POTENTIAL OF USING REMOTE SENSING TO ASSESS ACTUAL LAND USE DEVIATION FROM ABUJA MASTER PLAN: A CASE STUDY OF WUSE 1

BY

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A DISSERTATION SUBMITTED TO SCHOOL OF POST GRADUATE STUDIES FEDERAL UNIVERSITY OF TECHNOLOGY MINNA IN PARTIAL FULFILMENT FOR THE AWARD OF THE MASTERS OF TECHNOLOGY DEGREE IN REMOTE SENSING APPLICATIONS

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THE DEPARTMENT OF GEOGRAPHY, SCHOOL OF SCIENCE AND SCIENCE EDUCATION, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE.

FEBRUARY 2002.

DECLARATION

I hereby declare that this thesis is an effort made by me and has not been submitted in any form for another degree or Diploma at any University or Institution. Informations derived from published and Unpublished materials has been acknowledged in the text.

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CERTIFICATION

This is to certify that this dissertation entitled "Potentials of using remote sensing to assess actual land use deviation from the Abuja master plan: a case study of Wuse1" was undertaken by Akpu, Benedine in the Department of Geography of the School of Science and Science Education Federal University of Technology, Minna and was approved for its contribution to knowledge under the supervision of :

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DEDICATION

This work is dedicated to the "Divine mercy" of our Lord Jesus Christ.

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To God be the Glory.

ABSTRACT

There is a remarkable influx of people into Abuja city in recent times. This population growth is greatly manifested in the deviation from the Abuja master plan, which has necessitated the need to constantly monitor the implementation of the master plan in order to maintain the land use pattern as reflected in the master plan

In this study, the assessment of the potential of remote sensing techniques in monitoring master plan implementation and deviation in Abuja metropolis was carried out using SPOT panchromatic imagery of Abuja and the master plan. The extent of the deviations was calculated.

The study revealed remarkable deviations from the master plan showing great increase of the residential areas which is about 53% of the total area instead of about 38% as contained in the master plan; the green areas show 50% deviation while employment areas and, open space each show 100% deviation. This deviation should be adequately checked, in order to avoid land degradation due to developmental pressures and conflicting uses, which would leave Abuja like "any other Nigerian city". This can adequately be done using remote sensing techniques.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

1.0 INTRODUCTION

1.1 PREVIEW

Land use information is one of the essential tools for almost all urban development efforts. Changes in the use of land are, to a large extent, a reflection of how society responds to socio-economic, institutional and management practices, thereby, providing essential input for an objective evaluation of such practices. Yet, research shows that there is gross inadequacy of land use information in developing countries, especially Nigeria. Consequently, effective planning is made more difficult. The situation is compounded, partly due to lack of appropriate methodology to acquire background information to aid the decision makers as well as the urban planners.

Fortunately, a number of studies, especially in North America and Europe, have within the last three decades shown that remote sensing has great potential to provide cost-effective, timely, and efficient information on land use changes. In contrast, the application of remote sensing in Nigeria is limited.

Land use refers to the purpose the land serves such as recreation, agriculture or wildlife habit. Sabins (1999) defined land use as "the description of how a parcel of land is used such as for agriculture, residences or industry". According to him, accurate and current information on land use is important for many planning activities.

The use to which the various parcels of the land in Abuja Metropolis should be put was well planned and spelt out in the Master plan and development is expected to be directed towards it. This calls for the need to define "Master plan" at this juncture.

Ratcliffe (1981), defined 'planning' as "the making of on orderly sequence of action that will lead to the achievement of stated goal(s)". According to him, town planning has been variously described as "the art and science of ordering the use of land and siting of buildings and communication routes so as to secure the maximum practicable degree of economy, convenience and beauty" and an attempt to formulate the principles that should guide us in creating a civilized physical background for human life whose main impetus is foreseeing and guiding change". In other words, it is concerned with providing the right site, at the night time, in the night place for the night people.

Master plans serve as useful tools for desirable development of the urban areas. Masterplanning include all planning activities and its main aim is to present a comprehensive frame work to guide landuse changes (Marsh, 1991).

Due to the influx of people coupled with inadequate monitoring strategies, the land use of Abuja has drastically changed resulting in deviation from the original master plan and hence, conflicting uses of the land. The socio-economic and physical problems that characterise such unguarded rapid urbanisation manifest in uncontrolled urban

sprawl, development of slum, inadequate recreational open spaces, poor circulation which impede movement (both human and vehicle); unemployment, crime,inadequate housing etc.

Remote sensing is the science of acquiring, processing and interpreting images and related data, obtained from aircraft and satellites which record the interaction between matter and electromagnetic radiation. Remote sensing provides information on a wide range of topics which include land use, the global environment, renewable and non-renewable resources, natural hazard and geology (Sabins, 1999)

For quite sometime now, Abuja has been a scintillating source of pride, not only to Nigerians but also to Europeans who have been migrating from the country's many troubled spots & crises-ridden states to find a safe haven in it . But Abuja seems to be falling apart and may be soon, the centre may no longer hold. Perhaps, few years ago, one could write of Abuja as beautiful as a peacock. A walk in the night testified to this. The streetlight and interconnectivity of the landscape made Abuja an enduring monument in the subconscious. The roads are wide and "un-Nigerian;" the under bridges never housed lunatics or lay-abouts neither do the "molue" - like buses find a space.

The vegetation was as green as pear, and the flowers were well tended. New trees replaced the aged and fresh network of roads opened up once forsaken hinterland.

But presently, the story of Abuja is different. The city is growing away or deviating from the original Master plan. The city centre now

hosts fields of garbage which were not anticipated by the planners. The city's major means of transport is now motorbikes. Hawkers now dot the city coupled with the increasing number of beggers and compounded by the uncountable number of illegal structures that sprout up daily. Abuja's new reputation as just another Nigerian city seems real. Perhaps before long, if not directed or controlled, Abuja, Nigeria's most beautiful city may turn into another jungle that may further prop up the odd image of Nigeria's cities as a pack of irredeemable filthy cacophonic shanties.

It is in the light of the above problems that this study seeks to assess the land use change as a consequence of deviation from the master plan and the application of remote sensing techniques in tacking the problem.

1.2 STATEMENT OF RESEARCH PROBLEM

As a result of the influx of people into Abuja, the population has greatly increased and continues to increase. The rate of increase became even quite alarming following the various ethnic and religious crises in various parts of the country. As a result of this and other reasons, the land use pattern has drastically deviated from the original "Master plan". The areas originally allotted for education, recreation, shopping, open space etc are no longer put into such uses. The consequences of which are land use abuses, developmental pressure and conflicting uses. This calls for the need to constantly monitor the land use using Remote sensing techniques so as to plan and control the ever increasing

population. This would help to maintain to a greater extent, the land use pattern as reflected in the original master plan.

If this research is not carried out and the results implemented, the deviation from the master plan would continue, the result of which would be land degradation due to developmental pressures and conflicting uses. Consequently, the questions pursued in this study include among others.

a. What is the land use pattern for Abuja (Wuse 1) as laid down in the master plan?

b. To what extent has the present land use in Abuja (Wuse 1) deviated from the master plan?

c. What are the causes and consequences of such deviation?

d. How can remote sensing techniques be used in monitoring land use so as to channel it towards conforming with the master plan?

The answers to these and other questions would aid in the discovery of the land use changes as a consequence of deviation from the Abuja master plan; the laid down land use plan for Abuja and also indicate how Remote Sensing techniques can be used in solving the problem.

1.3 AIMS AND OBJECTIVES

The research aims at the assessment of the potential of remote sensing technique in monitoring master plan implementation and deviation in Abuja metropolis (Wuse 1).

In the bid to achieve this aim, the following objectives are pursued.

a. To identify the causes and consequences of land use changes.

b. To assess the relationship between the land use of Abuja (Wuse 1) and the master plan specifications using remote sensing techniques.

c. To proffer possible suggestions for further research.

1.4 JUSTIFICATION FOR THE STUDY

This study would aid planners in planning for sustainable management and development of Abuja. The study would also assist researchers that are investigating other similar issues so as to relate the findings in this work to theirs.

Furthermore, this study would aid the government in resource allocation and distribution of social amenities in Abuja for effective management. In addition, the research would proffer possible steps to be taken for further research.

Finally, the research would aid in the creation of civilised physical background that is convenient for the inhabitants as well as visitors since traffic congestion and other problems would be controlled.

1.5 SCOPE AND LIMITATION OF THE STUDY

This study would be limited to Wuse 1 due to time constraint and for a more indepth study of the area.

The limitations of this study include among others.

Financial Constraint – The cost of purchasing the data required, processing them into information as well as the cost of movement and other contingencies is very high.

Time constraint – A lot of time is taken to go for and acquire the data, process and to put the materials together.

One other major limitation of this research is the non availability of adequately recent data and when found, it is very expensive.

1.6 THE STUDY AREA

Abuja is a "neutral city" and a centrally located capital of the most populous black nation in the world (Nigeria). It possessed unquantifiable potentials for greatness. Abuja was set up about 25 years ago.

The idea which led to the rise of Abuja was conceived on August 9, 1975 by the then Head of State, Murtala Mohammed who set a seven-man panel led by the late Justice Akinola Aguda to examine the dual role of Lagos as a state capital and advise on the desirability of an alternative location. The city was budgeted to have 25,498 hectares of land which was to be developed in three phases. The seat of government was formerly and finally moved from Lagos to Abuja on 12th December, 1991 by General Ibrahim Babangida's regime.

The Federal Capital Territory (Abuja) covers an areas of 8,000 square kilometers which makes it more than twice the area of Lagos State. The vast land, according to Aguda panel was considered necessary so as to allow room for the capital city as well as city region that will provide most of the needs of the city including water, forestry, industrial,

agricultural, open spaces, defence, air transport etc.

Presently, the Federal Capital city (FCC) is planned to cover an area of about 250sq. km while the rest of the territory of the city region covers about 7,750sq. km.

Abuja was carved out from three states namely, Niger State which contributed seventy-nine percent of the land area and seventy-one percent of the indigenous population; Nassarawa state which contributed sixteen percent of land area and twenty-one percent of the indigenous population and Kogi state which made a contribution of five per cent land area and eight per cent indigenous population.

It is important to note that until the creation of the Federal Capital Territory (FCT), the area was among the least developed in the country. Things are now changing at a pace hardly marched by any other part of the country. This calls for continuous monitoring and using remote sensing techniques may be the most ideal.

