APPLICATION OF REMOTE SENSING AND G.I.S. TECHNIQUES IN THE ASSESSMENT OF THE IMPACT OF ABUJA F.C.C. ON JABI

By

Andrew A. Meyanga.

M.Tech. /873/2001/2002.

In partial fulfillment of the requirements for the award of Master of Technology degree in the Department of Geography in Remote Sensing Application.

Department of geography.
School of Science and Science Education.
Federal University of Technology. Minna. Niger State.

June 2004

CERTIFICATION.

This project titled "Application of Remote Sensing and G.I.S techniques in the assessment of the impact of Abuja F.C.C. on Jabi by Andrew A .Meyanga meets the regulations governing the award of the degree of Master of Technology of the Federal University of Technology, Minna.

.....
ct Supervisor
. A. Okhimamhe

9/10/05
.....
Date

.....
Department
T. Usman

.....
Date

.....
Examiner
Mashi

.....
Date.

.....
Graduate School
Abalaka

.....
Date

DEDICATION

This project is dedicated to God Almighty, through whose grace and favour I was able to complete the course. I return it all to Him with praises and adorations.

It is also dedicated to my dear Father and Mother. Elder Meyanga Adeboh and Nee Umali Adeboh: I am highly favoured by both of you.

ACKNOWLEDGEMENT.

My sincere thanks go to my supervisor. Doctor A.A Okhimamhe for her guiding instructions and
atience with me throughout this research work. Her strictness has not only made me do the right thing but
id helped me to develop myself more in the field of information technology. I am also grateful to all the
embers of staff in the department of Geography and most especially the Head of Department. Dr. M.T
sman. Professor Adefolalu. Mrs. A.E Odafen. Dr G.N Nsofor, Professor J.M Baba Dr. P.S. Akinyeye.
allam Salihu. Dr. A.S Abubakar and the last but the first, Dr. Halilu Shaba. If I ever become anybody after
e. he made me what I become. Thank you so much sir. my lecturer and friend indeed.

I want to also recognize and appreciate Mrs. Cordelia Meyanga that did most of the initial typing
ks and also helped in the proof reading. May God reward you abundantly. I must not forget to thank
mensely. the staff of the National Airspace Research and Development Agency. Mr. S.O Mohammed and
. Bayo that assisted me to get the images used for this project.

also want to say thank you to all the staff in the cartographic unit of the planning. land and surve
artment of the Federal Capital Development Authority for the assistance rendered during the procureme
he topomap and the comprehensive land use map of the federal capital city.

nally I return all Glory to God Almighty who has seen me through this stage. 'He is the Beginning
End'.

ABSTRACT.

A poorly managed expansion could have very costly consequences on its residents. There is the urgent need for policy makers to have a clear knowledge of these consequences. Both planners and policy makers must make it a point of duty to arrest development whose long consequences outplay the benefits. They should be able to measure the direction of such expansion, its causes and consequences, so as to able to effectively plan for the future. This research work has been undertaken to highlight some of the causes of urban sprawl and its relative impacts on both the suburban and the ex-urban. The types and consequences of sprawl development were also enumerated and explained.

To undertake this work, Landsat images, a topographical map and a comprehensive land use map were used. Land use and land cover change analysis was made using the topogragraphical that shows the type of development as at 1979 and landsat images that shows the level of expansion in 2001. Tables of data for 1979 and 2001 were then generated from laboratory analysis. At an estimated growth rate of 6.4%, it is projected that unless deliberate managerial measures are taken, the rate of expansion will reach Zagwalada by 2019. The study therefore illustrated the applicability of remote sensing to change detection and trend monitoring.

TABLE OF CONTENT.

LIST OF FIGURES.

LIST OF PLATES.

LIST OF TABLES.

1.0 INTRODUCTION.

1.0 1.1 BACKGROUND.

The study of urban dynamics has attracted the attention of various experts in recent times. The multi disciplinary gamut of this subject is of concern to the common man. ecologist. to the urban planners. civil engineers, the sociologist, the administrators and the policy makers. The urban environment is characterized by series of activities everyday. The first level of civilization was when man evolved and decided to live at the banks of rivers. There was an increase in population. and as a result of man's creativity he invented wheels and fire: created settlement and then lived in forest. Enormous progress was also recorded as man developed communication skills and increased his skills and his life style. The initial settlement then grew from hamlet to village and then village to an urban ecosystem.

The increased world population growth coupled with the high rate of migration has increased the urban population and urbanization process. These changes have also altered the land use/land cover pattern of the urban ecosystem. Since today, man can adopt and survive under any form of climate; it has been observed that urbanization is going on in all the nooks and crannies of this world. The rapid change in the urban landscape can be attributed to the development of excessive residential colonies. industrial up surge. and then because of its role as the economic. social. administrative and cultural hub of the nation. Studies have shown that a better understanding of the origin of life and its evolution will illuminate the current trend in urbanization and its consequences thereof.

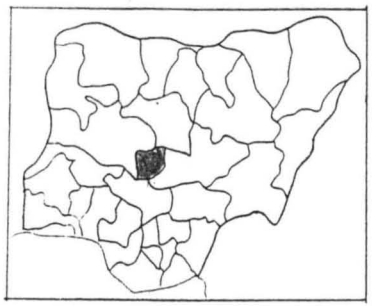
Sustainable development has been defined differently. The World Commission on Environment and Development in 1978 defined sustainable development as that "development that meets the needs of the present without compromising the ability of the future generations to

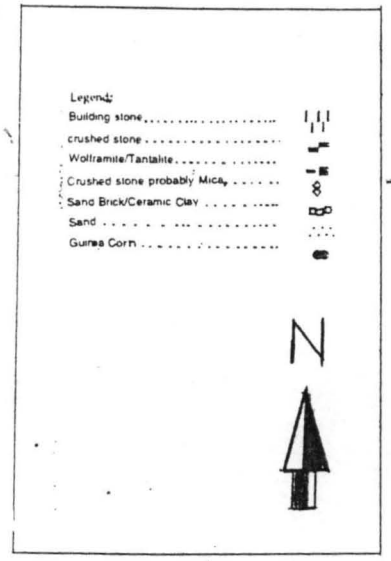
meet their own needs". The natural environment and land are vital factors that affect human survival. so for a sustainable urban development, aspects like water. air. energy, food. raw materials and land should carefully be taken care of. An alteration of the natural environment by ways of land use conversion that include forestland conversion, agricultural land to built-up areas has gross implications that are usually irreversible. Unsuitable development resulting from unsuitable landuse conversion will eventually bring about unsuitable environment for man.

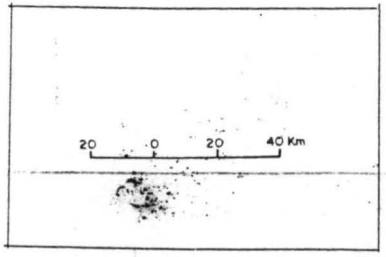
The federal capital territory is located between longitude 6° 45' and latitude 7° 45' east of the Greenwich meridian. and between latitude 8° 25' and 9° 25' north of the equator. The federal capital city can be described as been located between longitude 7° 22' and 7° 27' east and between latitude 9° 02' and 9° 07' north of the equator. In terms of land area it occupies about 8000square kilometers. The federal capital city represents about 250 square kilometers. This constitutes about 3% of the entire territory. As at 1977, the population of the city stood at about 5000 people with a population density of 9 persons per square kilometers. None of the major four roads leading to the territory was tarred then. These roads include the Bida-Abuja, Minna-Abuja. Keffi-Abuja and Koto-Abuja roads. The only tarred road that traverses the territory and was completed by 1980 was the Warri-Kaduna road. Geographically, the location of the federal capital territory could be said to be central. It is bordered to the north by Kaduna state, west by Niger state northeast by Plateau state, south by Nassarawa state and south west by Kogi state.

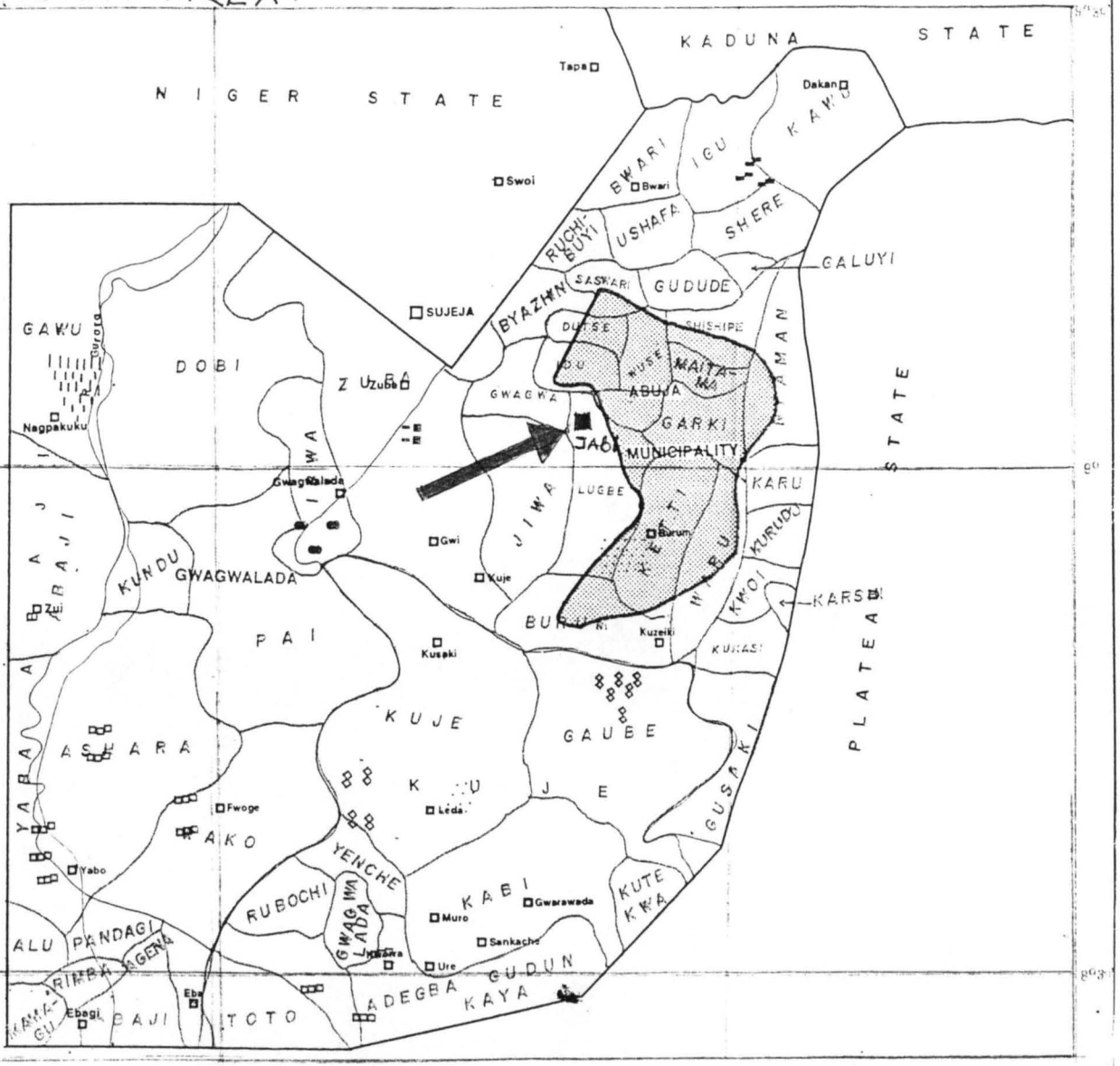
(a) Geology: The geology of the federal capital territory is made up of rocks of the Precambrian age. The trend of the rocks are in NNE—SSW direction. These rocks are greatly made up of granitic gneiss and magmatites. There is however a schist belt outcrops at the eastern margin of the territory. Kogbe (1978) observed that the rocks are generally sheared. These rocks could be categorized into five major groups. They include

MAP OF STUDY AREA.









