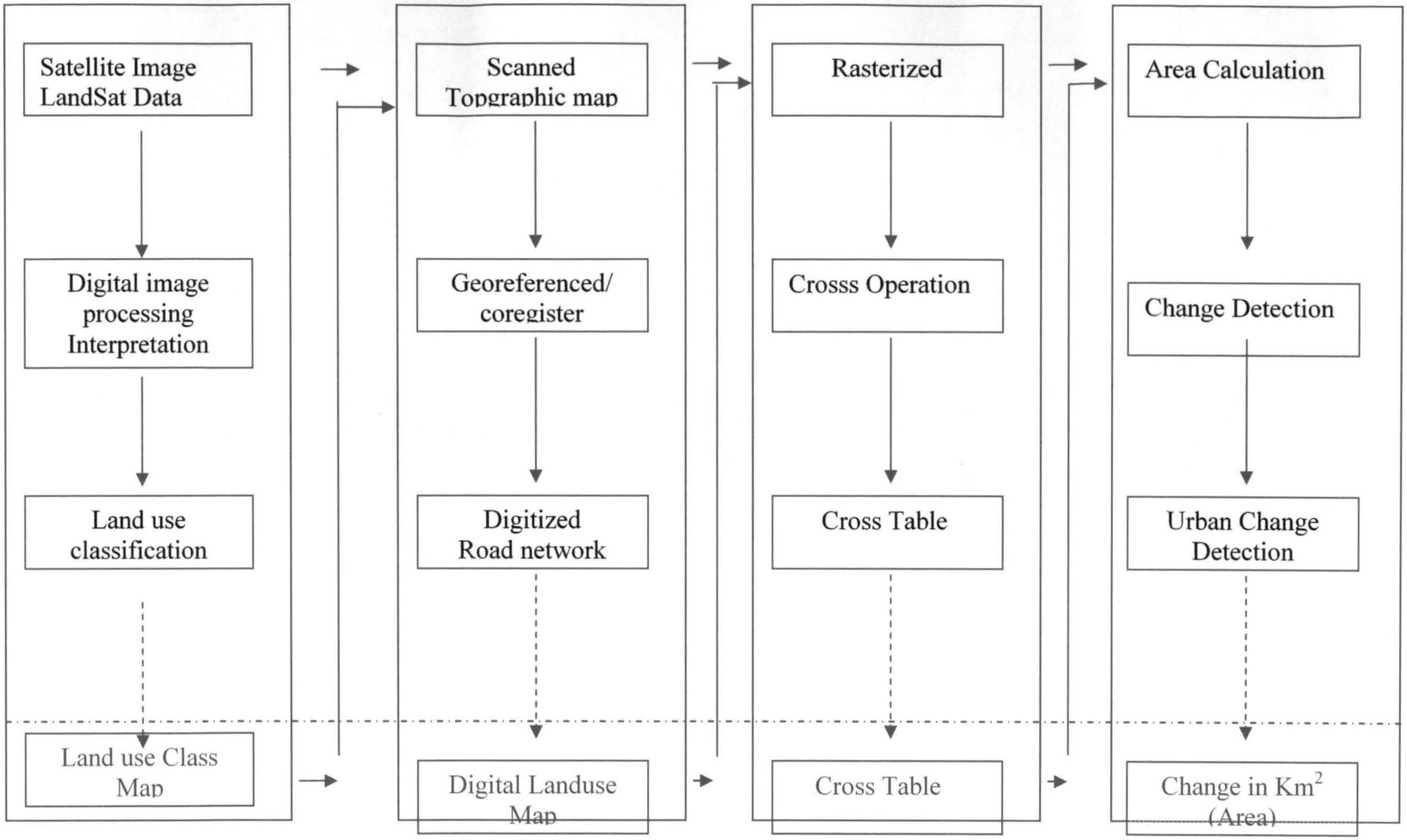
- Pre-processing: Geometric correction and image enhancement
- Image classification (unsupervised and supervised)

3.5 Evaluation and choice of image processing and GIS (Visualization) software

It is important to establish the software to be used and to evaluate the compatibility of the GIS software with the image processing software. In this project context, ArcView 3.2a was chosen as the GIS software and for visualization. IDRISI 32 was chosen as the image processing software because of its compatibility with the ArcView 3.2, ;user-friendly interface.