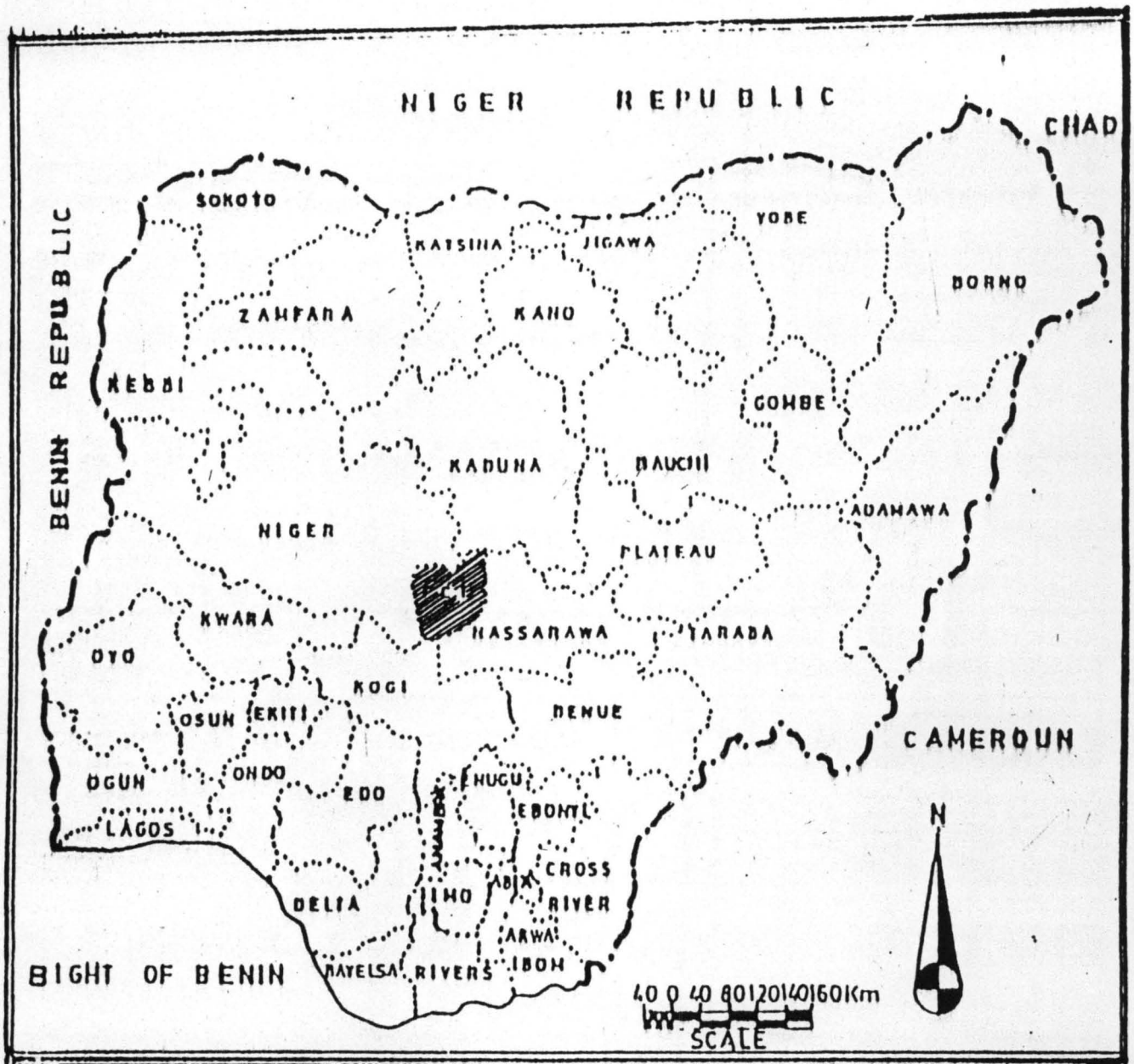

FIGURE 1.1 MAP OF NIGERIA SHOWING F.C.T.

SOURCE: OMOTAYO 2002

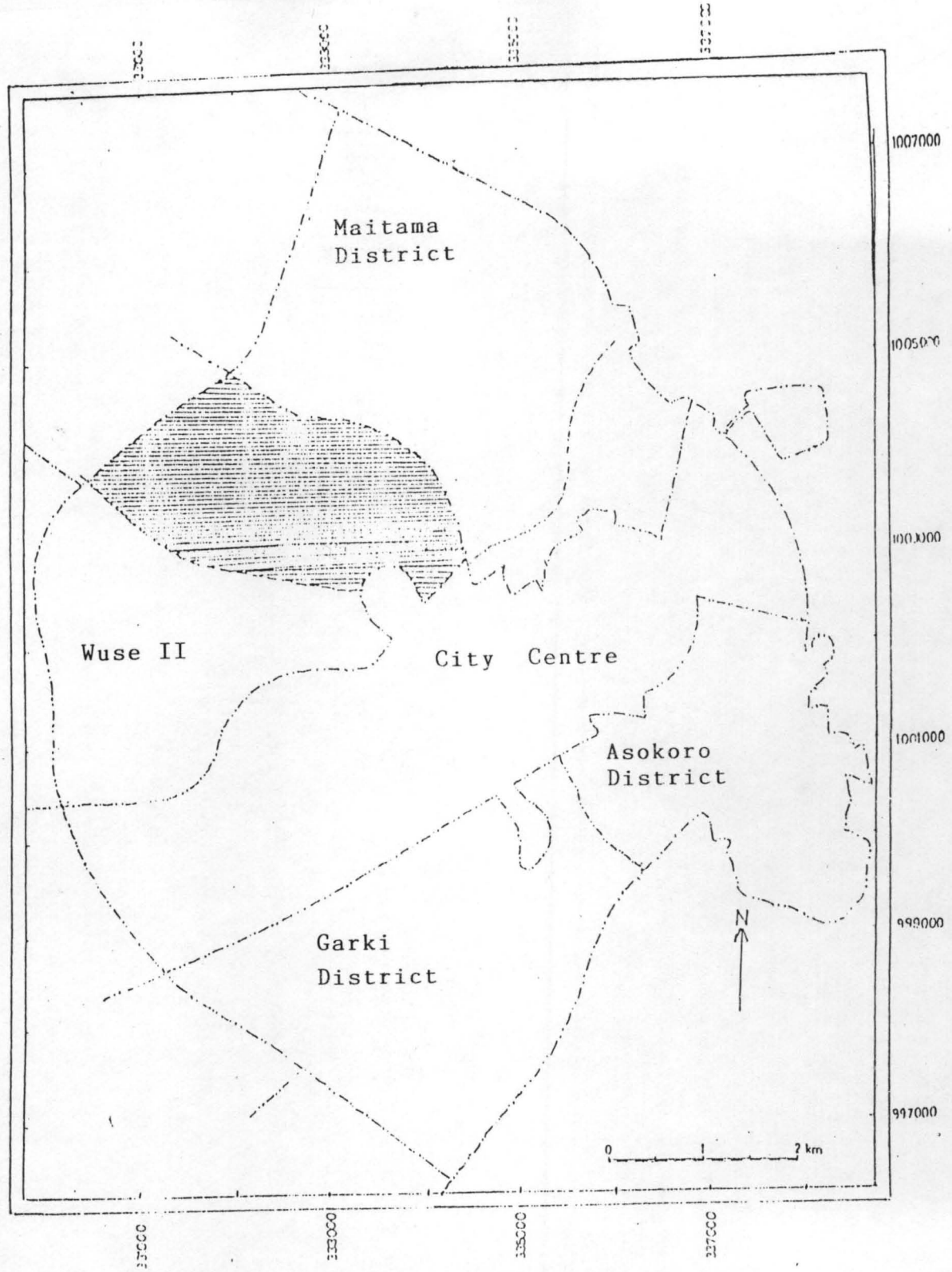

FIGURE 1·2 MAP OF PHASE I

KEY

The study Area.

SOURCE: FCDA

1.6.1. PHYSICAL SETTING

1.6.1 **RELIEF:** The lowest elevation in the Federal Capital Territory is located in the extreme south-west where the floodplain of the river Guraja is at an elevation of about 70m above sea level. From there, the land rises irregularly eastwards, northwards and north-west wards. The highest part of the territory is in the northeast with the existence of many peaks over 760m above sea level. Hills occur either as Clusters or long ranges. The most prominent ones include: the Gawa range in the north-east, the Gurfata range southwest of Suleja, the Bwari-Aso range in the north-east the Idon Kasa range northwest of Kuje and the Wuna range north of Gwagwalada. There are many roundish isolated hills called Inselbengs in other areas. Extensive plains are found inbeteeen the major hills most importantly area the Gwagwa plains, the Iku-Gurara plains, the Robo plains and the Rubochi plains. Indeed, about fifty two per cent of the Federal Capital Territory consists of plains, out of which the Gwagwa plain was selected for the building of the Federal Capital City (FCC).

1.6.1.2 **CLIMATE:-** Abuja has two main seasons that is wet (April to October) and dry (November to March). The high altitude and undulating terrain of the area regulates the weather.

During the dry season, the temperature varies between 30^0C in the northwest to about 37^0C in the southwest. This period is characterised by high diurnal ranges which may be as high as 17^0C. Temperatures drop considerably during the rainy season resulting from the dense cloud

cover. The diurnal range also drop to about 7^0C especially between July and August. The relative humidity in the dry season is about 20 per cent in the afternoon at higher elevations and at more northern locations but about 30 per cent in the extreme south. This low relative humidity coupled with the high afternoon temperatures account for the desiccating effect of the dry season also marked by the presence of the harmattan haze. During the rainy season, the afternoon relative humidity rises to above fifty per cent everywhere. For maximum human comfort, the northern locations are better especially the northwest. The extreme south is uncomfortably hot.

Rainfall in the FCT starts from about March in the southern most part of the territory and about April in the northern limits. The rainfall of Abuja shows very high seasonal fluctuation. The annual range is in the order of 1,100mm to 1,600mm. The rain ends around October in the Northern parts and extends to around November in the extreme south. The Federal Capital Territory (FCT) is located on the windward side of the Jos Plateau . This favours the higher rainfall total as one moves northwards from the south and this is rather strange as rainfall decreases from the south to the north. As a result, FCT receives more rain than areas on the same or even more southerly latitudes.

One important feature of weather in the Territory is the frequent occurrence of disturbance or line squalls. This is a weather condition characterized by the occurrence of dense, dark, cumulonimbus clouds with thunder and lighting, followed by strong winds and rainfall of very

high intensity which may last for up to half an hour and then followed by drizzle for several hours. The weather condition is then replaced by a few days of bright, clear skies. The phenomenon is associated with high connective activity aided by relief effects. It is most common in the late afternoons at the beginning and end of the rainy seasons and often causes serious damage to buildings.

Another noticeable weather phenomenon within Abuja is associated with the presence of isolated hills. These exert an influence on local weather as they trigger off conventional activity giving rise to intense relief rain in their immediate surrounding.

1.6.1.3 **SOILS AND VEGETATION:** The soils of Abuja are generally shallow and sandy in nature especially on the major plains like Iku-Gurara, Robo and Rubochi. The high sand content makes the soils to be highly erodible and the shallow depths is a reflection of the presence of stony lower horizons. Those on the Gwagwa plains are however, deep and Calyey, perhaps due to the influence of the parent materials like gabbro and fine to medium textured biotite ganite. As a result, the soils of Gwagwa plains are the most fertile and productive. They are also more ideal for urban development due to their being more or less from exposed interfluve summits.