(i) magmatic complex made up of migmatic (mi), migmatic gneiss (mg). Porphyry roblastic granitic gneiss (pg) and Leucocratic granitic gneiss intrusive.

(ii) metamorphosed supracrustal exogenic rocks that are also made up of mica schist (sh), marble (m). Amphibolite and amphibole schist (a), and fine medium grained gneiss. (iii) Intrusive granite of coarse grained granite. (cg). (iv) Minor intrusions that include Rhyolites (ry) Quartze-felspar porphyry (py), Dacatitea and Anddensites (an) Dole-rites(d) and Basalts (b).

(v)Other formation: Quartzite (qz), Pegmatite (p) Quartze vein (q).

(b) Relief: The lowest elevation in the federal capital is about 70 meters and this is found at the southwestern part. The highest is in the northeast. Here heights of over 760 meters are common sight. Prominent ranges include the Gawa range, Gurfata and Bwari-Aso ranges. Between the hills are intermittent plains and these also include the Gwagwa plains. Iku-gurara, Robo and Rubochi plains. It can be concluded that 52% of the F.C.T is made up of plains. The federal capital city is located on the Gwagwa plain.

(c) Climate: The climate of the territory is being dictated by two air masses. These are the tropical maritime air mass (TM) and the tropical continental air mass. The former which originates from the Atlantic Ocean is warm, moisture-laden and it is the rain bearing air mass. The tropical continental air mass is a dry, hazy and dusty air mass that originates from the great Saharan desert. The prevailing period of the tropical continental air mass which is also known as the North-East trade winds is between November of one year and February of the following year. It brings coldness over the federal capital region. The period of prevalence is a hazy period that has the significant implications of lips and skin cracking. The tropical maritime air mass prevails as from March to about November of the

same year. It is the wind that brings rain to all over Nigeria. The length of the rainy season is 190 days in the south and 180 days in the North, with an annual total of about 1632mm. ((Adefolalu 2001). The rhythmic alternation of these two important winds gives rise to two seasons over the study area. These are the dry season which is experience when the Tropical continental air mass (Tc) prevails and wet season that characterizes the presence of Tropical maritime air mass (Tm). The combined effects of these two seasons give rise to Guinea savanna type of vegetation and catchments of wooded savanna to the southern transitional belt of the territory.

The territory has two seasons. These are the dry and the rainy seasons. The rainy period is from April to October and the dry time is from November to March. Temperature could be up to 37° during the dry season with a diurnal range of 17°. During the rainy season it could be as low as 7° mostly in July and August. Humidity could be between 20% and 30% at the dry period over 80% during the peak of the rainy season. There is a very high seasonal fluctuation in terms of precipitation. The annual range is 1.100mm to 1.600mm. In conclusion the high altitude and undulating terrain of the territory act to provide a regulating influence on its weather.

(d) Vegetation: The territory is characterized by two major vegetation belts. These are the guinea savanna and wooded savanna. The unique attributes of the vegetation is that trees here are scattered with few grasses when compared to the Sudan savanna. The trees are deciduous and have tall trunks with thick back to withstand the occasional fire outbreak that is often experienced during the dry season. The leaves of trees are broad and grasses very tall. Examples of trees found here are locust bean, shear butter. oil beans and

Isobolinas. A breakdown of the vegetation composition shows that parkland or grassy savannah makes up 53%, savannah woodland 24.85 % and shrubby savanna 22.9%.

(e) Soils: The soil of the territory is shallow, sandy and highly erodible. However deep clayey soils are found around the Gwagwa plain where we have gabbros fine-to-medium texture biotite granite as parent materials. The most fertile and productive soil in the territory is found on the Gwagwa plain.

(f) POPULATION: It was estimated that the territory will have a population of about 124.677 by 1979 and 132,816 by 1980. It was then estimated to have an annual growth rate of about 2%. Contrary however, the incidence of unguided in-migration catapulted the population of the federal capital territory to 492,230 in 1980, and 516,900 in 1987 and 555.668 in 1985 (FCDA 1986.). Table1.2 below shows the population distribution by area councils.

Council Area	1981	1991	1999
1. Abaji	18,545	23,647	32,264
2. Gwagwalada+Kwali	39,865	80841	110,637
3. Kuje	29,265	61329	83,933
4. Municipal+Bwari	72,900	212,854	291,238
Total	170,575	378,671	578,238

Table 1.2. Population of the F.C.T (1981-1999)

Sources: Federal Capital Development Authority, Abuja.

(g) PEOPLE AND CULTURE: The federal capital territory houses people with very rich cultural heritages. These include musical dances, folklores, work of arts and crafts. Traditionally the gwaris which constitute the largest population are farmers that are spread in various area councils of the territory. They are very friendly, hospitable and

hardworking in nature. Other major ethnic groups within the territory include the Gwandara, Korros, Tivs and the Ebirras.

Currently, these major ethnics have so mixed up with migrants in the city and in Jabi, that it is almost impossible to identify a region where purely any of the indigenous tribe resides. In the past however, before the development of the federal capital territory, the korros live around the Sherre and kawu, the gwandaras were around Sereti, Nyanya, and karshi, while the gbagi were found in the central part of the federal capital territory areas like Karu, Garki, Maitama, Jabi, Mabushi, lugbe, and Durumi. Table 1.3 shows the distribution of the major ethnic groups by area council

Council Area	Gwari	Gwandara	Gade	Korro	Bassa	Ebira	Hausa	Tiv	Othes
Gwagwalada	69.6	5.9	5.9	13.1	0.1	2.6	2.1	0.1	0.6
Kuje	59.5	2.7	0.4	6.6	2.6	2.6	16.7	0.8	8.1
Municipal+Bwari	82.1	1.0	16.7	0.0	0.0	0.0	0.0	0.0	0.0
Abaji	35.5	1.2	1.4	50.1	2.5	6.6	0.3	2.2	0.2
Total	246.6	10.8	23.3	69.8	5.2	11.8	19.1	3.1	8.9

Table 1.3. Main ethnic groups in the F.C.T in 1984.

Sources Abumere (1993), based on University of Ibadan Consultancy Report

1.1.1 CONCEPT OF URBAN SPRAWL.

The present rapid world and urban population growth and the high cases of migration to the urban areas, have led to the expansion of the urban centers. Changes in urban sizes with reference to increase in their sizes have been brought about by land use conversion. More towns grow around the main cities. The suburb, towns and villages develop alone lines of communication like roads, rails, and courses of great rivers. There is however the need to differentiate between urbanization and urban sprawl.

Urbanization has been defined "as a form of urban growth that is a response to the often bewildering sets of economic, social, and political forces and to the physical geography of the area". Sprawl however is initiated and fuelled by factors like population growth, economy patterns of infrastructural initiative like construction of roads and the provision of infrastructures using public money and encouraging development. According to the United States General Account Office in 1999, sprawl lacks one definition. (Johnson 2001.).

However, Johnson (2001) forwarded several possible definitions for consideration. He however summed up that, since sprawl is 'discounted by some and yet demonized by others, a consensus cannot be reached'. The Sierra Club however attempted a definition of what constitutes an urban sprawl. To it, sprawl is seen as the irresponsible often poorly planned development that destroys green spaces, increases traffic and air pollution, crowds' schools and drives up taxes. (Sierra club 2001, 1). Sprawl has been compared to a disease process and therefore called a 'virus' (Dilorenzo 2000). Harvey and Clare (1971) described it as the scattering of the urban settlement over rural Landscape. In addition, Pendall (1999) sees it as a process of low density urbanization. Weitz and Moore (1998) had their own view too. To them sprawl connotes a discontinuous development. From these arrays of definitions and perception of the concept of sprawl; it is therefore to be considered in a space-time. It therefore implies that sprawl is not ordinarily the increase in urban land area, but the rate of increase relative to population growth. Conclusively, sprawl may then be said to have taken place when agricultural land is converted to non-agricultural and non natural uses and such uses exceed the rate of population growth (USEPA 2001).

1.1.2 SPATIAL FORMS OF SPRAWL

They are made up of three basic types. According to Harvey and Clark (1971). they include

(i) Low density continuous sprawl.

(ii) Ribbon sprawl and

(iii) Leap frog sprawl.

The low-density continuous sprawl involves the highly consumptive use of land for urban purposes along the margins of existing metropolitan areas. Basic urban infrastructures like light. water. sewer. roads are usually supplied to this region. When sprawl develops along road arteries from the city core outwardly, they are referred to as ribbon sprawl.

Land adjacent to corridors are developed but those without are not. However. as the land values increases the raw land near by will be put into use. The provision of infrastructures to this area is often perpendicular to the lines of communication.

Leap frog sprawl development occurs when development are in patches and discontinuous from the core of the city. The sites of development are often separated from the cities. and they are also separated from each other. Harvey and Clark (1971) observed that provision of urban infrastructures to this location will entail more capital allocation than the earlier two.