3.6 **Research Framework**

The following conceptual framework was adapted in the course of this project (see Figure 3.1):



Source: Author's compilation

Fig.3.1: The Diagram of Research Framework

CHAPTER FOUR

DATA PRESENTATION AND DISCUSSION

4.1 Introduction

This chapter presents the analysis of the general level of urban change in the study area between 1976 and 2001. The analysis was done using satellite image data from LandSat MSS of 1976, LandSat TM of 1987, SPOTXS of 1994 and LandSat ETM+ of 2001. First, image sub-sect was carried out contains the FCC. A time series analysis was then carried out to determine the level of urban growth between 1976 and year 2001 in the area.

4.2 Level of Urban Growth 1976-1987

The FCT was designated as the new capital territory of Nigeria in 1976. Land sat MSS image of 1976 with 80 meters spatial resolution was thus used as the based year data to establish the pre FCC development situation in the study area.

The 1976 land use/land cover map shows the preponderance of small-sized built-up areas that portrays the rural setting. The map reveals that there was little or no urban settlement in the area in 1976. Map statistics generated using the statistical function of ArcView show that the area was predominantly rural with 99.71 percent of non built up area(vegetation) (table 4.1). These findings shows that FCT was less developed, agrarian, with small(built-up) rural settlements that cannot be described as urban (see master plan for Abuja, 1979; Mabogunje and Abumere,).

Table 4.1: Land use / land cover change statistics, 1976.

S/N	LAND USE /LAND COVER CLASS	AREA (KM^2)	% OF TOTAL
1	Built – up area	0.145	0.29
2	Non Built – up area	51.267	99.71
	Total Area (Km^2)	51.412	100

The situation in 1976 began to change in 1980 when the construction of the FCC(fig.4.1) and its region commenced. The gradual development activities in the early 1980s culminated into mass construction efforts between 1985 and 1987 the military regime of General Ibrahim Babangida. The early development efforts include the construction of 51 primary Schools and 3,000 housing units within the city proper and about 6,000 units in the nearly satellite settlements (FCDA, 1986).

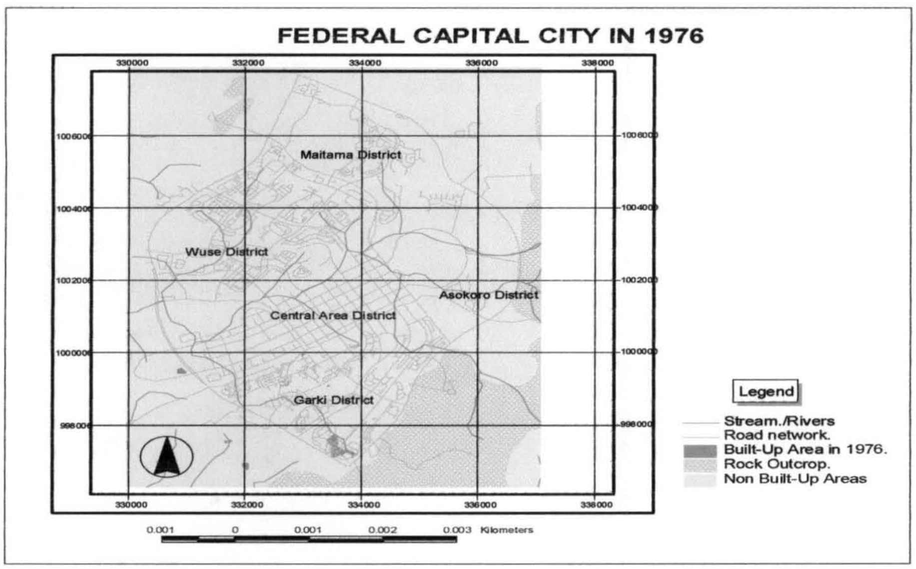


Fig.4.1: The Extent of Urban Built-Up in FCC IN 1976

In order to capture the level of urban growth in the formative fears land sat TM image taken in 1987 was used to assess the situation in the study area after eleven years of construction activities, the image was interpreted and the spectral signature of six major surface features were picked and digitized as polygons and lines..

The land use of 1987 reveals that both minor and major growth had occurred in the area. The map statistics (table 4.2) show that 14.99km^2 (29.16%) of the area was occupied by built-up settlement. while the non built-up areas (vegetation / Agricultural land) occupied 36.422km2 (70.84%).

Table 4.2: Land use /land cover statistics, 1987.