Abuja falls within the guinea Savannah vegetation zone of Nigeria. However, patches of rain forest making up about 7.4 per cent of the total mass of vegetation occur in the Gwagwa plains, especially in the gullied terrain to the south and rugged south-eastern parts of the

territory. Patches of the rain forest contain trees such as Antiris Africana, Anthocleista noblis, ceiba pentandra, cola gigentea, chlorophoia excels, Khaya grandirolia terminalia superb, piptadenianum africana, lophina alata and Dracaena arborea. The dominant vegetation of the territory is classified into three savannah types thus:

a. Park or Grassy savannah – This occupies about fifty-three per cent of the total area of the FCT. This is annual in nature with only a few trees among the grasses, namely, Albiza, Zygia, Butrospermum paradoxum, Daniella Oliveris and Parkia elappertoniana.

b. Savannah woodland – This covers about 12.85 per cent of the total area and occurs mainly in the rugged and less accessible parts of the territory especially in the Gurara, Robo and Rubochi plains and surrounding hills. The commonest tree species found include Afzela africana, Anogeissus leicarpus, Buttyroscarpus paradoxum and Daniellia Oliveri,

c. Shrub savannah – This occurs extensively in rough terrain close to hills and ridges in all parts of the territory and cover about 12.9 per cent of the total areas. The species composition varies extensively.

1.6.2 POPULATION AND SETTLEMENT

Based on the 1991 population census report (provisional figures), the population of Federal Capital Territory was 378,671 and projected at over half a million by the year 2000. However, it was only 170,575 by 1981.

Table 1.1 below shows this. A 1984 survey shows that this population was then predominantly Gwari though Bassa ethnic group was also fairly represented.

Table 1.1 Population of the Federal Capital Territory (1981 – 1999)

S/No	Council Area	1981	1991	1999 (Projected)
1	Abaji	18,545	23,647	32,264
2	Gwagwalada (and Kwali)	39,865	80,841	110,637
3	Kuje	29,265	61,329	83,933
4	Municipal (and Bwari)	72,900	212,854	291,305
	Total	170,575	378,671	575,238

Sources: For 1981, University of Ibadan consultancy (1984); for 1991, Federal Republic of Nigeria 1991 National population census (from Abumere, 1993) while figure for 1999 is projected based on annual growth rate of 4.0% for the FCT.

Analysis of the 1991 National population census data of the Federal Capital Territory (FCT) shows a somewhat equitable distribution of the population among six out of the main age groups (that is, 6-9, 10-14, 15-19, 20-24, 25-29, 30-34, 35-39), with each making up about ten per cent of the entire population of the territory. Three other age groups (that is, 40-44, 45-49, 50 and above) each constitutes about five per cent of the total population of the territory. Findings further shows that

literacy rate is higher among the former groups suggesting that those of ages between six and thirty-nine are relatively better educated. Results also shows that as at 1991, of the estimated active working population of about 122, 265, about fifteen per cent each were engaged in professional and technical – related sales and service works. About six per cent each belong to the production and agricultural sectors respectively.

Such distributional characteristics of the population is expected to have been greatly distorted following the influx of people, especially after the 1991 formal movement of the nation's seat of power to the territory. It is difficult for this to be ascertained now due to the absence of another census since that of 1991.

1.6.2.1 URBAN AND RURAL DEVELOPMENT AND PATTERN OF HUMAN SETTLEMENT

No settlement in FCT could be described as a town by 1981 since none had a population close to 5,000 talk less of 20,000. The settlement that had populations remotely approaching this were Karu, Abaji and Gwagwalada with populations of 4,125; 3,360 and 2,395 respectively. Today, a few settlements may be described as urban in as much as they have population of 20,000 or more. These include the Federal Capital City (FCC), Gwagwalada, Abaji and Nyanya/Karu. Others include kwali, Bwari,Rubochi, Karshi, Kuje, Gwagwa and Karmo. It should naturally be expected that as urbanisation intensifies in the territory, there would be an escalation of urban crises (slums, insecurity waste accumulation etc).

Rural development in FCT hinges to a large extent on agriculture which is the main occupation of the inhabitants of the area. Fortunately, the climate of the territory is quite favourable for agriculture. The FCT Agricultural Development programme (ADP) which was created in 1989 is basically involved in rural transformation in the territory especially through enhanced farming activities and provision of rural infrastructure.

1.6.3 NATURAL RESOURCES AND DEVELOPMENT

Agriculture, Forestry and other Basic Economic Activities. Ecologically, FCT is a transition area between the grassland zone to the north and the forest zone to the south. The area therefore, shares some of the characteristics of both the forest and Savannah (grassland) zones with the potentials to produce both forest root crops and tubers like yams and cassava as well as Savannah crops like grains and cereals.

There is high agricultural potential in the FCT and this can be seen not only by the current level of food crop production even with rudimentary methods, but also by the great variety of crops which can be sustained such as roots and tubers (yam), legumes (groundnut and Cowpea), grains (maize, sorghum and rice), seeds and nuts (melon seeds and benni seed), animal products (goat, cattle, sheep), fruits and vegetables. Many of these crops can provide the raw materials needed by several agro-based and agro-allied industries in the territory.

Despite the tremendous urban growth being experienced by FCT, agriculture has still remained the major occupation of many of its residents, especially the indigenous ones. In fact, about sixty per cent of the territory's land had been allocated to agriculture and forestry by the master plan.

In addition, the territory has about twenty forest reserves, specifically designed to ensure getting as much as possible, the positive benefits of tree and non-tree components of the ecosystem. Forest products include sawn-timers, paper, wood pulp and firewood.

Beside agriculture, residents of the territory are actively engaged in

various economic activities ranging from office work through trading service oriented activities to small scale industrial activities and women are highly involved in these activities.

1.6.3.1 **Mineral Resources:** There are varied mineral resources in the FCT which are of high quality and have potentials for both the domestic and export markets. The following are some examples of the minerals and their various applications:

a. Marble: Marble is perhaps the mineral with the greatest known quantity in the FCT. Marble deposits around the village of Burum alone are more than seven million tons and its quality is discovered to be excellent. Marble deposit is also found in the village of Kusaki, Kenada, Taka Lafia and Ele. These marble deposits are very important and will form an important aspect of the economic development of the Territory in future.

b. Tin Deposit: some deposits of tin are found in the FCT mainly around the village of Kusaki, northeast of Kuje district and somewhat also, northeast of FCT.

c. Stones: The stones are mainly granitic rocks found all over the territory and may be utilised as industrial materials – mica and talc schists or as rocks that will be useful as building materials.

d. Clay: Red clays that are suitable for house construction and bricks making are found in places like Izom, Dangara, Shenagu, Gwagwa, Karu and Kobo. Ceramic clays are also available in places like Rubochi, Yaba and Bwari.

For many of the minerals no detailed studies have yet been carried out to determine the extent of their availability and whether they are worth exploiting.

Numerous raw materials with various uses could be sourced for in the FCT. The table below illustrates this:

Table 1.2 RAW MATERIALS IN FCT AND THEIR USES

No	Types of Industry	Demand Prospects	Available Raw Materials	Products/Goods	Existing/ Suggested Location
1	Agro-Based	Very high	Maize, Sorghun, Soya bean, Banna and Cassava	Wood Industries, Beverages, Cement, Fish and Meat	Idu Industrial Estate, Kuje, Gwagwalada, Gwagwa, Bwari, Gurara, Usman, Giri
2	Agro-Allied	Very high	From Petrochemical plant in Kaduna, Iron and Steel	Fertilizer, Insecticide, Weed-killers, Machinery and Equipment	Areas outside the satellite towns, because the industries for the products produce some toxic materails
3	Construction	Very high	Clay, Limestone, sand & marble	Burnt Brick, titles, Sanitary ware, Polish stones, marble concrete blocks & ceremics	Izom, Bwari, Gwagwalada, Rubochi, Kasaki, Karshi, Yaba, Abaji, Kuje
4	Furniture	Very high	Wood Resources to support furniture industry	Furniture	Abaji
5	Service	Very high	Primary and secondary sectors, Human Resources and funds	Agriculture, Livestock, Forestry, fishing, Mining, Manufac-turing, Utilities, Building & Construction, Wholesale and Retail Trade, Transport and Communication, Government Service	Abaji, Gawu, Gwagwalada, Rubochi, Gwagwa, Burum, Bwari, Gurara, Yaba, Municipal Mpape, Idu, Gaube
6	Paper	High	Wood can be acquired from Edo State and some parts of the city.	Books, papers and toilet rolls	Idu, Municipal, Gwagwalada and Abaji
7	Electronics	Low	Over 90 per cent of the components can be imported	Radio, TV, Computers, Calculators, video, refrigerators, Transformers, Fans etc.	Idu, Gwagwalada and Federal Capital city FCC
8	Synthetic	Very high	From Kaduna Refinery	Rugs, Tanneries, saw mills, paints, types plasties	Idu, Gwagwalada and FCC

Source: Federal Capital Territory by Abubakar et al (2000)

1.7 ORGANISATION OF THE THESIS

This thesis consists of five chapters. Chapter one is the introduction to the researcn work. In chapter two, the related literature that could be laid hands on were reviewed. Chapter three concerns discussion on the methodology employed in data collection and analysis. In chapter four, the analysis of the data was carried out as well as discussions concerning it while the work was summarised, conclusions made and recommendations were put up in chapter five.

CHAPTER TWO

LITERATURE REVIEW

2.1 REMOTE SENSING TECHNOLOGY

Man is a universal being. Though he belongs to the biosphere, he is highly dependent on the atmosphere, hydrosphere, lithosphere, and even the biosphere. Man relies on environmental resources for survival but some of these resources are exhaustible, hence, the need for their management and conservation. In order to adequately manage the quality and quantity of these environmental resources, different types of informations are required. One way of obtaining such vital informations is from space and one of such tools is known as REMOTE SENSING. This leads to the question: What is remote sensing?

Remote sensing has been defined by various authors in different forms but with some features in common, which include obtaining information about an object at a distance from it.

Remote sensing is the science of deriving information about an object from measurements made at a distance from the object (that is, without coming in contact with it). The quantity most frequently measured in today's remote sensing systems is the electromagnetic energy emanating from the object of the interest (Swain and Davis, 1978).

Sabins, (1999), defined remote sensing as the science of acquiring, processing and interpreting images and related data obtained from aircrafts and satellites that records the interaction between matter and electromagnetic radiation. He further explained that remote sensing refers to methods that make use of electromagnetic energy such as light, heat and radio waves as the means of detecting and measuring target characteristics. Remote sensing does not include geophysical methods like electrical, magnetic and gravity surveys that measure force fields rather than electromagnetic radiation.