The causative factors also slightly differ; these include the physical geography such as rugged terrain. wetlands. mineral lands, mountains. water bodies. These may disallow a belt of continuous development or make it prohibitively expensive. Another factor that accounts for leap frog sprawl is restrictive land use policies. Jabi area can therefore be examined as a sprawl emerging from the establishment of the federal capital city of Abuja.

1.1.3 EXURBAN DEVELOPMENT AND SPRAWL.

Exurban development can be viewed as the development of non agricultural residential dwellings in predominantly agricultural and forested areas located beyond the suburbs of cities. Shaws (1991. 23) describe it as an extended low density development. Exurbanites are often people that formerly live in the urban core. Most of the dwellers of Jabi life camps come under this category. As they become wealthy and in some cases old. they seek for solitude and prefer living at the country side. They purchase second homes as rural retreat. Exurban development has affected the rural economy and rural land use activities like farming, mining and forestry in recent times. The interest of the Exurbanites often crashes with those of the traditional dwellers as regards the most appropriate use of the rural land. It can then be said that suburban development as a form of urban sprawl is rapidly consuming the rural land; threatening those aspects that make the country side special. This study intends to examine the level of urbanization that has taken place over the study area for at least the past twenty years.

Remote sensing techniques shall be used to study the development, patterns and the impacts of such development in relation to that of urban sprawl in the area under discussion. Data from this work will be of immense importance to the health plans of both Abuja town and the sprawl regions of the town. The various local councils will need it for periodic revenue and tax assessment. It is also vital for waste management authority, water supply, housing planning and other environmental protection agencies. The overall data is expected to serve as an input for general future plans and implementations.

Though there may have existed data on this particular areas of study in the past. there is the need for current and comprehensive inventories that will reflect the ever changing spatial phenomena. The most dynamic of these are the influx of migrants, changes in the economic

status. the structural changes in terms of housing and terrain configuration. the transportation modes and ownership of housing and means of transportation.

Considering the volume of data required for the exhaustive study of this nature. there could be no other more appropriate parameters than remote sensing techniques.

Remote sensing allows for a large volume of data to be collected and data can be acquired regularly too. This is made possible by the application of the multi-bands sensors that operate within the range of the Electro-magnetic spectrum. (E.M.S.).

Remotely Sensed images, topographical and land use maps of the study area will be used for this study. These will permit us to visualize the level of changes that have taken place over the time, and how this has led to the development of sprawl.

Adeniyi (1976) stated that for a reasonable developmental plan and implementation to be carried out. there is the need for us t o know what had been on the ground. what is on the ground. and what may soon be on the ground. This then implies that a current. regular and comprehensive data on Abuja and its peripheral settlements are necessary ingredients for effective and viable developmental plans. G.I.S. has proved a worthy tool for data compression. analysis and correlation. It shall be used to manage data generated in this study. .

1.1.4 REMOTE SENSING AND URBAN SPRAWL STUDIES.

Remote sensing has been defined as the scientific act of data acquisition through the use of electromagnetic radiation by a sensor that has no physical contact with the target. Man has been in the business of data collection from the beginning of creation. The

appearance of the new moon was always being looked forward to for certain ceremonies or activities at a particular season of the year. Hunters were able to look for, identify and interpret footprints and tracts of animals.

Signals, symbols and signs were sent and sensed by man in the forms of smokes, gunshots; drumming, gong and town crier were all in use before the advent of the conventional techniques of sending signals remotely. These were all forms of remotely sensed data. In the current dispensation, cameras are among the common sensors that are in use. Aerial photographs of the earth have been taken since 1930 from aircrafts. They were then used for city planning, military operations, and to record and monitor soil and forest changes among other uses. With the presence of computer aided software data acquired through special sensors called the multi-spectral scanners, infrared and microwave sensors can now be analyzed and interpreted. These sensors acquired data through the multiple portions of the Electro Magnetic Spectrum. This development helps in large quantity of information gathering and mapping. Invisible energy of the E.M.R is however recorded using the infrared and microwave sensors. Infrared is effective in heat detection and temperature variation, while the microwave is effective in the transmitting of pulses and recording of the reflectance.

The first landsat was launched in 1972 by the United States. Landsat 5 was then used to capture the image of the entire earth surface at an interval of 16 days. Each image then covered an area of about 31000 sq.km (11,970sq.miles). It has the capability of showing object to as small as 900sq. meters (9700sq. ft.). An improvement over this came through the French Spot (Systeme Probatoire D'observation de la terre). It has produced images as small as 100sq, m (1.100sq.ft). Since this period, tremendous improvements

have been made in the areas of sensors accuracy, sensitivity and speed. These include the operational Indian Remote Sensing that was launched on the 17th June, 1978 and French Agency Spot of 1986 that has the spatial ability of providing images of 3-D characteristics. It is quite useful in urban and rural studies. Ikonos now gives images of about 0.6 meter resolution which enables you to identify features as small as a table or a board ruler on an image acquired through Ikonos. (IKONOS WEBSITE.)

1.2 STATEMENT OF RESEARCH PROBLEM

The move to take the Federal capital of Nigeria to Abuja came in 1976. This was brought about as the land area of Lagos can no longer support the weights of the various Federal ministries, Foreign missions and private enterprises. It is worth noting that as at that period in time, Lagos was both a state and Federal Capitals. It then became the national and regional economic, social, and political nerve center of the country and the region it represented. All said discussed and agreed, Abuja was chosen as the federal capital city base on the criteria contained in table1.1 of the next page. It was a mere local village that did not have the attributes of even a zonal development office then. From 1980, construction work for the expansion of the area started in earnest. As designed, the federal capital city was meant to accommodate all the federal parastatals, various diplomatic offices and private organizations .This situation greatly led to the influx of population to the city and its peripheries. The unregulated population in-pore has had spill-over effects on the peri-urban areas which Jabi the study area was not an exception. Currently this trend has to a large extent altered the economy of the aforementioned settlement. From the traditional agrarian settlement it used to be, Jabi now has a

configuration of a very complex economic set up. The current national emphases are on political and economic affairs with little or no care for the environmental consequences of the unchecked growth in human number in a definite geographical unit and his activities thereof. There is therefore the urgent need for data base on this vital and important part of the nation. If they are available, they should regularly be updated to reflect the current situation on ground. Data of such are of immerse importance to policy makers, researchers and legislators, commercial and private enterprises. Remote Sensing information technology has gone beyond the level of ordinary physical mapping and now permeates into all aspect of human activities. Remotely acquired data had proved effective in the assessment of regional expansion, infrastructural development and depletion and also in the assessment of the level of landcover and landuse conversion. Land sat ETM of 2001, Nigeria Sat 1, topographical map of Abuja (1979) and a comprehensive land use map of the Federal Capital city are the tools for use in this study. This study intends to identify the extent of urban-rural conversion that has taken place overtime. Equally, the implications of such conversions and then possible solutions generated from the application of remote sensing shall be proffered

S/N	CRITERION	WEIGH BY PERCENT.
1.	Centrality	22
2.	Health and climate	12
3.	Land availability	10
4.	Water Supply	10
5.	Multi-access Possibilities	7
6.	Securities	6
7.	Local sourcing of Building Materials	6
8	Low population Density	6
9.	Power Resources	5
10	Soil	4
11.	Drainage	5
12	Physical Land Convenience	4
13	Ethnic Accord	3

Table 1.1 Basis for choosing Abuja as a federal capital
Source: F.C.D.A Abuja.

1.3.0 AIM AND OBJECTIVES OF THE STUDY.

1.3.1 AIM.

The aim of the research is to demonstrate the applicability of remote sensing and G.I.S Techniques in assessment of impacts of Abuja federal capital city on Jabi.

1.3.2 OBJECTIVES.

(a) Classify remote sensing images of Abuja for different historical dates to derive historical information on land use changes.

(b) Classify the digitized topo-map of Abuja of 1979 to obtain land cover information for that date.

(c) To generate information on land cover and changes between 1979 and 2001.

(d) On the basis of (c) assess the nature and magnitude of changes.

1.4 JUSTIFICATION.

Abuja for the past 17 years has greatly captured the attention of the whole world as the capital of Federal republic of Nigeria. Events in the federal capital city and its peripheral settings have also attracted a lot of researchers' attention in recent times. It is evident that as Abuja the federal city grows in structures, population, economically, socially, and in fame, one cannot loose sight of the clear indicators of urban poverty both at the city centre and particularly at the peri-urban environment of the great city. The importance of current data about the urban and rural livelihood of the federal capital territory dwellers to both policy makers and executors cannot be overemphasized. In a very complex and multi functional city like Abuja, there is the need for constant acquisition of relevant data about the entire location for effective planning, execution, management and monitoring.

Data of such importance can quickly and cheaply be acquired through the use of Remote sensing devices. A lot of firms from both within and off the shore of this country have been set up and are being set up currently in the Federal capital territory. These indicate the need for adequate information about the federal capital city and its environment. This then shows that the study will not only be relevant to the area council, and Federal Capital Development Authority, but also to our multi-million naira investors that are setting up their businesses in the country and Abuja in particular. Remote sensing is the basic tool that provides the capabilities for effective planning, management, resource inventory and monitoring for the millennium. (Bale et al, 1973).

Remotely sensed data and G.I.S computed data has the advantage of being updated to reflect the present features and events on the ground. It then meets the requirement for

provision of the right instrument for regularly and accurately acquired data for this purpose. Adequate data for comparative analysis of any urban and peri-urban setting is hoped to be available from this work. It has then been dimmed necessary to at this point consider the urban poor in our immediate environment. The economic status of any nation is dependent on the reasonable use it has put her natural resources to (Adeniyi 1972).The natural resources are coming from the neglected periphery or the peri-urban. It is common features of the country's economic process to tap the resources of an area in both the human and physical senses and that particular region forgotten. This therefore calls for a regular re-awakening of both the federal, state and the local government areas of this nation to be on the alert to both their physical and social environment in their decision making. Jabi and the surrounding villages were noted for abundant production of Yam. Fish. and Vegetables for Abuja in the past. Laborers that provide services to the always very busy workers came from Jabi and its environs. Currently this area is now being put under development with the resultant consequences of the indigenous farmers being displaced and the natural environment being concretized. Hence the need to evaluate the rate of change that have taken place over the period under consideration. consequent of the establishment of the federal capital territory.