S/N	LAND USE /LAND COVER CLASS	AREA (KM^2)	% OF TOTAL
1	Built – up area	14.99	29.16
2	Non Built – up area	36.422	70.84
	Total Area (Km^2)	51.412	100

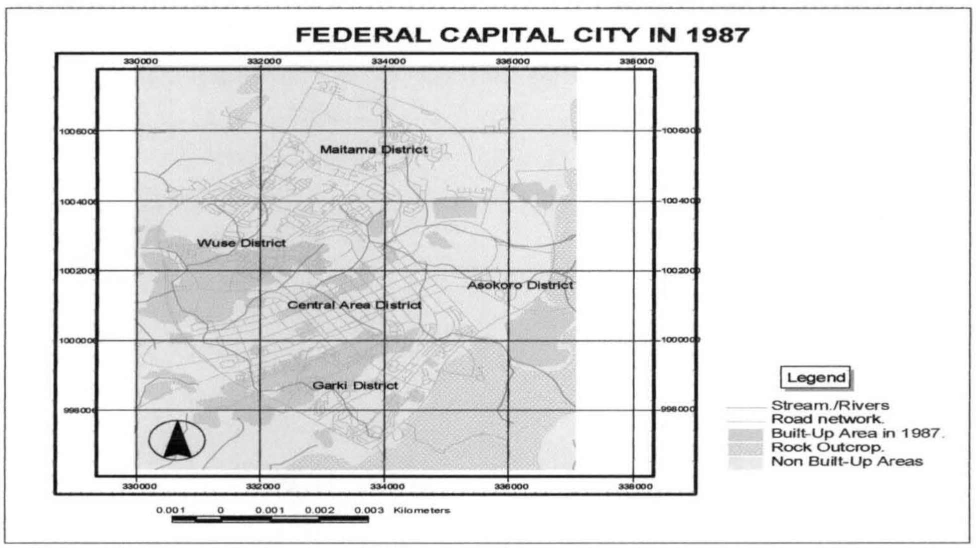


Fig.4.2: The Extent of Urban Built-Up in FCC IN 1987

An idea of change between 1976 and 1987 was analysed by comparing the values in table 4.3. As shown in table 4.2 the built – up area increased by 14.85km^2 (69.88%) while there is decrease in non built-up area. However, the major change n the 1976 – 1987 periods is from vegetation / Agricultural land to settlement (built – up area).

Table 4.3: Land use / land cover change statistics, 1976 – 1987

S/N	Land use /land cover class	Area (Km^2) Length 1976 1987		Increase decrease	Percentage change
1	Built – up area	0.145	14.99	+ 14.85	69.88
4	Non Built – up area	51.267	36.422	-14.845	30.12
	Total Area (Km^2)	51.412			100

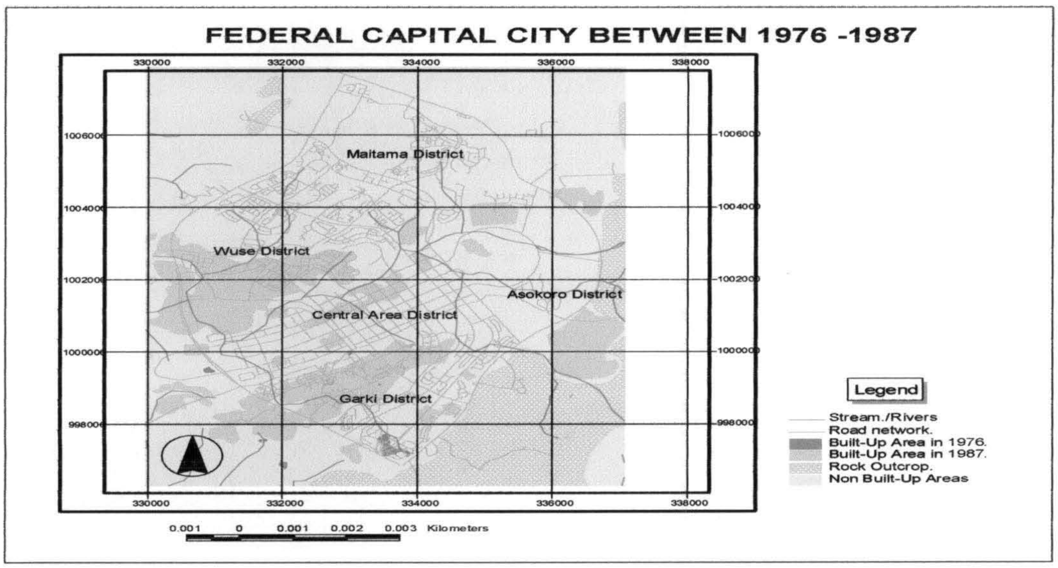


Fig.4.3: The Extent of Urban Built-Up in FCC between 1976 - 1987

Generally, major urban growth occurred in the central part of the study area covering the main land of the municipal Area council Development pattern followed and east – west direction with many of the settlement occupying areas of least resistance as the rocky areas constituted development barriers.