Remote sensing is not a new technology. For man has been ascending above the earth decades before now in order to observe it from a distance and thereby, learn more about it. Area photography has been used extensively for this purpose. A sophisticated technology has emanated over the years, which uses photographic sensors for remote sensing (Swain and Davis, 1978). They explained further that the recent development of satellite carrying earth observational sensor systems has provided large quantities of data (photographic and other forms) concerning the earth surface, which has the capability of assisting in solving various human problems. Such problems include relieving critical food shortages; monitoring and controlling environmental pollution; augmenting declining supplies of natural

resources and planning the orderly growth of cities. In the light of these, satellite data are of great importance to man in as much as they can be transformed into useful information quickly and economically.

Aerial photography, being the initial form of remote sensing, has been used to discover many oil wells and mineral deposits since its inception in early 1800s. This implies that if all these could be derived using only the visible region of the spectrum, more could be discovered using other wavelength regions. In 1960s, the technology was developed to obtain images in the infrared (IR) and microwave regions thereby expanding the scope and application of remote sensing. The development and allocation of manned and unmanned earth satellite started in the 1960s. With the exception of aerial photograph, most remote sensing data are obtained in digital format and processed by computers to produce images to be interpreted (Sabins, 1999).

Swain and Davis (1978), asserted that many of the early techniques used in remote sensing were developed for military reconnaissance during both the first and second world wars. Shortly after, the need to apply these methods to the solution of peacetime problems became obvious. Civil engineers were among the first to used remote sensing for non-military purposes early in the preceding

century as a means for surveying and mapping. The United States Department of Agriculture commenced the nationwide use of aerial photography for soil surveying in 1930s. The use of human interpreter to analyse photographs obtained from airborne cameras was well established by the 1940s.

Swain and Davis (1978), explained further that presently two major branches of remote sensing can be identified, that is:

(a) Image oriented- those that are based on pictorial aspects of the data and uses analysis, which rely heavily on the generation of an image;

(b) Numerically oriented- this results directly from the development of the computer and it emphasises the quantitative parts of the data, treating the data abstractly as a collection of measurements. In this case, an image is seen as a convenient mechanism for viewing the data.

2.2 REMOTE SENSING AND NIGERIAN DEVELOPMENT

According to Fred Holye (1948) a British astrophysicist, wrote that "...Once a photograph of the earth, taken from the outside is available. Once the shear isolation of the earth becomes plain a new idea as powerful as any in history would be let loose"(in Abiodun 2000). His prediction has become a reality for long. Earth observation systems now in operation and those planned for the future, include a variety of satellites and high resolution sensor systems meant for collecting data for use in such activities as meteorological observations, earth resources surveys and management, environmental assessment, coastal studies, marine observations, disaster mitigation, national security and various civil works. On-going demonstration and operational projects on the application of different aspects of space technology to food security, forestry and water resources assessment, fisheries and marine resources, mitigation of natural and

anthropogenic disasters, environmental pollution control, communications and information exchange, education and health-care and transportation are a clear evidence of the contribution of the technology in meeting human development needs. Inspite of this realization, only very limited number of African countries such as Egypt, Morocco and South Africa are moving ahead, while there is the possibility of a renewed commitment in Nigeria.

One may ask this question why should Nigeria utilize remote sensing and what should be the manner of this utilization?

The contribution of remote sensing together with other tools like Geographic informal systems (GIS) and Global positioning systems (GPS) to mineral exploration in Nigeria like other African countries by foreign companies would one day, be a past story, albeit, in the positive. Also, there are a number of problems that are peculiar to the tropical world including Nigeria for which these technologies can make great contributions to their solution. For instance, Africa needs an understanding of its ever-present tropical clouds, their formation and their characteristics as well as the extent and distribution of her natural resources. To achieve this, the microwave technology is important. This also helps for the determination of stratified atmospheric composition, temperature and humility. These elements are needed for accurate weather forecasting and if necessary cloud

seeding, particularly for the benefit of African farmers. Nigerian formers are not exceptions.

Remote sensing can play the following roles in the management of Nigeria's natural resources and environment.

(a) Agriculture, forestry and water resources:

Remote sensing is one of the most practical tools that can be applied to take the challenges of boosting sustainable food production and of assessing the extent and rates of desertification and deforestation which have had an impact on both crop and livestock production in Nigeria. Presently, reliable space acquired multi-temporal and multi-spectral data are being used globally to up-date inventories of agricultural resources through the production of relevant maps and charts on water resources, soil characteristics, land-use practices and deforestations. Copious data on most of Africa's territory have been acquired over the years by the several satellites and capable African scientists are ready to make good use of such data in the interest of their own countries and the continent at large.

(b) Fisheries and marine resources: Presently, a number of space-faring countries are using several aspects of space technology such as the coastal zone color scanner (CZCS) on board NASA's Nibus satellites and the sensors on board the European space Agency's METEOSAT and ORBIMAGE'S

satellites to monitor and harvest the fishery resources from the productive regions of the world including near Africa's shores. It is important for Nigeria to understand how to enhance the exploitation of its marine resources so as to guarantee their conservation and protection. Satellite remote sensing can be of great assistance in such an effort.

(c) Natural and anthropogenic disasters: Africa is not in immuned to disasters, whether human made or natural and Nigeria is not an exception. The devastating Sahelian drought and famine, which began at the end of the 1960 and continue to early 1980s was particularly hash on the countries within the sahel regional. The drought made a mockery of the hydrological predictions and the economic projections associated with the design and construction of Lake Kainji and Dam projects in Nigeria. Lake Chad is also yet to recover its effect. In West, East, and Southern Africa, drought and the attendant desertification and flash flood are equally common and the vulnerability of the affected societies is often very drastic and tragic. Forest fires are also common in most African countries including Nigeria, as well as floods and landslide in areas that have lost their forest cover. Though space technology cannot prevent these disasters, it can

contribute to the lessening of the environmental vulnerability of our planet.

(d) Environmental pollution control: The main contributors to environmental degradation in Africa including Nigeria are unregulated discharge of domestic and industrial wastes, emissions from the exhaust systems of motor vehicles, particularly in urban areas, deforestation, and oil-related pollution among others. Although oil has brought much wealth to a few African countries, it had been accompanied by extensive pollution of the coastal waters that are rich in living resources. The shores of Algeria, Gabon, Libya, Nigeria, Kenya and Egypt have been particularly hard hit. Gas flaring is another major environmental problem in the oil-rich African countries like Nigeria. Apart from its economic loss, gas flaring is also contributing to the green house effect and the corresponding global warming. These pollution problems can be monitored and corrective measures taken with the aid of satellite-acquired data...

These shows that Nigeria should commit itself to a thorough understanding of remote sensing technology and appropriately apply it to solve problems and address her development programs.

2.4 MASTER PLAN AND ITS IMPLEMENTATION

The Master plan has developed from the technical professions of architecture, surveying and engineering. It is some times described as a blue print and it operates upon a rigorous established administrative structure. Though it tries to direct all the activities connected with the physical environment, and it is based upon the notion of public benefit and amenity, it is singularly ill-equipped to deal with the majority of social issues and some times not compatible with economic expediency (Ratcliffe, 1981).

A Master plan was also described by (Sabo , 1984) as being synonymous with physical planning whose scope only cover the future pattern and control of land uses and the future construction and modification of facilities.

Planning is an iterative process of which the master plan is the first and most fundamental step. In fact, the success of a master plan can be estimated based on its utility in guiding the subsequent planning and design process (master plan, 1979)

According to (Marsh, 1991), the main aim of master planning is to represent a comprehensive framework to guide land use changes. In the master planning process, goals are formulated relating to land use, economic, environment, demographic and transportation. Existing conditions are analysed and alternative plans are formulated

which are then tested against the goals and existing conditions and in the end, one is adopted. A 'Master plan is usually made up of 3 parts thus:

(i) A program proposal consisting of recommended guidelines and proposed land use;

(ii) A physical plan, showing the recommended locations, configurations and inter-relationships of the proposed land uses and

(iii) A scheme for implementing the master plan, which identifies funding, sources, enabling legislation, and how the changes are to be phased over time.

The nature, scale and form of the environment are the basis on which the plan is painted. A good knowledge and record of the topography, climate, geology, minerals, areas of special interest, location of rich agricultural land and sources of pollution are required by the planner. With these informations, the plan can be drawn.

The components of planning are utilities, employment, housing, shopping, education, leisure and recreation, movement, management and evaluation (Ratcliffe, 1981). He further described the need for planning. That planning is essential to secure the maximum practicable degree of economy, convenience and beauty as well as guide in creating civilized physical background for human life. That is,

It helps in providing the right site, at the right time, in the right place and for the right people. Master plan therefore, produces solution to urban problems that are predominantly physical in character such as land use maps, zoning, density controls, building regulations and planning standards.

Master plan implementation means the physical carrying-out of the master plan or design (Sabo, 1984).

It is familiar but valid criticism of land use planning that it places less emphasis on "the quality of the action". Much more effort, time and money is spent on the production of land use plans on paper than on the achievement of those plans in reality and it is that part of planning that has direct effect on the public. Statutory structure planning now requires the land use planning authority to promote, encourage and influence all the individuals and agencies within its area, so that in the detailed planning and implementation of their own activities, they fit in with the overall wider strategies. That fit in to the traditional view of implementation, which comprised three types of activities. They are:

(a) Organisation and co-ordination- the frame work for organisation and coordination is needed once the implementation of the plan begins;

(b) Control-land use planning depends more that any thing else upon its techniques of control to implement preferred policies. This aspect requires great number of staff and impinges most directly on the public, yet, relatively little attention is given to it;

(c) Stimulation- the activities of analysis of the existing situation in an area and its possible futures, the presentation of such information and the involvement of member of the public and other organisations in assessing option can all be seen as "stimulating" activity. This is very vital in the implementation exercise; monitoring, to provide information needed as feedback to the overall land use planning process (Roberts, 1999).

Patterson (1979) described the tools for implementing plans. According to him, the tools are not systematically developed. Most of the tools used for carrying out planning have been adopted for that purpose rather than been designed for then. Though some of the instruments are useful in solving urban development problems. Most of the legal tools controlled by ordinance or code are restricted to the government to which legislative powers are delegated. The non-coercive tools such as the right to plan, to review proposals and to participate in giving planning advice have been more broadly

delegated. The legislative tools are established through grants of authority from the state. They consist in assigning of the four basic powers of government: the police power, the power of eminent domain, the taxing power and the spending power. The use of eminent domain is avoided when the use of the land tends to create

Another important group of planning is public authorities. They may be single or multiple purpose in nature established to carry out large activities involving planning, housing, transportation, new town, centre city development, industrial development, land acquisition and almost any other aspect of development process. The serious limitation of the planning tool is due to the high degree of policy-making autonomy, which many of the authorities enjoy. They can be very useful in carry out planning process when required and effective inter agency co-ordination can be secured.

The Abuja master plan is the document(s) prepared by the International Planning Association (IPA) and presented to the Federal Capital Development Authority (FCDA) prescribing the pattern and modes of physical development that should be embarked upon in building Nigeria's new federal capital city, Abuja and its environs known as the federal capital territory (Sabo, 1984).