1.5 SCOPE AND LIMITATIONS OF THE STUDY

The choices of the topic and study areas were made based on the available images. land use maps and topographical map of the federal capital territory. Time also had a very great impact on this work. The study was limited to the federal capital territory whose images. topographical map and a comprehensive land use were available. These were

acquired through the assistance of the Nigerian Airspace Research and Development Agency {NASRDA} and the land survey department of the Federal Capital Development Authority. Abuja. The images include Land sat of 2001 of 36meters resolution. land sat of 2002 at the same resolution and Nigeria Sat 1 at 36meters resolution. Jabi was then located and identified. Image interpretation was carried out in the laboratory using Arc View 3.1 and Envi.3.5 runtime and Idrissi 3.2 software: these were used in the estimation of the area coverage of the various land use classes. Various image enhancements. such as stretching. querying, annotation and classification were carried out.

The study therefore is limited to the information acquired from the land sat ETM images of 2001. 2002. and Nigeria Sat 1 image of the federal capital territory. topographical maps. land use map, and other written literatures on the area and ground truthing. One other limitation is the time lag between the times the images were acquired and of the air photograph from which the land use map and the topographical maps were extracted. The disparity in the interpretation from the various data sources were however rectified through groundtruthing.

The Federal capital city and Jabi were the study areas. The Federal capital territory is made up of six area councils. These include Abuja municipal. Bwari. Suleja. Gwagwalada. and Kuje. Jabi has been chosen because it is a settlement that had a very direct impact of rapid expansion due to the establishment of the Federal Capital City on its environment. One of the reasons for selecting this location also, is that of time constraint. Accessibility to the locations is also among the reasons for taking this location. Data on the area are also available. It is intended that the livelihood and provisions of infrastructures. transportations and physical development in terms of built- up areas are some of the

variables that shall be examined in this research. The aforementioned variables of the Jabi the study area strongly call for this study in view of its proximity to the federal capital city. Remote sensing and G.I.S parameters such as digitizing, area delimitation and estimation as well as histogram analysis shall help in unveiling the environmental changes that have taken place over the past 20 years as well as the impacts thereof. It is hoped that from this case study as it relates to Jabi a peripheral settlement, inference could confidently be made to any of the peri- urban settlements of the city.

Remotely sensed data have been used in this study because of the several inadequacies tied to statistics from government offices. They are either too old or outdated. or are incorrectly acquired and falsified where they are available. Remote sensing data especially those on the landsat ETM images of the federal capital territory as used in this studies have helped to overcome such shortcomings. (Ikhouria 1983. Adeniyi (1980. Jense1996) In the area of assessing the core-periphery interaction, not much work has been done as major interest are often concentrated on the urban areas at the expense of the periphery which is the traditional natural resources base. The need for this data as it affects the suburbs and the federal capital city is one of the many concerns of this study

1.6 THE RELEVANCE OF REMOTE SENSING AND G.I.S TO THIS STUDY

Remote sensing has been defined by several authors differently. However. a more holistic definition seems to have come from that given by Short (1982). He defined remote sensing as the process of acquisition of data and derivation of information from an object. and an area on or above the earth surface or from materials (targets) using sensors that are separated from the target through the interaction of both extremes via the

Electromagnetic spectrum. The quantity, quality and location of natural resources could easily be identified and assessed by the use of remote sensing. (Adeniyi 1987)

The use of remote sensing gives us a multi-purpose image that can be refined to suit many users' demands. Changes in our environment being it natural and man made can easily and daily be recorded by remote sensors. This enables the monitoring and management of the ecosystem and even distant earth's atmosphere. The cost in terms of man hours and finance has reduced the relevance of traditional survey to this modern day studies. The use of remote sensing became very obvious when we examine the following advantages of the system.

(a) Remotely sensed data, either the optical and digital type can permanently be kept depending on the storage and care given to the document. The data could be stored in compact disks, floppy 3.5 diskettes or the hard copy that could be printed out and kept.

(b) It has multi spectral ability that even outside the visible bands you can operate at the micro wave band. This is the capability that enables sensing come rain come sunshine. Radar sensors propagate pulses to the target and through the antenna, the reflectance is recorded. The reflectance contains the properties of the object that is being sensed.

(c) It can effectively be used to study dynamic processes, like urban sprawl, desert encroachment, the arrival of tornadoes, flooding, forest fire and movement of human and wild animal populations. Satellites images are presently being acquired every minute these days. This facilitates accurate monitoring of any dynamic process like the ones listed here.

Aerial photographs and images have attributes such as shape, size, shadow, patterns, places, textures, site and association. These attributes help in the identifications of areas and structures, as well as detection of changes that had taken place over time and

rectification for accuracy. These merits of Remote Sensing enable us to assess what had been on the ground. what is on the ground and what will be on the ground in the nearest future.

CHAPTER TWO

2.0. CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

2.1 URBANIZATION AND ITS CONSEQUENCES.

Man has a great land mark in the area of building towns and cities. Urbanization is the physical process through which towns and cities expand. Every country of the world is characterized by the presence of large cities and towns of great population. History has it that as at 1800. the only urban centre was London with a population of only one million. This was about 3% of the world population. Urban settlements or centers are noted for the presence of opportunities and hence they will always continue to attract more people.

In the developing and developed worlds. urbanization has caused a lot of problems in recent time. These problems include increase in social vices. congestion of houses and vehicles. polluted environment, poor sanitary outlook, poor housing. high cost of living and acute cases of employment, but to mention a few. The rate of urbanization has now risen to 29% per annum all over the world and it is predicted to rise to 50% by the year 2006. (WHO 2002.).

2.2 URBAN CHANGE AND CHANGE DETECTION

One part of the evolution trend of nations is the changing of their capital cities from one location to another for either spatial or political reasons. In most cases political reasons are more influential than the spatial aspect. Australia has changed hers to Canberra. Brazil to Brasilia and Cote D'Ivoire to Yamoussoukro. Theirs were initiated by the demand to alleviate the pressure on the traditional capital cities.

Several factors have necessitated the move for a new capital city out side Lagos. The inadequate land for expansion, lack of centrality, urban crisis, and lack of proper cosmopolitan were a few of the reasons advanced. Abuja then became the popular choice and construction work began immediately after the proclamation of the area as the federal capital city in 1976. The establishment of the federal capital city has had a pull effects on the rural population. People from the country side that are impoverished due lack of employment, overpopulation resulting from high birth rates, starvation and pressure on land and the inordinate need for any means of survival and the white collar job in particular.

Abuja that has been seen as a "no man's land" that wears a look of having a better chance for a well paid job, comfortable accommodation, social amenities and a more reliable source of daily living. This is what Nigerian think, expect and are led to believe. The contrary however is the reality as the population in Abuja has soared up. The phenomena on ground are that demand for housing has increased. There is in addition to the demand for more motorable routes as the population has increased, more schools and hospitals are equally needed to cater for the teaming population of this city.

The movement of federal ministries from Lagos to Abuja has sparked up expansion in all directions. Many of those that moved into Abuja may likely not have much money, and the implication on the long run is that they will erect temporary shelters, typical of these are those at Gwagwa, Karimo, Mabuchi and part of Jabi areas of the federal capital city

Remote sensing and G.I.S techniques shall be used to examine the multi-dimensional changes that have taken place over time in this city. Attention shall be specially focused on Jabi with references to its physical environment.

2.3 ABUJA AND JABI.

With the current rate of development the satellite towns near the city have undergone and are undergoing a lot of physical, economical and psychological changes. The need for land for residential buildings has led to the expansion of the built up areas and a great reduction in the agricultural land of Jabi area. For a sustainable development, there is the need for us to know what is currently going on around Jabi. The nature of the natural environment has been presently concretized; vegetation of the area removed, pollution and reckless waste disposal is the order of the day and natural habitats utterly destroyed. The cost of living here has increased and crime rate risen. There is pressure on the few amenities available, informal settlement is a common sight in this area now and these, kindle the interest for this study.

2.4 ABUJA AND SPRAWL DEVELOPMENT.

The need for a federal capital came in 1914 when the southern and northern protectorates were amalgamated. Kaduna that appears centrally located geographically was then suggested by the then governor general, Sir Fredrick Lord Lugard. Kaduna's location gave the impression that it is equidistant from the four corners of the country. The suggestion was however not accepted by the home lords. Instead, Lagos was crowned as the capital of the federal republic of Nigeria. A position it held until 1975. On August 9th, 1975, General Murtala Mohammed who was then the military head of state inaugurated a 7- man committee headed by Justice Akinola Aguda. They were given the task of carving

out a politically non-affiliated location that will serve as the capital of Federal Republic of Nigeria. This need arose out of the fact that Lagos in view of the rapid economic and population growth could no longer support the weight of it. At this critical time. Lagos was as both the capital of Federal Republic of Nigeria and capital of Lagos state. The product of the committee's intensive work resulted in the recommendation of Abuja as the federal capital. Their recommendation was accepted in 1976, under decree no. 6. Ten days before he was murdered in a coup detat. specifically on the 3/2/76. General Murtala Mohammed proclaimed Abuja as the federal capital of Nigeria.

The land area of Abuja is put at 8000 square kilometers. It is bordered to the north by Kaduna state. west and North West by Niger state, to the south by Kogi state and to the Eastern part by Nasarawa state. It is located between longitude six degrees forty three minutes and seven degrees thirty minutes east of the Greenwich meridian and between latitude eight degrees fifteen minutes and nine degrees ten minutes north of the equator.
Of the toal land area of federal capital territory, the federal capital city occupies 256 sq kilometers and that forms 3% of the total land area. Currently the Federal capital territory is made up of six areas councils. These include Abuja municipal area council. Garki. Bwari. Abaji. Gwagwalada and Kuje.

2.5 REOMTE SENSING AND URBAN CHANGE DETECTION.

Remote sensing techniques have been used in several studies to detect urban land use changes. Such changes detected, have helped to illuminated the impacts of such changes in recent times. Some of these are discussed below.

Sokoto area was studied in 1983 by Omojola and Soneye. Here, an integrated data made up of those from remote sensing and G.I.S were use in mapping and inventory of land use and land cover. Still in Nigeria Ikhouria (1993) applied remote sensing and G.I.S

parameters to the study of land use change in the North-East part of Edo. Adeniyi (1980) also studied changes in Lagos area using remotely acquired data. A lot of studies from these few examples given above have been carried out with reference to environmental studies using remote sensing and G.I.S. With the integration of the computer approach to image processing and G.I.S modification. there is a high level of accuracy. great speed in processing time. ability to manage and analyze large volume of data at a time and the ease of modification of input data. Details of those studies are discussed below. It is at this junction hoped that this study will concretize this fact as they relate to remote sensing and G.I.S as vital tools for the acquisition and analysis of urban-rural interaction. with particular reference to the current change trend and other environmental issues.