4.3 **Level of Urban Growth, 1987 – 1994.**

The physical development in the FCC and its surroundings continued in the post 1987 period. The 1987 – 1994 periods witnessed mass construction and population influx due to the movement of government's establishment from Lagos to Abuja between 1986 and 1990 and the eventual movement of the seat of the Federal government to Abuja in 1991.

The level of urban growth 1987 – 1994 in the study area was investigated using SPOT XS image taken in 1994. The image was processed and the land use/ land cover map of the area was composed to show the level of urban growth in 1994. It is evident from the map that the FCC has developed further and settlements merging together. The landcover statistics in 1994 (table 4.4) shows that the built – up area covered 38.210km^2, while non built-up area accounted for the remaining 13.202km^2 of land.

Table 4.4: Land use / land cover statistics 1994.

S/N	LAND USE /LAND COVER CLASS	AREA (KM^2)	% OF TOTAL
1	Built – up area	38.210	74.33
2	Non Built – up area	13.202	25.67
	Total Area (Km^2)	51.412	100

In order to analyse the spatial distribution of the land use / land cover change, the developments in 1987 (figure 4.2) were superimposed on those of 1994 (figure 4.3) to produce a composite map (figure 4.4). The change statistics as shown in table 4.4 reveal that the built – up area increased by 23.22km^2 (45.16%). while the non built-up land have decreased by 23.22 (54.84%).

Table 4.5: Land use / Land cover change statistics 1987 – 1994.

S/N	Land use /land cover class	Area (Km^2) Length		Increase decrease	Percentage change
		1987 1994			
1	Built – up area	14.99	38.210	+ 23.22	45.16
2	Non Built – up area	36.422	13.202	-23.22	54.84
	Total Area (Km^2)	51.412			100