In the process of planning, the IPA team which was inaugurated in 1977 examined the planning and operation of other capital cities

and reviewed the experience of urbanisation in Nigeria coupled with the analytical procedure were combined to produce plans which synthesize a broad range of values, objective and concept. (Master plan, 1978).

The resultant master plan is designed to provide long- term guidance for the orderly implementation of the new capital city. It provides a general framework for development within which planning for various systems and sectors can continue. The name of the existing town of Abuja in Niger State was to be changed to Suleja so as to avoid confusion with the name of the new federal capital city (Master plan, 1978).

The work of the International Planning Association (IPA) commenced in July 1977 with mobilization exercise and information gathering. The first report was presented in February 1978 which was the program. By March 1978, the second report which was on site evaluation and site selection was presented. By May 1978, the third plan which was on regional plan was presented followed by report number four which was master plan. The fifth report was presented in 1979 on design and development manual. The final report was presented same year (1979) which was the final report as well as the master plan of 1:10,000 and the central area plan.

2.5 SPOT AS REMOTE SENSING SATELLITE

SPOT (System Pour l' Observation de la Terra) program was conceived and designed by the French Centre National d' Etudes Spatiales (CNES) SPOT has developed into a large scale international program with ground receiving stations and data distribution outlets located in more than thirty countries (Lillesand, 1994).

According to Sabins (1999), France launched the SPOT-1 satellite in 1986 on an Ariane rocket from French Guiana. The identical SPOT-2 and SPOT-3 satellites were launched in 1988 and 1993 respectively. Like Landsat, SPOT has acquired hundreds of thousands of images in digital format that are commercially available and are used by scientists and different disciplines. SPOT-1, -2 and -3 have identical orbits and sensor systems.

Lillesand et al (1994) described the orbit characteristics of SPOT-1, -2 and -3. They have a circular near-polar, sun synchronous orbit with an altitude of 832 km and an inclination of 98. 7^0 . They descend across the equator at 10.30 a.m. local time with slightly later crossings in northern latitudes and earlier in southern latitude. For instance, SPOT crosses areas at a latitude of 40^0 N at approximately 11.00 a.m. and areas at 40^0 S at 10.00a.m. The orbit pattern for SPOT-1-2 and -3

repeats every 26 days. That is, any point on earth can be imaged using the same viewing angle at this frequency. However, pointable optics of the system enable off nadir viewing during satellite passes which are alternatively separated by one and four and occasional five days based on the latitude of the viewing area. The ability of SPOT-1-2 and -3 to revisit an area is important for two reasons. First, it increases the potential frequency of coverage of areas where cloud cover constitutes a problem. Second, it makes it possible for an area to be viewed at frequencies ranging from successive days, to several days and to a few weeks. Such repeated observations are required for application areas like agriculture and forestry.

Lillesand (1994) went further to describe the sensors on board SPOT-1-2 and -3. The systems weigh about 1750kg and the main body of the satellites is about 2x2x3.5m. The solar panel has an over all length of about 15.6m. The SPOT platform is compatible with a variety of sensor payloads due to its modular design. The sensor payload comprises of two identical high-resolution visible (HRV) imaging systems and auxiliary magnetic tape recorders. Each HRV is designed to operate in either of two modes of sensing thus:

1. A 10m- resolution panchromatic (black and white) mode over the range of 0.51 to 0.73um.

2. A 20-m- resolution multi spectral (color infrared) mode over the ranges 0.50 to 0.59, 0.61-0.68 and 0.79 to 0.89um.

The HRV uses along- track or push broom scanning system, which does not employ a scanning mirror, but rather employs a linear array of CCDs arranged side- by- side along a line perpendicular to the satellite orbit track. The distinctive advantage of this scanning system over mirror-sweep systems is that it does not require moving parts. This increases the life of the system and also eliminates the geometric errors introduced in the sensing process by variations in scan mirror velocity. In addition, linear array detectors can remain on an area longer than those employed in sweeping systems. This increases the relative signal- to- noise performance of the linear array instruments.

SPOT-1, -2 and -3 systems afford broad range of viewing conditions and spectral modes of operation. The specific observation sequence for the Toulouse, France loads a given day of satellite operation into the systems on board computer by the Toulouse, France ground control station while the satellite is within its range. The day's operating sequence for each HRV is controlled entirely independently. This includes the viewing angles of the two instruments, the spectral mode of operation, the timing of image

acquisition and the modes of data transmission. The on board tape recorders are useful when images are got over areas outside the range of a ground receiving station. In such situation, the recorded image data are transmitted to the stations when the satellite reenters their range.

Lillesand (1994), the SPOT program has been designed to provide long- term continuity of data through the anticipated launch of several systems. As a result, several design changes are proposed for SPOT-4 which include the addition of a 20-m resolution band in the mid-infrared portion of the spectrum (between 1.58 and 1.75um). This is to improve vegetation monitoring and mineral discriminating capabilities of the data. Also, mixed 20-and 10-m data sets would be co registered on board instead of during ground processing. This would be achieved by replacing the panchromatic band of SPOT-1, -2 and -3 (0.49 to 0.73 um) with the "red" band from these system (0.61 to 0.68um), which would be used to produce both 10-m black and white images and 20-m multi spectral data. Another change planned for SPOT-4 is the addition of a separate, wide field-of-view, sensor called the Vegetation Monitoring Instrument (VMI). Though designed basically for vegetation monitoring, the VMI will be useful in a range of applications where frequent, large area coverage is essential. The VMI is designed to provide an image swath 2000 km

wide, with global coverage being obtained on a daily basis. The spatial resolution of the VMI is 1km and data will be collected in the following bands: blue (0.43-0.47um), green (0.50-0.59um), red (0.61-0.68um), near IR (0.79-0.59um and mid-IR (1.58-1.75um). Flown in combination, the VMI and the HRVS will afford the opportunity for coincident sampling of comparable large area, coarse resolution data and small area, fine resolution data. SPOT-4 is planned for launch in 1997 and is intended to operate at least till 2002. Planning for SPOT-5 is in progress. This system is planned to incorporate 5-m spatial resolution and along-track stereo imaging capability among others.

2.6 REMOTE SENSING APPLICATIONS

Remote sensing has been applied in various field of study. A number of studies have shown that remote sensing can be useful for oil spill detection. A consortium of petroleum companies; government agencies and research centres used radar data from the ERS-1 satellite to explore the Gulf of Mexico where oil seepage normally occurs. Possible seep sources were located. Ezebunwa (1995) also applied remote sensing technology in the detection of oil pollution in Niger delta. Gas flames, moored storage tankers, wasted disposal sites and off shore structures were all identified.

Nurhie (1999) used Aerial photographs of 1987, land use map of 1996 and master plan of Abuja in monitoring land use and land cover

changes in Wuse district, Abuja. He discovered considerable changes in the land use 1 land cover of the area and that the changes do not conform to the master plan. Fabiyi (1995) carried out similar study. He used the SPOT panchromatic imagery, to monitor master plan implementation of Abuja (phase I). Massive deviation in the implementation of master plan was revealed. He grouped the deviations into 3:

i deviation by displacement

ii deviation by omission

iii deviation by substitution

Adeniyi (1982) used Side Looking Air Borne radar (SLAR) data to calculate the area occupied by land use and land cover. 69 coloured out puts were produces and the figures got, were used to provide a generalised picture of land use and land cover distribution in Nigeria. Nkambwe (1981) applied multi data aerial photographs to measure the physical growth of Ile-Ife between 1950 and 1970. Three main features were noted in the growth from the aerial photos they are, pattern, degree and direction.

Jaiye (1998), made use of aerial photograph to study traffic control and planning in Minna. The researcher discovered among others that the number of traffic warden determines the rate of accident. The study also revealed that though the traffic volume in

Minna was far below was far below what was obtainable in other state capital of Nigeria, yet the traffic problems are enormous.

Okhimamhe (1993) combined the spot satellite imagery acquired in 1986 with aerial photographs of 1974 in the detection of changes in the land use/ land cover in the Burum / Tiga area. The study revealed that 38,897 hectares of changes have taken place where crop / pasture land, wooded shrub land had increased by 104 %. The study also showed that the sandy area has increased.

Adeniyi (1980) used sequential aerial photography and Computer techniques for monitoring urban growth in Lagos. He used Black and white aerial photographs for 1962 and 1974 to produce the area of land occupied by each land use type during each time period, the magnitude and type of change as well as the location of where changes have occurred. The spatial pattern and relationships of land use types and changes were determined.

Bingham et al (1983) produced land use maps of Mali by visual interpretation of enlarged prints of landsat imagery. Images acquired in different years and seasons were used. The inconsistency in date between images introduced problems in interpretation and the preparation of a consistent legend.

From the literatures reviewed, it can clearly be seen that some of the techniques applied by the various researchers can be utilized in this study, which attempts to use remote sensing technology to assess the actual land use deviation from Abuja.

CHAPTER THREE

METHODOLOGY

3.0 INTRODUCTION

This chapter deals with the data used for this research, the collection procedure and sources of the data, the instruments and the procedure used in analysing the data.

3.1 Data collection and procedure

All relevant available data whether maps, reports, statistics or imagery were obtained and examined in order to acquaint the researcher with the research topic and area of study. This was made possible through the university library (Federal University of Technology Minna), the National library, Kaduna, Federal Polytechnic Kaduna library as well as the planning and survey department Federal capital Development Authority (FCDA), Abuja. Pre-interpretation field reconnaissance was conducted and the study of the available data sources to enable survey journey to be adequately planned.

Amongst the data collected were the SPOT imagery, which was the panchromatic type. This was possible through the mapping office of the survey department in FCDA courtesy CNES. The master plan for Abuja was also obtained from the planning section of the Federal Capital Development Authority (FCDA) Abuja. Field work or ground truthing was also conducted for verification. Table 3.1 below shows the data collected and their sources.

Table 3.1 Type and source of Data

Type of data	Date	Scale	Source
Spot imagery (panchromatic)	5/1/94	1:100,000	FCDA
master plan	1978	1:10,000	FCDA
Field work	2002		Observation

Source: Author, 2002

3.2 Remote sensing data

SPOT panchromatic imagery was the main data for the research. SPOT panchromatic operates on 10-m resolution over the range of 0.51 to 0.73um, which makes it ideal for this study. In addition, it has a repeat cycle of 26 days which was also adequate for the study area due to the high rate of growth or development of the city particularly in recent times; as some would refer to Abuja as the fastest city in the world. SPOT satellite employ along-track or push broom scanning system, which does not make use of scanning mirror. This scanning system help to reduce the geometric errors in the sensing process due to variations in scan mirror velocity. Also, linear array detectors can remain on the area within their instantaneous field of views (IFOVS) for relatively long time, which increases the relative signal-to-noise performance of the linear array instruments. These and other advantages makes SPOT image an idea on

for such a study as this. One other reason for the choice of SPOT panchromatic image data was that it was one of the most recent remote sensing image data that the researcher could lay hands on as at the time of the research work.