The applicability of remote sensing was demonstrated by Dunford in 1980 in the study of rural development in Africa. The purpose for using this particular parameter was to minimize the money. personnel and time that will be required by such exercise. In the study. he used aerial photograph, enhanced landsat imagery and topographical map of the area and earlier study records of the area. He was able to acquired information about the land use and land resources data of Arusha in Tanzania for the period of three months. The area he studied covered the rift valley of northern Tanzania and surrounding highland and plains. The areas named above are areas of ruggedness and reconnaissance survey of the areas was firstly undertaken. Digitally enhanced landsat images of three years duration (1972-1976) were integrated for the delineation of the mapping units. They equally used the systematic flight style in the bid to do the interpretation of the data. More studies were also carried out using the vertical colour aerial photography. It is on record that the villagers were also involved in the study of this area; this assisted them in identifying

habitations, landuse and the boundaries of the village areas. The study proved the efficiency of the area coverage of remote sensing and the economy of materials and men.

Using remotely sensed data, Rao (1994) estimated the growth of the built up in India for 2001. Rao in 1994 was able to do this through visual interpretation using the interpretation key he has prepared. He identifies three main determinants of growth. To be able to forecast future growth he used three methods. These are the casual modeling method, cross classification and rating methods. The casual method was used to detect the causes for that affect built up in Tuni area and also tried to calibrate the formula that will predict future values with accuracy. The growth of the dependent variables and its influence on the growth rate was computed using the cross classification method. Finally he used the rating method to circumscribe the parameters which developed due to the influencing variables. These methods used provided comparative and accurate estimate for the present and future built up areas with minimum errors.

Treize et al (1994) also carried out a study in the north eastern fringe of metropolitan Toronto in Canada. Remote sensing data and G.I.S technologies were also used for the work. The work was carried out to examine the rate and nature of land cover and land use change in the area. The specific location was the rural-urban fringe of Markham. Data used in the study include global positioning system data, land zoning maps, Ontario basic mapping data, panchromatic data and the analysis of multispectral data from SPOT. Image. Software developed at the University of Waterloo on a vax 11/785 computer in the FORTRAN 77 was used for the image analysis. This was combined with the Dipix Aries III analysis system. Regions of interest using resampling and classification methods of image analysis were identified. Areas classified included industrial, fallow land.

cropland. pavement. grassland, forest and trees, and bare dry soil and residential are among others. Imparting GPS data and SPOT HRV classification with the land zoning information into a TYDAC SPAN geographical information system. A matrix overlay was performed to construct a map containing significant information. A combination of these set provided accurate and enough data for land use and land cover and also portrayed the trend of development activities. The formula used in this study is also relatively appropriate for the identification of both residential and industrial land use from SPOT HRVXS and Panchromatic data. In attempt to assess land use change

Mattikali ((1995) combine vector based G.I.S with remotely sensed data. He used landsat images of the area as at 1989, 1984 and 1987. Land use map of 1931, 1963 and 1972 of the area was also used. He undertook digital scanning and manual digitization of the data on area acquired before 1984. The unsupervised classification was used however for images required after 1984. Rasta and vector based data were used in his analysis. He integrated the remotely sensed Rasta data by developing an interface between the vector G.I.S and the Rasta image processing system. Data conversion algorithm was used to handle both data sets Mattikali made used of the FORTRAN-77 AND Arch macro language. (AML). Landuse detection was carried out applying Boolean logic to vector formatted data. Using the Boolean operation namely the union, he developed an algorithm to apply the union operation to specific data of the River Glea catchments to derive change statistic. Six landuse categories were identified. They were urban categories. arable. grassland. woodland, water and bare soil. In every union operation he used two successive coverages that gave him 5 unioned coverages and each of these was analyzed for the land

use change. He was able to determine the change over the area for over the 18 years that data were collected.

Remote sensing techniques were also used to detect changes in vegetation and land use changes in the N.E. part of Edo State of Nigeria. Ikhouria (1993) combined the topographical maps. vegetation maps and aerial photographs of the area for the years 1967 and 1977 black and white for his study. By visual interpretation. he was able to identify land use land cover categories of forest. farmland. settlements. water. grassland. and wooded shrub lands. He found out that there was a rapid depletion of the forested lands. rapid territorial expansion of settlements, and the size of the agricultural land had increased. This finding became very useful in re-organization of the rural-urban economic analysis of the middle belt of Nigeria.

Changes in Lagos area was studied by Adeniyi in 1980. He used sequential aerial photograph for this change detection. He developed 9 nine major landuse and land cover categories and 45 subcategories. The nine included Residential, Commercial Industrial. institutional. transportation, utilities, recreational, open spaces, vacant land. non urban land and water. Aerial photographs of 1962. and 1974 were used. They were both of scales of 1:40000 and 1:20000 respectively. His analysis was concentrated to the central part of the aerial photograph alone. This was to avoid the effects of excessive relief displacement. To ascertain the accuracy of his interpretations. he undertook ground truthing of the area.

Through manual transfer. data from the aerial photograph were transferred to the base maps using the Lomb zoom transfer and the Bausch scope. With the aid of a clear Mylar sheet with 100m X 100m grid land use in the area were coded with the relevant land use category code. He did that with a special computer program. This enhances comparison of

data of the two periods on a cell to cell basis. From that exercise he was able to identify locations of changes, amount or degree of change and later produced land use change map with a drum paper. With the computer aided accessories, data manipulation, interpretation, interpolation and generalization of large volume of data were all made possible. Though there were instances of scale differences, the changes that have taken place were so prominent and glaring from this study. This is shown in the areas of rapid growth of residential land use and a strong lateral expansion of the urban areas of Lagos state of Nigeria.

Doyle et al., (2001) did a study on the significant threat to environment resources that is emanating from the very rapid rate of urbanization in the United States. Satellites remote sensing data were used to assess the pace at which residential buildings were taking over the natural habitat thereof. Barnes, Morgan and Roberge (2000) also carried out a work on the environmental impacts of urbanization and impervious surfaces on the Chesapeake Bay mid-Atlantic Region in 2000. Space acquired images were also used for their analysis. Arnold and Gibbons (1996) did a similar study and used the same remotely sensed data too. Johnson (2001) and Scheuler (1993) equally made use of images from satellites in studying the impacts of urbanization and impervious surfaces in various locations in the United States at different times. . In 2003, Cheng J. and Masser did a project on urban growth modeling in Wuhan, People's Republic of China. They equally made use of remote sensing techniques. Remote sensing techniques were also used by Civco et al (2002), in their attempts to quantify and describe urbanizing landscape in the northeast United States.

These are a few of the previous studies that dwelled on environmental issues that have to do with land use and land cover change. From the analyses, we have seen the efficacy and applicability of remote sensing and G.I.S in land change detection researches.

From the application of Remote Sensing techniques to find the changes and the tailing environmental impacts. a lot of solutions and suggestions have been proffered by past researchers thereby helping in solving environmental problems emanating from such changes. It is also my strong hope that this study too will also illuminating the applicability of remote sensing to land cover and use change detection, the impacts thereof and thereby aiding in environmental monitoring, management and modeling.

CHAPTER THREE.

3.0 MATERIALS AND METHODOLGY

3.1 Description of data.

(i) Topographical map of the Federal capital territory.

This was obtained from the planning, land and survey department of the federal capital development Authority. This map was originally drawn in 1979 and revised in November 1991. The topomap has a scale of 1:200,000 and was revised, produced and printed by Cartoprint (Nigeria) Limited Kaduna. From this map the federal capital city with Jabi were located. Using this map, the built up area as at 1979 was estimated using the Envi Runtime soft wares. On this map magnetic variation as at January had annual change of 5° 5'. The projection of the map was according to the Universal Traverse Mercator. And meridian of origin 0° 00' East of Greenwich. Image properties of this topographical map are contained in figure 3.1 below.

(ii) Landsat images.

For the purpose of image interpretation, three types of images were used for this purpose. These are Landsat ETM of 2001, Landsat ETM of 2002, and NigeriaSat 1. Before critical analyses were made, the three images were georeferenced and disbanded. This was to facilitate digitizing. Digitizing was done using Idrissi 3.2 version 2. From the three images it was possible to visualize the current extent of development and the amount of agricultural land taken over by urban expansion. It was possible to see also that Jabi which was by the 1979 topomap outside the city has now been totally swallowed up. Using Arc View, Idrissi 3.2 and Envi 3.5 Runtime. The images were classified, digitized

Image identity.	Landsat Dec. 2001.
Width (cm)	71.7
Width (pixels)	2798
Heights (cm)	56.3
Heights (pixels)	2203
Vertical resolution	100
Horizontal resolution	100
Colour	True
Compression	Uncompressed.
Bit depth	24
File type.	TIFF.

Fig 3.1. Properties of the Landsat image of 2001.
Source :Compiled by the Author

Layer name	L7_Dec01_mss_enh.
Layer type	Raster.
Data type	24_bit RGB
Reference system	UTM 32n
Reference unit	Meters
Min X	0
Max X	2798
Min Y	0
Max Y	2203
Columns	2798
Rolls	2203

Fig 3.2 Layer properties landsat 2001 image.

Image identity	TopoAbj.
Height (cm)	14.98
Height (pixel)	882
Width (cm)	15.02
Width (pixels)	887
Horizontal resolution	150
Vertical resolution	150
Bit depth	8
File type	TIFF
Colour	Palletized
Scale	1:200,000
Year	1979
Publisher	Cartographic unit. F.C.D.A.

Fig.3.3. Properties of the Topomap of Abuja.
Source: Compiled by the Author.

Height (cm)	47.45
Height (pixels)	1868
Width(cm)	47.45
Width(pixels)	1868
Vertical resolution	100
Horizontal resolution	100
Bit depth	24
Colour	RGB

Fig 3.4 Properties of NigeriaSat-1 image.
Source: Compiled by the Author.

and annotated. With the Arc View and Idrissi soft wares area estimation of the features on the images were carried out. Properties of the topographical map landsat and the NigeriaSat-1 images are shown in figures 3.1, 3.2 and 3.3 above. The topographical map was converted to a geotiff image format before analysis.

(iii) COMPREHENSIVE LAND USE/LAND COVER MAP OF ABUJA.

This was acquired from the Federal Capital Development Authority Abuja. Titled ABUJA the federal capital city. the plan was draw with a scale of 1:10000.

The comprehensive land use plan was drawn by SF CONSULTANTS NIGERIA in cooperation with SF Cologne consultants West Germany.