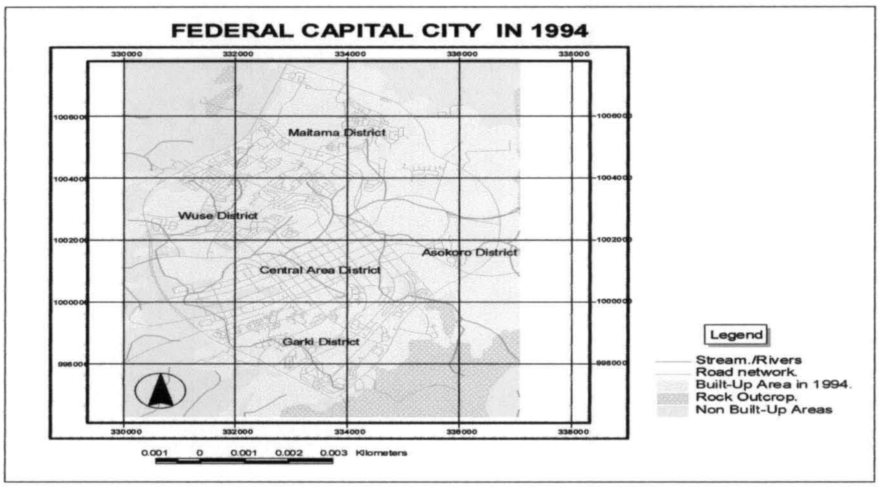


Fig.4.4: The Extent of Urban Built-Up in FCC in 1994

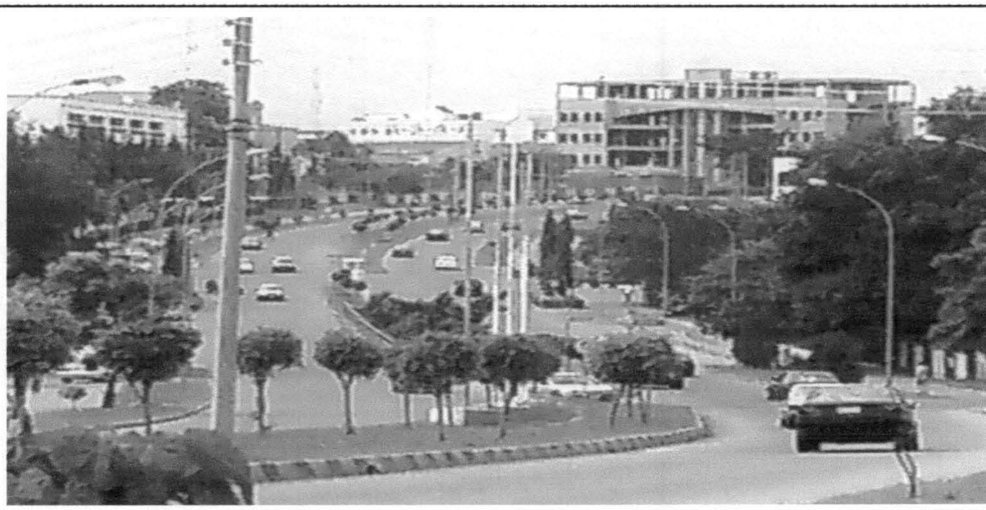


Plate 1: Wuse Zone 5.Wuse District Abuia FCC.

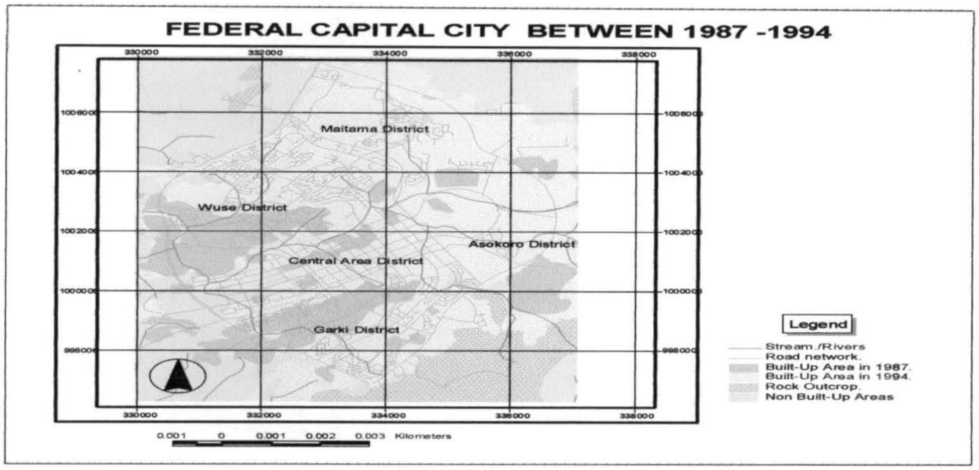


Fig.4.5: The Extent of Urban Built-Up in FCC between 1987 – 1994

4.4 An Assessment of the FCC Phase I Development: 1994 2001.

The 1994 – 2001 periods witnessed the progressive stabilization of the urban growth process in the FCC. The period was characterized by extension of infrastructure such as residential housing, Schools, Clinics, roads etc. by the government and private individuals. Available statistics show that the government's houses had reached 8,842(table 4.6) in 1998 (MFCT, 1998). All these development efforts contributed to urban growth in the study area.

Table 4.6: Summary of Available Housing stock in Abuja,1998.

S/N	**Location**	**No of units**
1	Garki District	4232
2	Wuse District	2436
3	Maitama District	238
4	Asokoro District	346
12	Garki II	240
13	Development Area	1696
	Total	**8,842.**

The stage of Urban growth as at year 2001 was assessed using LandSat ETM+ image with 30 – mete resolution taken December 2001. The processed image result reveals a continuation of urban change in FCC (plate 2). The built – up area had increased by 10.51km^2(95.15%). This brought total built –up area to 48.71 km^2 in 2001 with 2.492 km^2 (4.85%) non built-up area (green area).