The SPOT imagery obtained covered the scenes on the 5th day of January, 1994 and it covers the whole of Abuja North East (NE) on the scale of 1:100,000. At this scale, it was possible to identify the land uses. The imagery had a geometric processing level of precision (2B) and the projection used universal Transverse Mercator (UTM).

The master plan for Abuja which was a representation of the 18 months work by the Federal Capital Development Authority Board, the members of staff of the Federal Capital Development, the several advisory panels and FCDA consultants, was also obtained. The master plan was designed on the scale of 1:10,000 in 1978. By the international planning Associates (IPA) that was commissioned in 1977. For the purpose of this study, the study area (Wuse I) was delineated from the master plan for the purpose of a comprehensive study.

The master plan usually comprises of a programme proposal which is made up of recommended guild lines and proposed land uses; a physical plan, showing the recommended locations, configurations and inter-relationships of the proposed land uses and a scheme for

implementing the master plan. For the purpose of this study however, the emphasis would be on the physical plan.

3.3 Materials

Remote sensing applications are instrument dependent, the nature, type and accuracy of the interpreted data is to some extent, dependent on the type of materials used. For the purpose of this study, the materials used for the visual interpretation of the SPOT imagery covering the study area and other remotely sensed data are sets of mirror stereoscopes, tracing paper, graph paper as well as field studies and planimeter.

Table 3.2 List of materials and uses

S/No.	Materials	Uses
1.	Mirror stereoscope	Magnifying the image
2.	Tracing	Tracing out the master plan
3.	Planimeter	Calculating the area
4.	Graph paper	plotting the bar chart
5.	Field observation	Verification

Source: Author, 2002

3.4 Procedure for Remote Sensing data Analysis

The SPOT panchromatic data of Abuja North-East, with a scale of 1:100,000 and a resolution of 10. m was obtained from which Wuse 1 (the study area) was carved out after scanning it into the computer system. The imagery was visually interpreted with the aid of mirror stereoscope. Based on this interpretation, the uses to which the various parcels of land in the study area were put as at the time of the satellite scene was covered was ascertained. The interpretation of the SPOT panchromatic imagery was not an easy one due to the black and white nature of the imagery. The buildings could be clearly seen in bright tones and the block nature of the buildings were also visible. The vegetation could also be seen as it appeared in dark tone. The road networks were also clearly seen in their bright tones due to the smoothness of the water surface.

The master plan of Wuse 1 which was the future physical plan or design plan of the area was also visually analysed. The master plan for Abuja was on the scale of 1:10,000 from which the master plan for the

study area (Wuse 1) was delineated. The various uses to which the different parcels of the land in the study area would be put was clearly Outlined in the master plan. This was based on the use, which a particular parcel of land can best serve. Some portions of the land were designated for low density residential, some for medium density residential, some high density residential, some portions of the land, still, were allotted for schools (nursery, primary and secondary schools); some for commercial purposes; some, public utilities and some still, for religious activities. Some portions of the land were also assigned to parks and recreational activities; and some, for green areas or forest reserves. For the Master plan to be accurately implemented for maximum benefits, the various lands ought to perform their various functions as assigned. The different uses were carefully identified on the master plan.

3.5 Interpretation

At this stage, the master plan for the study is (Wuse 1) and the SPOT Panchromatic data were compared. Transparency was laid over the master plan and the imagery in order to compare the details or informations on the uses of the various parcels of land. This was done in order to determine the deviation of the land uses of the study area from the master plan. By comparing and contrasting the master plan and the satellite imagery, the deviation was clearly seen as shown in the next chapter of this thesis. This deviation was based on the time at which the

satellite data was captured in in 1994. Ground truthing of the study area was carried out in order to ascertain the present situation on the ground. The result of the ground truthing was then used in up dating the satellite imagery and consequently, an adjusted or up-dated land use map of the study area was produced. The up-dated land use map now clearly shows the difference between the master plan and the present land uses in the area. This is clearly indicated in the next chapter.

The extent of the deviations were quantified by calculating the areas in km^2 of the study area using planimeter. The areas occupied by individual land uses were calculated after which the percentage of the deviation was worked out.

3.6 Field Checking

Due to the wide range of time between when the satellite scene was covered (5th January 1994) and the time of the research (2002), it was obvious that a lot of changes might have taken place in respect of land use due to the rapid growth and the development of Abuja. This necessitated the need for field observation in order up-date the satellite imagery. This was also necessary for further verification in order to make up for or at least reduce the errors due to the limitations of human senses. This was adequately carried out and the physical nature of the land scape, land uses and the interrelationships of the land uses of the

study area were ascertained. The result was shown in tabular form and was also graphically shown.

Having discussed the methodology that is, the data types and sources, methods of data collection, instruments used and the general procedure for analysis, it was also vital to meticulously follow these methods logically in order to bring out the results obtained from the procedure adopted in the study. The next chapter clearly shows detailed analysis and discussions on the findings and implications of the research work.

CHAPTER FOUR

ANALYSIS AND DISCUSSION

4.0 INTRODUCTION

Having analysed the spot satellite imagery and the master plan of the study area (Wuse 1), to identify the uses to which each portion of land has been allotted, they were compared to ascertain the level of deviation. The ground truthing of the area was also carried out for the verification of the interpreted imagery. The result of the analyses can be explained in the following ways:

4.1 Comparison of Master plan and spot Imagery

As the satellite scene was compared with the master plan of the study area, great deviations from the master plan were observed. Tables 4:1; 4.2 and 4.3 clearly show these. Table 4.1 shows the proportion of area designated for each land use on the master plan. Table 4.2 shows the present proportions of the area being occupied by each land use while table 4.3 shows the proportion of deviation of each land use from the master plan

a. Green areas – Parts of the areas designated for green areas had been converted to other uses. 2.9km^2 that is, 13.65% of the total area was designated for green areas on the master plan (table 4.1) But the area presently occupied by green areas is about 1.45km^2 which is about 6.82% of the total area (table 4.2). This shows that 1.45km^2 of the green areas has been taken over by other uses