The major land use classes included in this plan were residential, educational, community and commercial, public institutions, utilities and employment area, open space, recreational and undevelopable land. Details embedded in this plan were used to concretize the analysis of the land use categories of the study area.

3.2 METHODOLOGY.

The topographical map of Abuja was initially scanned unto the system and saved as GeoTiff image before further analyses were carried out. On the map built up area was represented by red colour, water body by blue colour and elevated areas by brown colour.

3.2.1 IMAGE CONVERSION.

The topomap and the images were initially saved in the system using the TIFF format. During the process of image conversion, they were imported into the Idrisi 32 release two corridor through file.

Importation of the images could either be through the general conversion tools. government/data provider formats, desktop publishing formats or the software specific format. Desktop publishing formats was mostly used during this work. The desktop publishing format enables one to import TIFF image to Idrisi, Jpeg to Idrisi, PCX to Idrisi or TGA to Idrisi. Idrisi soft ware enables accurate conversion. The input and output files names were supplied while output reference information as well as output documentation stated. The reference parameters specified were that of number of rows. columns. minimum and maximum X and Y coordinates, reference systems as well as reference units. The reference system used for this purpose was utm34n and the unit was metres. Area estimation was done using both the Arch View and Envi runtime software.

3.2.2 DIGITIZING PROCEDURES.

To enable clear visualization of the image, the layer frame was maximized. Using the zoom and arrows symbols of the composer bar, image was rightly positioned for the digitizing processes. Information required for this process include the specification of the name of the layer to be created, symbol file for display, data type layer type and the ID or values The layer names used in the project included built up area, Jabi dam, reserved area and erosion land among others. Layer type could either be in the form of points, lines, polygon or text. Polygon, text and lines were used by the researcher in this work. Symbol files used are the Idrisi symbols that are made up of bipol 256, grey256, Idri16, Idri256, Idripoly, qual16, qual256, uniblack and uniwhite. Qual256 was extensive used in this work. Polygonal digitizing, the data type remained as integer while the ID or value is varied for various features.

In the process of digitizing, features could be added to the active vector layer or an entirely new layer for features could be created. Addition to active vector requires the retaining of Id or value while a change in the values is an indication of a new feature to be digitized. Apart from digitizing using Idrisi 32 release two, layer properties, map properties and feature properties can be determined via the composer bar on Idrisi 32.

After digitizing, the composition of the digitized image could be saved or printed directly. The composition could be saved with the following output options.

It can either be saved as map file or as window bitmap (BMP). It can also be saved as window metafile (WMF) or saved still as window enhanced metafile. (EMF).

Most of the images in the work were saved in the window bitmap formats after digitizing.

We also choose to just copy the composition to the clipboard. Finally, we can opt to save the current view of the highlighted raster layer as a new Idrisi image.

When these are completed, output file name is selected via either Idrisi 32 folder. Idrisi tutorial or my document. The final output is an image analyzed for all forms of information.

3.3. DESCRIPTION OF LANDUSE CATEGORIES.

A comprehensive land use map of the federal capital city drawn in 2004 was obtained from the cartography unit of the planning, land and surveying department of the Federal Capital Development Authority. The major land use categories are discussed below.

(i) RESIDENTIAL

The residential zones are classified into four major types. These include the Low density areas, medium density, high density and areas of mixed developments.

The low density areas are those meant for diplomatic uses. The high density areas include luxury apartment while the areas of mixed development is made up of both residential and commercial uses. On both landsat images, the built up areas were represented by purple colour, and on the Nigeriasat1 by greenish colour. The low density area areas are found predominantly around Maitama districts and Wuse zone 2. High density residential zones are found in Wuse zone 2, they include zones 4, 5, and 6.

Areas of mixed development that are characterized by both residential and commercial are however found in Garki district. These include area 7, 8, 2 and 1.

(ii) Educational Zones.

The areas designated by these are locations of Nursery schools, primary schools and post primary. Identified areas include the Abuja polytechnic, Garki, community secondary

school Asokoro, American international school Abuja Nigeria-Turkish International School Wuse 11 and government college Garki.

(iii) Community and commercial

This category is made up of city district and neighborhood centres. They also include health clinic, religious institutions and hotels. The districts here referred are the central business district as the city centre and districts centre of Wuse, Garki and Maitama areas. It also includes the International Arcades in Asokoro, The Jumat mosque and the National Ecumentrical centre in the central area.

(iv) Public Institutions, Utilities and Employment.

This category is made up of government and public institutions, public utilities and employment areas. Prominent here is the three arm zone; the three arm zone is made up of the presidential complex, the National assembly and the Supreme Court. It also includes the Vice President resident and state house annex.

Outside the three arm zone is located the ministries zones. The ministries zones are grided in pattern and they also separate the three zones from the central business districts and the city centre. The first lane is made up of the Federal high court, ministry of agriculture, office of the head of service, executive office of the President, ministry of external affairs, ministry of transport and ministry of aviation. Next to the ministries zones is the cultural zones. This is made up of the National museum, national square, national mosque and the national Cathedral.

Others include the International conference centre, Nigerian Security minting and printing, national theatre, Nigerian institute of Internal affairs and the Federal radio cooperation of Nigeria annex.

(v) Open space, recreation and undevelopable lands.

The National Arboretum occupies the largest percentage of the open lands in the Asokoro Districts. This is followed by the Abuja plant Nursery and I.B.B golf Course The southern margin of the inner northern express way is also bounded by a belt of undeveloped land.

Other areas include the rocky terrain of northern part of Maitama districts and edge of the outer Northern express way and the Kukwaba National park. Areas around the southern parkway and the outer southern transit way are also area of reserved lands

Undevelopable land.

This includes flood and erosion areas, steep ground and forest reserves. The eastern parts of Asokoro district, North western part of Maitama and dotted areas of Wuse and Garki fall under this. Finally, apart from the asokoro hills, other prominent area of hilly nature is the katampe region.

CHAPTER FOUR

4.0. RESULTS AND DISCUSSION

4.1 Introduction.

In attempt to generate data for this project, various image analyses were carried out. The tables below show the estimated area values of the Landuse classes considered. Table 4.1 presents results of the area estimation based on the topographical map of Abuja of 1979. Table 4.2 equally reveals the data for 2001 as extracted from the Landsat image of December 2001. Table 4.3 however, shows the comparative figures for the two years.

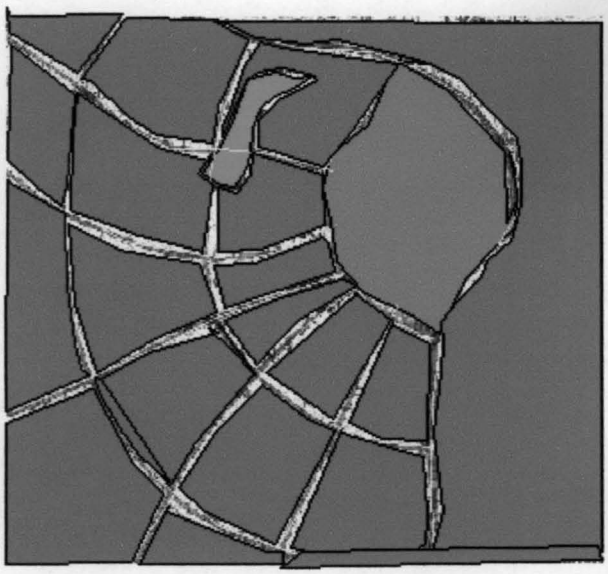
4.2. INTERPRETATION OF THE 1979 TOPO MAP OF THE STUDY AREEA.

A topographical map of Abuja produced in 1972 and revised in 1992 was used to calculate the built up area as at that time. The map which was initially scanned onto the system was then reproduced in soft as tagged information file format. (TIFF). This was done to facilitate the use software like ArcVview and Idrissi 3.2 for the image analysis from the map analysis. It was revealed from area estimation that the potential agricultural land has the largest percentage of area of 202.7sq.km (202700hectares) constituting about 79.1% of the entire 256 sq. km allocated for the development of the Federal capital city. This was followed by the built up areas that make up 38.8 sq. km (38800hectares) and that was about 15.16%.

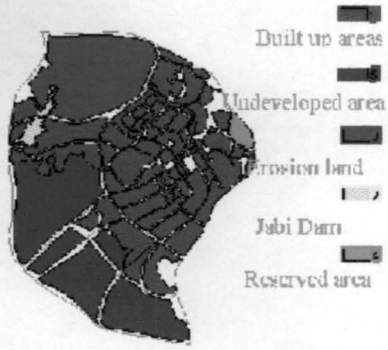
Rugged, flood and erosion terrain covered 2.77% of the area that was about 7.1sq.km (7100 hectares). The Jabi dam was the only surface water body within the federal capital city. It occupied approximately 5.33sq. km. (5330hectares) and that amounted to 2.07%.

Digitized TOPOMAP OF ABUJA (1979).bmp

Fig 3 Topomap of Abuja (1979)



Digitised Abuja image.



Conversion from landsat 2001.bmp

Landsat 2001

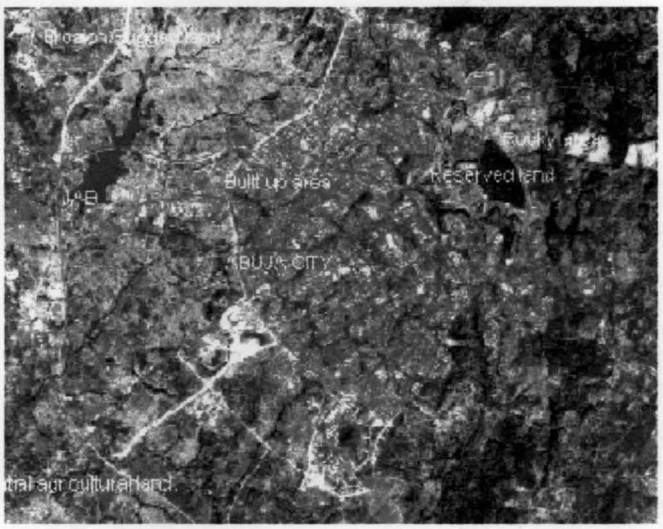
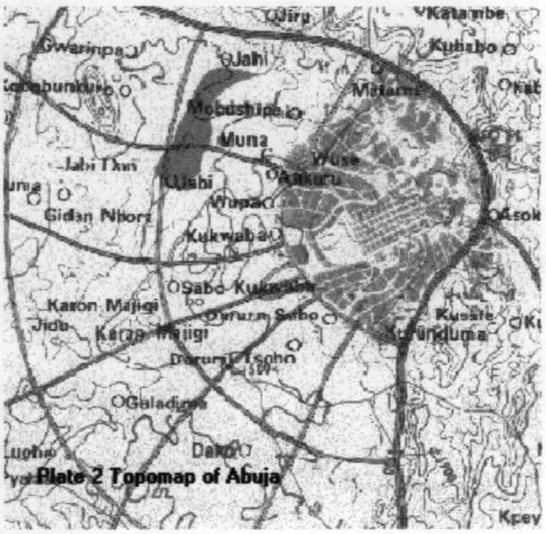


Plate 2 Topomap of Abuja.