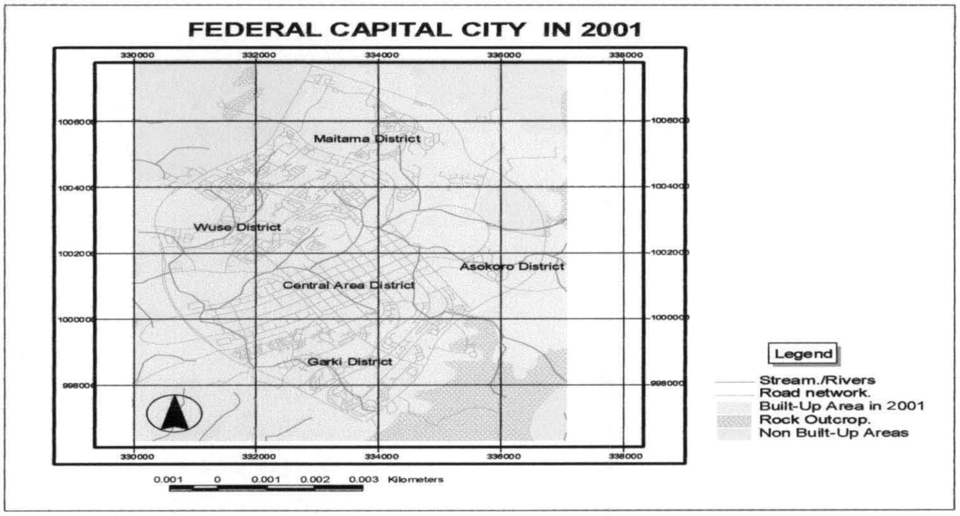


Fig.4.6: The Extent of Urban Built-Up in FCC 2001.

A change detection analysis was done by superimposing the developments in 1994 on those of year 2001 (figure 4.7). The composite map shows the extent of urban change between 1994 and 2001 was revealed.