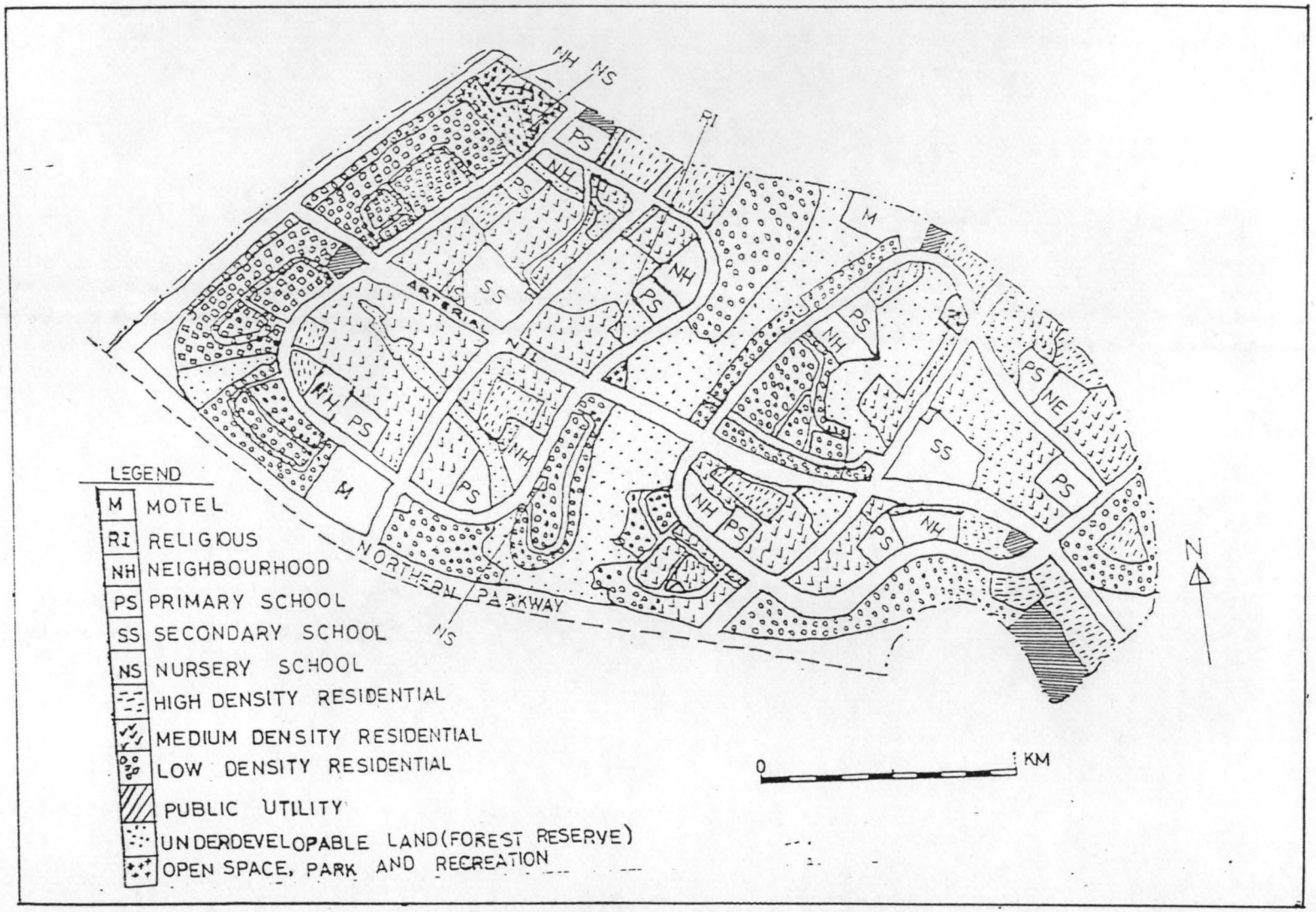

FIGURE 4.1 MASTER OF WUSE I

SOURCE: MASTER PLAN

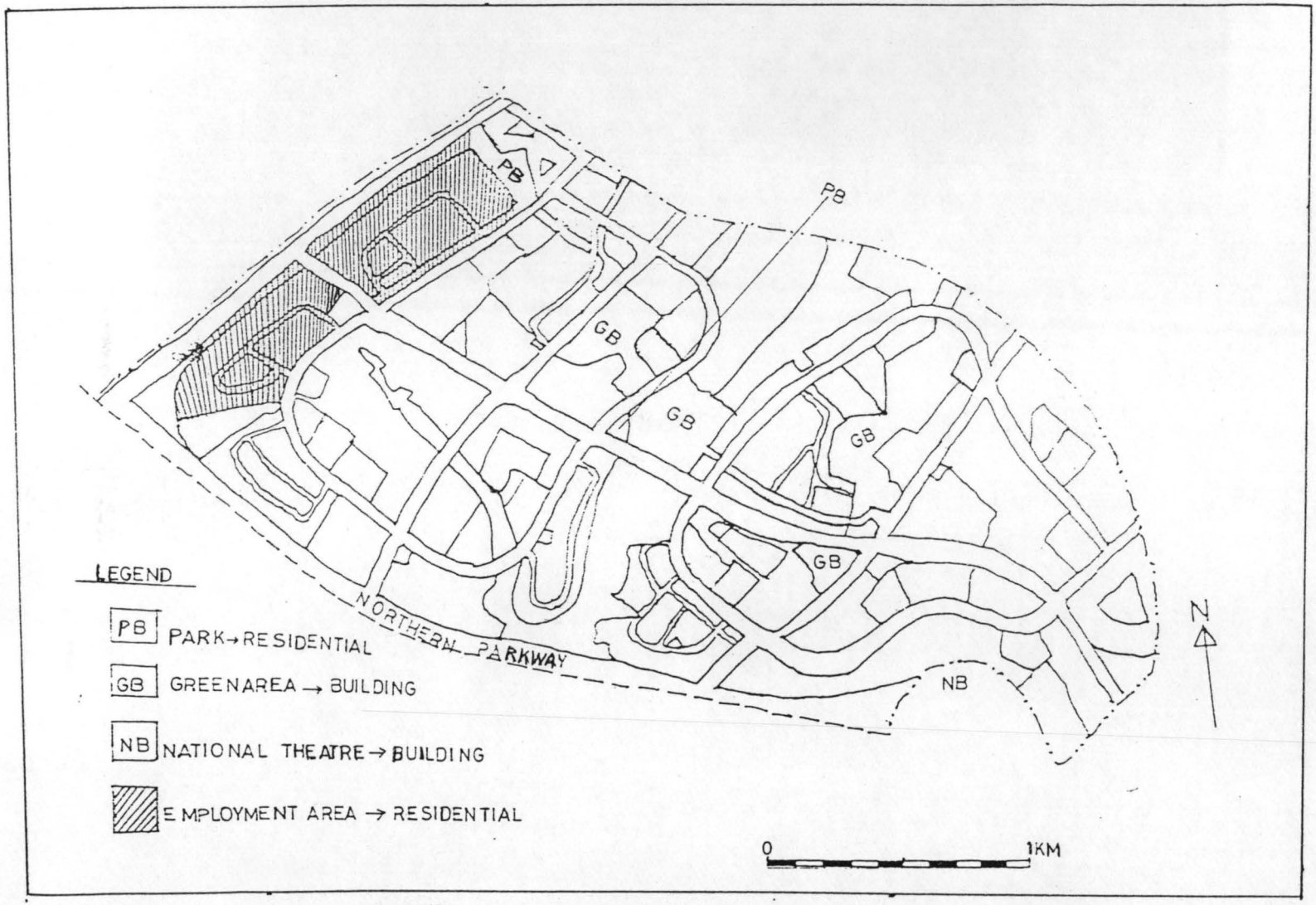

FIGURE 4.2 DEVIATION MAP OF WUSE I

SOURCE : Field survey, 2002

COMPARISON OF MASTERPLAN WITH PRESENT LAND USE

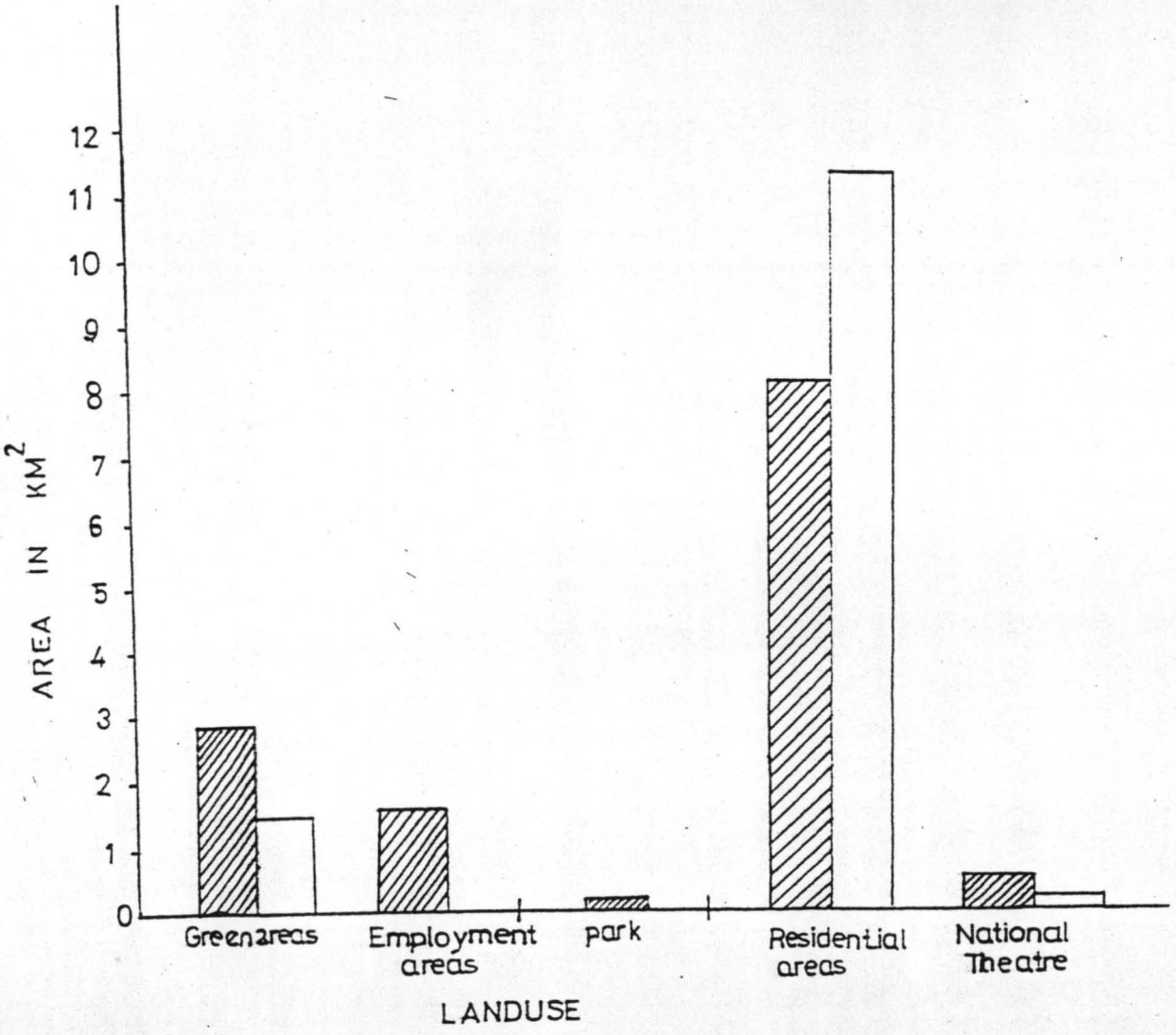

FIGURE 4.3 SOURCE : Field survey, 2002

Table 4.1 Proportion of **area designated** for each land use on the Master plan

S/No	Land use	Area occupied (km^2)	Percentage(%)
1	Green Areas	2.9	13.65
2	Employment Areas	1.55	7.29
3	Park, open space and recreation	0.15	0.71
4	Neighbourhood	0.75	3.53
5.	Schools	0.35	6.35
6	Public Utilities	0.40	1.88
7	Residential	8.10	38.12
8	Motel	0.45	2.12
9	National Theatre	0.45	2.12
10	Roads	5.15	24.24
	Total	21.25	100

Source: **Field survey. 2002**

Table 4.2 **Actual Proportions of the Area being occupied by each land use at present**

S/No	Land use	Area occupied (km^2)	Percentage(%)
1	Green Areas	1.45	6.82
2	Employment	0	0
3	Park, open space and recreation	0	0
4	Neighbourhood	0.75	3.53
5.	Schools	1.35	6.35
6	Public Utilities	0.40	1.88
7	Residential	11.25	52.94
8	Model	0.45	2.12
9	National Theatre	0.15	0.71
10	Roads	5.15	24.24
11	Unclassified	0.30	1.41
	Total	21.25	100

Source: Field survey, 2002,

Table 4.3 Proportion of deviation by each land use type

S/No	Land use	Area on Master plan	Actual Land use (km^2)	Deviation (b-a)km^2	% Deviation
1	Green Area	2.9	1.45	-1.45	50
2	Employment Area	1.55	0	-1.55	100
3	Park, open space and recreation	0.15	0	-0.15	100
4	Residential	8.10	11.25	3.15	38.89
5.	National Theatre	0.45	0.15	-0.30	66.67

Source: Field survey, 2002,

which is 50% of the total green areas (Table 4.3). In other words, a green area shows 50% deviation from the master plan.

b **Open Space, Recreation and Parks** – The analysis reveals that the portions of land allocated for open space, recreation and park by the planners as stipulated on the master plan has been converted to other uses, precisely residential. 0.15 km^2 of the total area was allotted to open space, park and recreation. That is 0.71% of the total area (Table 4.1). Presently, all the areas allocated for open space, park and recreation have been taken up by residential structures. This implies that 100% of the area in question has deviated for another purpose (Table 4.2) presently, none of that land is used for the purpose that was assigned to it (Figure 4.3). All has been lost to other land uses.

c **Employment Areas** – The employment areas, open space and recreation have been converted to residential uses, which is yet an indication of deviation from the master plan as shown in fig4.2. The master plan stipulated 1.55km^2 that is 7.29% of the total area for employment areas (Table 4.1). At present, 1.55km^2 of the employment areas has been taken up by residential buildings showing 100% deviation (Table 4.2). Table 4.3 shows that of the areas designated for employment areas, nothing is left for that purpose. Figure 4.3 shows this graphically as the master plan can

be seen to equal the deviation and as a result, no aspect of that parcel of land is left for employment areas, which it was designated for.

d **National Theatre** – The portion of the land according to the analysis, slated for national Theatre had not been developed for that purpose. But some parts of the land are already being used for other purposes. Figure 4.2 clearly shows this. 0.45km^2 that is, 2.12% of the total area was designated for national Theatre (table 4.1). Out of this land, the portion left for national theatre is 0.15km^2 which is 0.71% of the total area (Table 4.2). This indicates that about 67% of the area has deviated from the plan (Table 4.3) This is graphically shown in figure 4.3. The extent of deviation can be seen to be more than 50% as the deviation bar could be seen to be more than half of the bar representing the master plan,

e **Residential** – The residential areas are seen to have greatly increased. This is because they have taken over other portions of land designated for other uses (Figure 4.2). According to the stipulations on the master plan, 8.10km^2 of land was assigned for residential purposes. That is, about 38.12% of the total area (table 4.1). On the other hand, the total area presently occupied by residential structures has increased to 11.25km^2 which is about 52.94% (Table 4.2). The proportion of area occupied by residential

structures has increased from 38.12% to 52.94% of the total area. This reveals that residential area has a positive deviation of 3.15km^2 (Table 4.3). Thus shows that residential areas not only used up its area, but has as well added to its area. This means that more than 52% of the whole area is residential while less than 48% of the whole area is shared among other uses. This is clearly shown graphically on figure 4.3. The present area used for residential purposes is larger than that stipulated on the master plan. Residential area is the only portion of land that has a positive deviation while others have negative deviations; that is; losing portions of their land or the entire area to other uses. A good proportion of the land is presently occupied by residential structures.