Reserved lands constituted 0.82%, making up 2.1sq.km. (2100hectares.). This was the land cover situation immediately after the establishment of the federal capital city in 1979. These figures were obtained using the Arc View soft ware.

4.3. INTERPRETATION OF THE LANDSAT AND THE NIGERIANSAT-1.

These were images acquired in December 2001. December 2002 and January 2004 respectfully. They were obtained from the National Airspace Research and Development Agency. (NASRDA) Abuja. There was at least twenty years gap between the information contained on the topomap. and any of the above images. From the various image analysis

S.N		Area (cm)2	Area (km)2	Area (pixels)	Area (%)
1	Built up area	19.4	38.8	780.48	15.16
2	Water body	2.65	5.3	103.98	2.07
3	Rugged/erosion land	3.55	7.1	139.16	2.77
4	Reserved area	1.05	2.1	41.16	0.82
5	Potential Agricultural land	101.3	202.7	3910.96	79.18
	Total	128	256	5017.6	100

Fig 4.1. 1979 figures for landuse/landcover.
Source: compiled by the Author from topomap of Abuja 1979 on a scale of 1:200000. After it has been converted to GeoTiff image.

S.N		Area (cm)2	Area (km)2	Area (pixels)	Area (%)
1	Built up area	118.5	237.9	4668.9	92.93
2	Water body	2.65	5.3	104.41	2.7
3	Rugged/erosion land	3.55	7.1	139.87	2.77
4	Reserved land	1.05	2.1	41.37	0.82
5	Potential agricultural land	1.75	3.6	68.95	1.41
	Total	128	256.	5023.5	100

Fig 4.2 2001 Figures compiled from Landsat image.
Source: Author.

conducted. it was evident that a great change has occurred in the land use land cover structure of the Federal capital city and Jabi in particular between 1979 and at least 2001.

Analysis revealed that there was a great increase in the size of the built up areas of the federal capital city. The built up areas now occupy over 92.93% of the land area allocated for the development of the federal capital city. This is an area of about 237.9sq.km (237900hectares) out of 256sq.km (256000hectares), allocated for the capital city. Regions identified as potential agricultural land or what may have constituted the natural environment of the federal capital city had a drastically decreased to 1.41% accounting for just 3.6sq. km. (3600hectares). These areas are currently found being used as refuse dump sites or temporary garages. The government reserved land remained fairly unaltered and the water body with 2.07% which is equivalent to 5.3 sq.km (5300hectares) remained unchanged. Rugged erosional terrains remained at 7.1 sq.km (7100 hectares). constituting 2.72%. The areas are presently being reclaimed. This are portrayed by figures 4.1 and 4.2 above. The change analysis was done by comparing the land under development and developed as at 1979 and those developed and under development in the year 2001 using the earlier mentioned soft ware.

4.4 CHANGES BETWEEN THE PERIODS 1979 AND 2001/2002.

During the period under discussion great changes have occurred. These were reflected in the decrease of the areas identified to be potential agricultural land or still the natural environment of the federal capital city. A data table was generated from the figures obtained for these two different periods under observation. It was meant to illuminate the changes that have taken place over these years. It was discovered that between these periods about 12years, over 77.1% constituting about 199.1sq.km (199100hectares) of

agricultural land has been taken over for the developmental purposes. Fig 4.3 below illustrates these facts.

	Area in1979 (km)2	Area in 2001 (km)2	Difference (km)2	Difference (pixels)	Difference (%)
Built up area	38.8	237.9	199.1	1528.72	77.8
Potential agricultural land	202.7	3.6	199.1	7986.38	77.8
Water body	5.3	5.3	———	———	———
Reserved land	2.1	2.1	———	———	———
Rugged/Erosion surfaces	7.1	7.1	———	———	———

Fig 4.3 1979 and 2001 data compared.

Source: compiled by the Author from Table 4.1. and Table 4. 2.

From the images interpreted, there was a great increase in the built up areas. This can be attributed to the increase in the number of government establishments and the influx of migrant population, consequent of the establishment of the federal capital city. The built up areas in this case are made up of government establishments and residential quarters, private investments and their residential quarters, cooperate organizations and the squatters' settlements in some cases. Jabi that started as workers' camp has now been entirely swallowed up by the growth of the Federal capital city.

4.5. DISCUSSION OF RESULTS.

Abuja has been noted to be a region of very sparse population prior to the establishment of the federal capital city. As at 1979, there was no single secondary school no hospital and no single tarred road within or linking the town. And the population of the territory stood at Abaji 4995, Karu 3556 and Gwagwalada 3460. (Abumere et al. 1989)

A lot of changes have taken place since then. The 1998 figures revealed that there are presently 269 primary schools in the area, 35 secondary schools, two federal government colleges, one federal college of education, one gifted child school, over four women development centers, over 48 primary institutions and over 120 bed-roomed hospitals. (Abumere and Mabogunje, 1989)

Most of the head offices of all government ministries are now located in the Federal capital city or within the territory. A combination of the establishments of all these institutions and the need to erect more residential houses for the operators has led to the eating up of the potential agricultural land by way of urbanization. The need to construct more roads to facilitate accessibility to these various organizations had also taken up a large chunk of the area under discussion.

The developmental activities in the federal capital city have grossly led to the destruction of natural Vegetation and the distortion of the entire ecosystem thereof. Areas hitherto noted to have played a vital roles in climatic moderation has now been concretized either for the erection of buildings for residence, schools or cooperate entities or for road construction.

Removal of the vegetation also exposes the surface to erosion agents and occasional flooding during great down pour. Carbon dioxide emission in the ever noisy capital city has altered the lower air composition of Jabi. The level of waste disposal and the population has now put the once pure peripheral environment into another ugly shape.

The original inhabitants of this area have now been sent to new Wuse, New Nyanya or New Karu. This has resulted in loss of united cultural identity. The establishment of the federal capital city has also widened the poverty gap, as it has

heralded the rapid development of squatters' slumps. Examples are abundant at Mabushi. Gwagwa and Karimo areas.

From the master plan of the city, it is expected that the land area that may be required for the setting up of the city was 256 sq.km (256000hectares) or 3% of the territory. This implies that over 97% of the territory will not be affected by the city size. Already this area is almost exhausted. The implication is that areas outside designated radius will have to be developed to accommodate the inhabitant of this ever growing city.

From the figures computed based on the city alone the growth rate stands at 6.4% per annum. It is therefore projected that unless the level of development is checked and controlled. the entire territory will within the next 15 years or so turns into a single city characterized with all the attributes and problems of mega polis.

The questions therefore 'will we still have a trace of natural environment again'? What will the urban environment be like in terms of climate, environmental hazards. crimes management, waste management and all obvious problems tailing an exploding population at the heart of this great country?

There is therefore the urgent need for the planners, administrators and urban geographers and environmentalists to sit and decide on the nature of environmental tomorrow we wish to hand over to next generation.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS.

5.0 SUMMARY.

The research was carried out with the main objective of demonstrating the applicability of remote sensing and G.I.S techniques in the assessment of the impacts of the F.C.C on Jabi area. It was also meant to study the factors responsible for the sprawling of the federal city, patterns of the sprawl and its environmental consequences.

During the course of the study, areas examined include the land use and land cover changes, occupational transformation of the settlement, population changes, and composition of the population and the relative impacts of population influx into the federal capital territory.

The work was meant to highlight to the policy makers the implications and consequences of an unguided urban growth.

5.1 SUMMARY OF FINDINGS.

From the study conducted, there had been tremendous changes in the study area between 1979 and 2004. Most notable is the transformation of the economy from that of agrarian society to that of a complex and mixed economy characterized by the presence of different artisans, craftsmen and men from all walks of life. This has led to pronounced reduction in the potential agricultural land and an increase in the built up area in the peripheral locations around the city. Some of the impacts of the federal capital city on immigrants include the increase in the peak hour ozone level.

Fatal accident per 100000 persons has increased. Rarely will a day pass by without a fatal accident occurring along the Zuba-Abuja express road or the Nyanya- Abuja road.

The daily kilometer driven per person has also increased. Traffic delay has also increased especially along Abuja-Jabi and Karimo axis.

To actually X-ray the consequences of the Federal capital city in the territory, it should be viewed based on the socio-economic and environmental impacts of this urbanization on the environmental and natural resources in Jabi and other peripheral locations around the federal capital territory.

Socially, while some school of thought agued that urbanization helps in reducing housing gap, other are of the view that the cost of owning or hiring in and around federal capital cities have increased. Matthew Khan (2001) concluded after a study in U.S that while sprawl is reducing the housing gaps between blacks and whites it is increasing the affordability of housing in both suburban and the city.

In the case of the federal capital city Abuja, the growth of the city now takes the richer and more enlightened closer to indigenes and the poorer suburb dwellers.

The federal capital city imposes considerable economic, aesthetic, physical and economic cost on Jabi and other settlements close to it. Economically, this included high cost of transportation, high rentages being charged by landlords, ill-health resulting from polluted air which eventually leads to reduced workers productivity. Emotionally, the original Gwari man that inhabits the area has now been sent packing to New Wuse, New Nyanya or New Karu. This brings loss of Community spirit, values and loss of sense of place. Jabi has been submerged by the city and that aesthetic beauty that goes with the natural environment has been lost to more ugly, monotonous suburban landscape.

Among the numerous physical cost of the Federal city on Jabi are the overcrowded schools (especially the government owned ones), increase in traffic congestion, longer commuting

times and more aggressive driving patterns. Despite the longer hours of commuting and traffic hazards, city residents still prefer the suburb environment where they perceived life to be purer in terms of environment consideration.

Degradation of environmental resources.

The role of the natural ecosystem as it relates to biological and physical activities in the environment cannot be over emphasized. Prior to the expansion of the federal capital city, the natural environment of Jabi areas with its vegetation that constituted the wetlands that served as flood control. The vegetation regulates climate and provided clean air, clean water and on the whole a well-functioning environment. The establishment of the F.C. had led to the degradation, misuse, and in some cases absolute destruction of the vegetation and the biomass thereof.