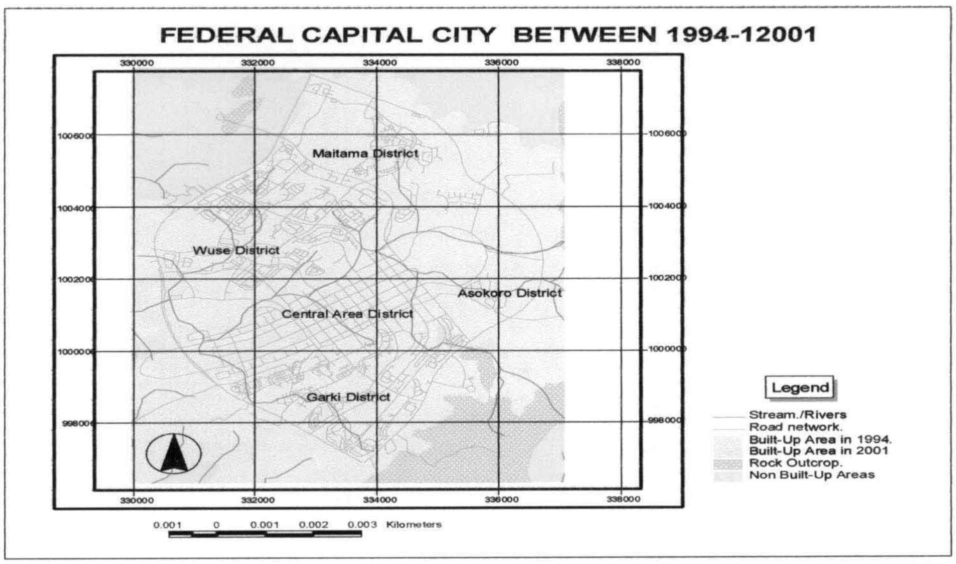


Fig.4.7: The Extent of Urban Built-Up in FCC between 1994 – 2001

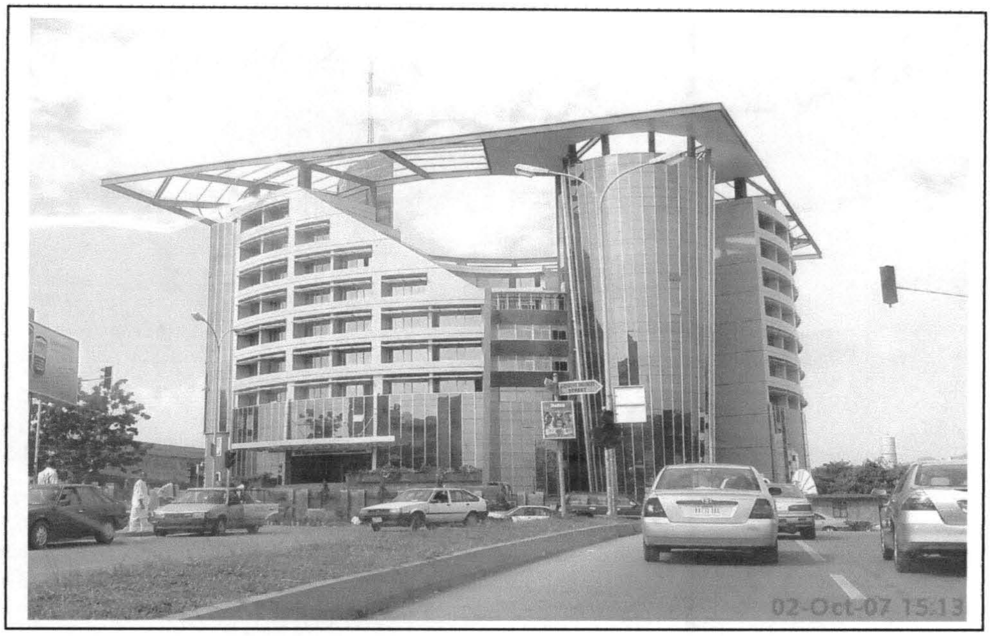


Plate **2**: Magnificent structure located at the Central Area of Abuja FCC.

The above time series analysis reveals that spectacular urban change has occurred in Abuja and its immediate environment in the last two and a half decades. Major Urban change was recorded in the FCC, while accounted for 0.29%, 29.16%, 74.33% and 95.15% of the total built – up area in 1976, 1987, 1994 and 2001 respectively. Indeed, the political decision to construct the FCC has generated physical development influence in the territory. Streams of migrants whose destination was Abuja have continued to populate the nearby satellite settlements because the city could not accommodate them. The increases in population have resulted in physical developments and the eventual growth of these settlements.

CHAPTER FIVE

SUMMARY FINDINDS CONCLUSIONAND RECOMMENDATION

5.1 Summary of Findings

The quantitative results through GIS data collection and analysis, and visual detection of urban change reveals the extent of urbanization processes in Abuja FCC. There is a clear increase in the amount of urban land from 1976 to 2001. The increase in built-up land use was visible and result shows increase in the percentage of urban land. In 1973 - 1987 urban land constituted approximately 0.29% of the study area. In 1987 to 1994, urban land accounted for approximately 29.16% of the study area. In 1994 to 2001, urban land accounted for approximately 95.15% of the study area of FCC. The result of the time sires analysis revealed that urban change has occurred over the last twenty four years. Other findings are summarized below:

1. Results showed that the built-up area FC City expanded at an annual average of 2 km^2. Analysis of the classified map showed that the physical growth of urban area is upsetting the other land cover classes such as farming, water resources, vegetation, etc.
2. The analysis further shows that there is a great decrease in none built – up areas, which could be ascribed to physical construction. The reductions suggest a reduction in the amount of flora and fauna specie in the area. This probably linked to the fact that the rate of reduction of the natural vegetation is not commensurate with the rate at which the vegetation replenishes itself.

3. The analysis also reveal full extent of development in Phase I between 1994 and 2001.This implies that the development is at peak.Hence,might not witness any meaningful expansion over time to come as previously observed.

5.2 Conclusions

This research conceptualized urban change from a geographic perspective in order to assess the spatial distribution of development patterns using Geographic Information Systems. The results, produced using a medium resolution satellite image data, have identified areas built-up areas and non built-up areas such change occurred since 1970s to date.

The methodology can be used in the decision-making process of the selection of areas that need mitigation measures to be adopted which will reduce or even reverse their degrading potential. This study has looked into the possibility of combining remotely-sensed with ancillary data, in order to study the potential urban changes. The results of this research reveal that there is merit to use space technology data in change detection assessment.

5.3 Recommendations

In view of the findings the following recommendation were made:

1. Regular monitoring of dynamic urban changes analyses should be encouraged and evaluation of the influence of the changes in our cities should be used to sensitize our urban managers through capacity building workshop.

2. Urban managers and planners should be encouraged to use Remote Sensing as a monitoring tool. Hence urbanization processes can effectively and efficiently managed.
3. Urban planning processes are highly dependant of data on demorgraphy, changing landuse, urban sprawl and the environment as whole. Hence Remote sensing data such as Satellite imageries with extensive coverage and data integration advantage would be require.

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