The lush green side works and burgeoning trees that dot the high way giving it great beautiful outlook are giving way to make shift hawkers with wares displayed all over the area.

Though some of the schools are yet to be developed, the parcels of land assigned to them were observed to be vacant or undeveloped. In such case, they could not be regarded as deviation in this sense since the portions are yet to be developed and the development of the area follows a gradual process.

4.3 Causes and Consequences of Deviation from Master plans

4.3.1 Causes of Deviation

The causes of deviation from master plans are numerous but they vary from one society to the other. The causes of deviation of Abuja land use from the master plan as was deduced from texts, observations and interactions with FCDA Staff and the residents in the area include amongst others.

(i) Political decision and Influences

(ii) Poverty

(iii) Inadequate education and awareness of the populace

(iv) Inadequate equipments and data

(v) Inadequate fund

(vi) Non strict adherence to total compliance to the master plan

(vii) Increase in population

i. **Political and influences** – Political instability is one of the reasons for the deviations from the master plans. Change in leadership either at national or Federal Capital Development Authority (FCDA) level normally brings about new ideas resulting to changes in implementation strategies. Furthermore, the high rate of corruption such as bribery and favoritism in Nigeria has greatly contributed to the deviations of the master plan in Abuja. Those who could peddle influence in the regime especially the military regime were said to have enjoyed the privilege of building vast estates without approved

plans some buildings were said to be structurally above all environmental laws in the city and the authority seems helpless about it. This could be one of the reason why the areas or parcels of land designed for open space, park and recreation was diverted for other purposes. The same is applicable to the employment areas amongst others.

ii. **Poverty** – The poverty level in Nigeria is so high that the people struggle very hard to make ends meet. They can stay anywhere in as much as they can earn their means of livelihood. They occupy any available space and would not listen to any sermon on environmental management for sustainable development. The popular saying that "A hungry man is an angry man" becomes true in such situation. This could be one of the reasons why the lush green sidewalks are giving way to make shift hawkers. The same is true of the green areas.

iii. **Inadequate Education and awareness of the populace** – The entire public are not adequately educated or made to be aware of the importance of complying with the master plan proposals during implementation. They are not aware of the implications or consequences of non-compliance with the master plan stipulations. This could be one of the reasons why the portion of land slated for

the National theatre was converted to other uses. The same is applicable to employment areas and open space.

iv. **Inadequate Equipment and data** – The inadequacy of equipments and current data for monitoring master plan implementation contributes to the causes of deviation from master plans. This could practically be seen as the most current satellite data that could be found in Abuja as at when this research was going on was the SPOT imagery acquired in 1994. This could be one of the reasons why the lush green side walks area giving way to make shift hawkers amongst other deviations.

v. **Inadequate fund** – The available fund is inadequate for the development of the areas for the purpose it was meant for. This exposes the land to the danger of being converted for other uses due to high rate of competition on the available land. Moreso, even when the fund is available, mismanagement of the fund or misplaced priorities could divert it to other uses. This could one of the reasons why all the parcels of land assigned to open space and parks have deviated for other uses.

vi. **Non strict adherence of implementation process-** The non strict adherence by Federal Capital Development Authority officials to ensure total compliance with the master plan is one of the causes of deviation from the master plan inadequate effort and time

is committed to the monitoring of master plans implementation. This could be one of the reasons why residential structures now occupy most parts of the land.

vii. **Increase in Population** – The population of Abuja has grown tremendously in recent times. This was partly due to the Inter-ethnic and religious crises that were experienced in various states of the country. As a result, many people re-located to Abuja in search of peaceful living. For this increased population to be accommodated, other parcels of land that were designated for other uses, were diverted to residential buildings. This was one of the reasons why residential areas now occupy more than 50% of the entire land in the study area (Wuse 1).

4.3.2. Consequences of Deviation from master plan

Abuja, the Federal capital city is growing at a very high taste hence, she is said to be the fastest growing city in the world. At this rate of growth, it has also been discovered that there are remarkable deviations from the master plan due to various reasons. The next question that comes to mind that needs to be addressed is "what are the consequences of deviation from master plan".

The essence of master planning is to order the use of the land and siting buildings and communication routes in order to secure the maximum practicable degree of economy convenience and beauty. It also

helps to create principles that guide the building of a civilized physical background for human life. In order words, it helps to provide the right site, at the right time, in the right place and for the right people.

Master plans produce solutions to urban problems that are mainly physical in character such as land use maps, zoning, density controls, building regulations and planning standards.

Deviations from master plans results in numerous urban problems such as inadequate or poor housing; traffic congestion which impede movement, environmental pollutions resulting from indiscriminate waste disposal, industrial pollutants, automobile fume emissions; unemployment; inadequate supply of power and quality water and general degradation of the land and other natural resources.

For instance the quality of the environment is drastically reduced if there is no vegetal cover. As was discovered, about 50% of the green areas has been taken over by other uses. Amongst other advantages, vegetal cover contributes to a healthy environment as it reduces the green house effect thereby, moderating the temperature of the land and the climate at large. But when they are removed, the soil is exposed and also, the carbon dioxide emitted into the atmosphere that would have been absorbed by the vegetal cover remains, thereby, contributing to the global warming effect and consequently, "climate change" which has become a global issue.

In addition, recreation centres are very vital, as relaxation is very essential for healthy living. One with sound health (body and mind), has the capability of high degree of productivity which is greatly needed by Nigeria presently. Inadequate relaxation means poor health conditions and consequently low productivity among others.

Deviation from the master plan of Abuja would leave Abuja like every other Nigerian city (with characteristics of unplanned city) and the aim of shifting the capital of Nigerian to Abuja from Lagos would be defeated. This is because Abuja would have all the features of Lagos (poor housing, traffic congestion, unemployment, amongst others).

CHAPTER FIVE

5.1 SUMMARY

Abuja, the Federal Capital Territory is presently experiencing rapid growth and development as it is regarded as the fastest growing city in the world especially since the transfer of the sit of power to the city coupled with the various ethnic and religious crises experienced in different parts of the country. This has attracted a lot of people to the city and consequently, there is deviation of the land use from the master plan of the area. This necessitated the need to study and determine the extent of deviation, the causes and consequences as well as advance possible solutions in order to attain sustainable growth and development so as to prevent Abuja from turning out like other Nigerian cities.

The study was made possible through the collection of SPOT panchromatic satellite imagery and master plan of Abuja from the survey and planning departments respectively of Federal Capital Development Authority (FCDA). Due to limited time and for comprehensive study. Wuse I was chosen as the study area. The master plan and the satellite imagery were compared and the extent of deviations from the master plan was calculated.

The analysis reveals a remarkable deviation of the land use of the study area from the master plan. The study shows that 1.45km^2 that is

about 50% of the total area designed for green areas have been converted to other uses. The open space, recreation and parks had completely been taken over by residential structures. This implies 100% deviation of the land.

It was also discovered that the employment area, open space and recreation areas have also been converted to residential area. The 1.55km^2 stipulated for employment area has completely been taken over by residential buildings.

The study also reveals that the parcel of land assigned to national theatre on the master plan was 0.45km^2 that is, 2.12% of the total area. Out of this portion, only 0.15km^2 is left which means that about 67% of the area has deviated for other purposes.

The study also shows that residential areas has greatly increased. The area assigned to residential buildings by the master plan was 8.10km^2 that was 38.12% of the total area. This area has presently increased to about 11.25km^2 that is, about 52.94% of the total area.

The causes of deviations could be attributed to poverty, inadequate form, non-strict supervision by FCDA officers increase in population, political decision and influences, inadequate education and awareness of the populace, amongst others

5.2 Conclusion

The study has successfully studied the potential of satellite data in the assessment of actual land use deviations of Wuse 1 in the federal capital city Abuja from the master plan. The extent of deviations of the various land uses were ascertained and the possible causes and consequences of the deviations were determined.

The study shows that there is remarkable deviation of the land use from the master plan. Of all the uses, residential purposes now occupies more than 50% of the total area. This could obviously be mainly due to the increase in the population of the area. Adequate monitoring strategies using remote sensing techniques would be ideal in effectively monitoring the growth and development of the area. This would consequently help to guide against deviations of land use from the master plan; and would invariably lead to the sustainable development of the study area (Wuse 1) and Abuja at large.

5.3 Recommendations

There is tremendous need to continously monitor master plan implementations so as to easily identify any deviation in good time this can be adequately done using remote sensing techniques. The benefits of remote sensing are so glaring that the problems are not frequently articulated. Remote sensing affords accurate, timely and cost effective data. Nigerian should therefore, establish a satellite ground receiving stations that are really operational. Though Nigeria is planning to launch her own satellite into space which is of course a welcome development but before then, we should have functional ground receiving station.

In addition, remote sensing data should be acquired at regular basis. This would aid in the provision of adequate and up-to-date data for effectively monitoring master plan implementation for effective decision making.

There should be proper awareness on the importance of remote sensing in Nigerian development for effective decision making. The populace should also be made to be aware of the importance of complying with the stipulation of the master plan.

Furthermore, one of the essential prerequisites for a successful technology program is the building of the various indigenous capabilities especially human resources. Adequate manpower should be development in the field of remote sensing. Though remote sensing program is offered

in few Nigerian universities such as Federal University of Technology, Minna, Centre for Remote sensing in Jos, as well as RECTAS in Ile-Ife; even then, more Universities in Nigeria should include it in their school programme and adequate facilities should be provided for proper training.

Also, a multi-disciplinary approach to master plan preparation should be adopted from the on set in order to prevent extensive deviation. The master plan should be made a littler more rigid putting into consideration the nature of users (Nigerians).

In addition, for proper implementation of the master plan, poverty should not only be alleviated, but completely eradicated. This is because it is only then, that the people (Nigerians) would listen to the sermon of preserving the environment for sustainable development through compliance with the master plan.

Our leaders should also be educated on the importance of complying with the master plan. In the implementation process, the officials responsible should be strict about it and no "sacred cow" should in any way be tolerated. The implementation law should be obeyed.

Moreso, much more effort, time and money should be devoted to the implementation of the master plan which brings the plan into reality than just spending much on the production of master plan on paper without achieving it in reality.

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Scale: 1:100,000

Projection: UTM; Spheroid: Clarke 1880, Zone 32 CNES 5/1/1994

Geometric Processing Level of Precision (2B)

APPENDIX 1 : SPOT Panchromatic Imagery of Abuja N.E.