5.2. CONCLUSION.

This study conducted has revealed some very important findings that are expected to be of great values to the town planners, users and town managers. Firstly, the city has been allowed to grow unchecked. The rate of growth does not by any means conform to what was planned for the area. The unregulated growth had led to the loss in the potential agricultural land and the natural environment that once existed there. There had been tremendous degradation of the soils, increase in environmental hazards and great increase in waste production. The study has proved the applicability of Remote Sensing technology and G.I.S in change detection and monitoring analyses at almost all level.

It is also necessary to suggest in this concluding part that there is an urgent need for the study on the other more specific environmental consequences of this rare

urbanization on the immediate suburb and city core itself. Being particularly located within the radius of the federal capital city and considering its proximity to the central business distinct. the poor sanitary condition of Jabi. Mabuchi. Karu. Gwagwa and Karimo areas call for urgent attention by the Municipal area council authority or the federal government at large.

Unemployment is one of the major factors for youths' involvement in crimes. Many of such youths are abundant in the study area and other peripheral locations near the city center. More detail studies in this direction for proper planning Administration and crises management is hereby advised.

Finally. because of instrumental shortcomings, it is inevitable in works of this nature to be error-proved. The data should serve as starting raw materials for further and more detailed studies on other peripheral settlements and the federal capital city as whole.

5.3 RECOMMENDATION.

In view of the non-renewable nature of some earth's natural resources. development plans and processes should be as effective as possible so as to guarantee future safety of the environment. This equilibrium point at times appears unattainable for the facts that there is a wide gully between the conservationist. the town planners and the policy makers and the inhabitants of the immediate environment. For an effective growth management and monitoring. it is recommended here that there should be regular researches on the evolving nature of our environment. With the launching of the NigeriaSat.1, it is advised that regional image processing stations should be set up in the various geo-political regions of the

country. This will help disseminate data on the various environmental issues confronting the regions. With this in place, Nigeria can then think of a central data management system where exchange of data on the various parts of the country could be contemplated.

In line with this, our institutions of higher learning and the National Centre for Remote Sensing Jos as well as the National Airspace Research and Development Agency Abuja should be fully equipped and staff thereof, well remunerated for full capacity performance. Regular seminars, symposia and workshops to educate the masses and land developers about the implications of wrong use of the environment and the applicability of Remote sensing technology to environmental issues should be encouraged. Students studying remote sensing applications in higher institutions of learning should be given grants, sponsorship or scholarship as forms of encouragement. It is also recommended that there should be regular co-operative meetings between the planners, planning agencies, policy makers, and the National centers for remote sensing. This bring about mutual understanding that will ensure a common drive towards a safe environment

REFERENCES.

Abumere S.I. (1993). The federal capital territory Abuja. Nigeria: Giant in the Tropics. Vol. 2. state survey. Gabumo Publishers. Lagos Nigeria.

Arnold, C.L. Jnr. and C.J. Gibbons (1996). Impervious surface coverage. The emergence of a key environmental indicator. Journal of the American planning Association. 6(2): 234 258.

Barlow S.A et al. (1998). The effects of Urban sprawl on timber harvest. Journal of forestry. (December 1998): 1014.

Barnes et al. (2000). Impervious surface and the quality of Natural and built up environments. A white paper for the project Chesapeake Bay From Space

Curran P.J. (1985) Principles of Remote Sensing. Longman group limited, Singapore.

David Waugh (2001) The new wider world. Nelson Thornes & sons. U.K.

David Waugh &Tony Bushell (2001) Key geography. New foundations. Nelson Thornes Ltd U.K.

DiLorenzo W (2000) The myth of suburban sprawl. U.S.A Today (May 2000) 128:54 6.

Dr. Jaffrey Luvall et al (1999). The urban heat island phenomenon and Potential mitigation strategies. APA proceedings.

Emielu F.E and Emielu S.A (1995) Human and Regional geography for senior secondary schools. West African books publishers Ltd. Lagos. Nigeria.

Ewing R. (1994). Characteristics, causes and effects of sprawl. A Literature review on Environmental and urban Issues. 21 (2):1 15.

Irons. J.R.. Williams D. L.. Markham B.L. 1996). Landsat-7 and beyond IGARSS '95 Lincoln. NB.

John Smith and Rogger Knill (2001) GCSE geography in focus. John Murray publishers Ltd. London

Johnson M.P (2001) Environmental Impacts of urban sprawl. A survey of the literature review and proposal research agenda. Environment and Planning A 33:717735.

Kogbe C.A (1979) Geoscience investigation of the Federal capital territory phase 1 (F.C.C. site) Consultancy report by the Ahmadu Bello University Zaria to the F.C.D.A Abuja (unpublished)

Larson. R.A. and Lennar, S., (1991). A practical approach to satellite image analysis for environmental monitoring. Land focus publishing limited. Sweden.

Lo C.P.. (1986) Applied remote sensing. Longman Inc., New York.

Lillesand T.M. and Kieffer R.W. (1979) Remote sensing and image interpretation (3rd Edition) John Willey and Sons. U.S.A.

MacLean A.I (1994). Remote sensing and Geographical Information Systems. An integration of technologies for resources management: a compendium. American society for photogrammetry and remote sensing. Maryland.

Kent B. Barnes et al., (2003). Sprawl development, its patterns, consequences and measurement. Centre for geographic Information services. Towson University.

Markham B.L and Barker, J. L. eds. (1985). Landsat Image Data Quality special issues. photogrammetric engineering and remote sensing, 51(9): 1245-1493.

Petit C.. and Lambin E. F. (2001). Integration of multi-source remote sensing data for landuse change Detection. International Journal of geographical information submitted

Petit C. and Sudder T. (2001). Quantifying process of land-cover change by remote sensing. Resettlement and Rapid land-cover changes in S.E Zambia. Paper presented.

Sander S.A et al. (1997). Human migration and agricultural expansion. A threat to the Maya tropical Forest. Journal of forestry, 95:27-32.

Short, Nicholas M. Snr. (1994). The Remote sensing tutorial. Code 935,

Goddard Space flight centre, Greenbelt, MD 200771.

Tekena Tamuno N. and Atanda J.A (1989). Nigeria since independence. The first 25 years. Volume IV. Heinemann Educational Books (Nigeria) Limited. Ibadan, Nigeria.

Thomas, K.J (1994). Proposed atmospheric correction for the solar-Radiometer IGASS'94 Pasadena, reflected bands of the Advanced Space borne Thermal Emission and Reflection. CA 2002-2004.

Udoh R.K. and Mamman A.B. (1993). Nigeria Giant in the tropics. Volume II state surveys. Gabumo Publishing Co. Limited. Lagos, Nigeria.

USGAO (1999) Extent of federal influence on urban sprawl is unclear. GAO/RCED 99-87 Washington D.C. The U.S General Accounting office.

Young S.S and Wang. (2000). Land-cover change analysis of China. Using global scale pathfinder. AVHRR Land-cover (PAL) data. 1982-1992. International Journal of remote sensing. 00(00):0000-0000.

GLOSSARY.

1. **Image**: the optical representation of an object produced by light rays from the object that is being refracted or reflected as by a lens, mirror or sensors.
2. **SPOT**: Systeme Probatoire D'observoire de la terre.
3. **Sensors**: The instruments on board a platform.'
4. **Target**: - The objected that is being reflected or sensed.
5. **Sprawl**: - To spread in an untidy/unplanned way in different directions over a large area.
6. **Monitoring**: To observe, record, analyze and report on a phenomenon over a period of time.
7. **Longitude**: An angular distance measured east or west of the Greenwich meridian.
8. **Latitude**: An angular distance measurement north or south of the equator.
9. **Equator**: - A great circle on earth, 90° from its poles.
10. **Territory**: - An officially defined geographical unit of land area.
11. **Range**: The difference between the highest and lowest readings in climatic analysis.
12. **Diurnal range**: the difference between the daily highest and lowest readings

13. **Precipitation**: Water in any form which falls from the atmosphere to the surface of the earth. It includes rain, snow, sleet, and hail.
14. **Deciduous:** Periodic shedding of leaves by trees as a form conservation of water in the dry season.
15. **Spectrum**: The array of colours of wavelengths obtained when light from source is dispersed, as in passing in through a prism or grating.
16. **Radiation**: The emission of electromagnetic waves from a body such as the sun and the earth.
17. **Bands**. Emission or absorption lines, usually in the spectral of chemical compounds or radicals.
18. **Arch View**: An image analysis software
19. **Idrissi**: image analysis software.
20. **Envi 3.5**: image analysis software.
21. **Vector:** A quantity that has both magnitude and direction.
22. **Pixel:** An individual picture element in a detector. E.g. a particular silicon diode in CCD or a grain in photographic emulsion.
23. **Urbanization**: this is the process where the proportion of people living in towns and cities increases.
24. **Wetlands**: An area where the soil is frequently or permanently waterlogged. with the water table being or near to the ground surface.
25. **Ozone**: A layer of oxygen allotrope that is located in the stratosphere. (15-20km) above the earth surface.

26 **Urban heat Island**. The zone around and above a built up urban area which has higher temperatures from the surrounding rural area.

27. **Topographical map**: a map which shows the surface features of an area to scale.

28. **Ultra violet radiation**: Electromagnetic radiation of wavelength shorter than the shortest (violet) wavelength to which the eye is sensitive. Radiation of wavelengths in the approximate range of 100 to 400 angstroms.

ABBREVIATION.

1. **A.M.L.** Arch macro language.
2. **E.T.M.** Enhanced thematic mapper.
3. **EM.R.** Electro magnetic radiation.
4. **E.M.S.** Electro magnetic spectrum.
5. **F.C.C.** Federal capital city.
6. **F.C.D.A.** Federal capital development authority.
7. **F.C.T.** Federal capital territory.
8. **G.I.S.** Geographical information system.
9. **G.P.S.** Global positioning system.
10. **I. R.S.** Indian remote sensing.
11. **M.S.S.** Multi spectral scanner.
12. **NASRDA.** Nigeria airspace research and development agency.
13. **RGB.** Red, Green, and Blue.
14. **Tc.** Tropical continental.
15. **Tm.** Tropical maritime.
16. **TIFF.** Tagged information format.
17. **USEPA.** United States environmental protection agency.
18. **UTM.** Universal traverse Mercator.
19. **GMT.** Greenwich meridian time.
20. **.M.W** Electro magnetic waves.