APPLICATION OF REMOTE SENSING IN PLANNING: A CASE STUDY OF MINNA AND ABUJA

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CERTIFICATION

This thesis entitled: "APPLICATION OF REMOTE SENSING, IN PLANNING, A CASE STUDY OF LIMAWA WARD, MINNA, AND F.C.C PHASE 1 ABUJA by ABDUL HUSAINI meets the regulations governing the award of the Degree of master of Science (Urban and regional Planning) of Ahmadu Bello University Zaria, and is approved for its contribution to knowledge and literally presentation.

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DEDICATION

This work is dedicated to all the people that stood by my side during the course of my studies.

ACKNOWLEDGEMENT

I am grateful to God Almighty for sparing our lives to see this time. I wish to express my gratitude to my supervisor Dr. J. B. Kaltho for guiding me through, Mr. G. P. Khanna for his interest in our studio practice, Dr. M. B. Yunusa our new head of Department who always listen to us especially during reviews and to all the staff of the Department.

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Thank you all and God bless.

DECLARATION

I hereby declare that this thesis has been composed by myself and that it is the out come of my research work. If has not been accepted in any previous application for a higher degree. All sources of information are especially acknowledged by means of references.

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14/2/2008

DATE

ABSTRACT

Adequate data are some of the requirements of successful planning. In Nigeria, the conventional sources of data and methods of collecting them have been largely inadequate.

Remote sensing Is taken as a compliment to the conventional methods. It has had wide application in fields like agriculture, Forestry, archeology, geology, planning etc. In this study attempt was made to assess the level of awareness of remote sensing by planners, the cost of acquiring this data and areas of application that are of direct relevance to planning in Nigeria.

Population which forms the basic requirement for any meaningful planning can be estimated using remote sensing. Using an area In Minna, the population was estimated from remote sensing data and compared with figures from other existing sources. The difference between the census figure (12,000 people) and our estimate (11,700 people) is only 2.5%.

The phenomenal physical growth of the F.C.C Phase 1 over a 10-year period (1984-1994) has been measured and estimated quickly and cheaply using remote sensing. Between this period the growth rate of F.C.C Phase 1 was about 1193% or average 119% per annum. This clearly shows the dramatic growth of the city. The implication of this on the physical infrastructure can thus be drawn. These include housing, transportation, accommodation problems as well as general deterioration of the environment.

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CHAPTER ONE:

DESIGN OF THE STUDY.

1.0 INTRODUCTION.

Effective urban planning requires access to accurate and continually updated information concerning the changing conditions of urban areas. In most third world cities, accurate up – to – date data on population, settlement size and number and land use are non – existent. This makes planning urban infrastructure and shelter programmes difficult, if not impossible, since there is limited knowledge of the existing locality. Further, the high lost and time required for traditional data collection methods have made systematic updating of urban data base beyond the reach of many planning authorities.

Population data is very important in physical planning and need to be up – to –date so as to be able to provide the required services. Thus, studies of population composition (according to Chapin 1970) assist in estimating residential space requirements for various dwelling types consistent with existing and anticipated family size, income levels, and the needs of each segment of the life cycle. Population data assist in determining the amount of space needed for recreation areas, schools and other community faculties for segments of the population. The distribution of the population further provides clues as to how these various land uses and facilities should be located in the urban area. Therefore, population studies not only provide a means of scaling total space needs for selected land use categories at different periods of time in the future but also give an indication as to how these total space needs should be allocated to different parts of the urban area at any particular time.

Land use changes induced by rapid urban growth under scores the need for up-to-date land use data and maps. Many cities in the third world have urban population growth rates in excess 6 percent, doubling their population nearly every ten years. There is need to monitor more closely the pattern of urban growth to improve planning and activities to accommodate this growth. Most of the errors in past Nigeria censuses have been attributed to some organizational defects, prominent among which is the lack of adequate information on the number of settlements and distribution of enumeration areas.

Since the late seventies the use of remote sensing as a technique of acquiring data for various applications was established. The first major attempt in Nigeria was the NIRAD (Nigeria Radar) project commissioned by the Federal Department of Forestry to take radar for the whole country. The choice of radar for the project is its ability to penetrate clouds unlike other remote sensing systems that cannot penetrate clouds and since the Southern part of the country is always covered by cloud, radar was clearly the best. The radar imagery provided by NIRAD project was aimed at a wide range of research including that on cities, towns and principal built-up areas; land use pattern, population, major road networks and rail links. This project seems to be the most recent nationwide remote sensing data source for wide ranging applications in various fields including planning.

1.1 STATEMENT OF RESEARCH PROBLEM

Although remote sensing technique was used in NIRAD project and the areas that would benefit from the data provided includes urban and regional planning, there has not been any deliberate attempt to incorporate remote sensing into day-to-day planning activities in Nigeria. Most state planning authorities rely on the near obsolete toposheets and time consuming reconnaissance surveys for their basic data requirements. The wealth of information provided by remote sensing on regular basis is hardly noted nor utilised in urban planning.

Instead of generating their own data using remote sensing sources, planners have depended on the surveyors who rely on their topo sheets and cadastral maps. Some of the information surveyors would provide are irrelevant to planning because the two professions view the environment from different perspectives.

Heaps' of aerial photographs of major towns taken at different periods are common in planning offices wasting due to non-utilization. It is very unlikely if government can commission a flying project like it was done up-till the eighties. These photographs of various dates-1960, 1966, 1979 and 1982 can be used by planners to measure the nature and rate of urban growth and estimate population. This is a viable and complimentary source of planning data which has been poorly utilised.

Vital information on urban spatial growth, in Nigeria, can be easily obtained from non-governmental organizations like United Nations, and

World Bank. Our planning offices are more concerned with land sub-division and development control than on other vital aspects of the urban environment. Employing professional hands and with relevant facilities a lot of information can be derived from remote sensing and by so doing planning offices would become data bank s of urban activities.

The failure and poor attitude of planners towards employing new techniques and their neglect of other crucial urban phenomenon like growth of both the city and population is affecting the performance of planners and planning. In the F.C.D.A where some of the current remote sensing data are available it is the surveys department that controls them and they produce the working maps for planners.

However, the surveyors are concerned with the physical aspects of the environment while planners require data on both the physical, biological and socio-economic components of the environment for planning purposes. The remote sensing data provide unbiased and diverse information on the environment, which makes it suitable for planners to use in their activities.

Failure to use new data gathering techniques for planning activities has meant a dependence of planning on obsolete methods and on other professions, which have interest in the administration of land. It has also limited the scope of planning activities thereby gradually eroding the high position of planning in urban management. It is in the light of this that the study focuses on the scope of remote sensing, its nature and demonstrate its application in physical planning in F.C.C phase 1 and Minna.

1.2 AIM AND OBJECTIVES.

1.2.1 AIM

The study aims to appraise of the scope of remote sensing and its application in physical planning.

1.2.2 objective

The objectives are to:

(i) Examine the concept, scope and application of remote sensing in physical planning.

(ii) Examine the existing method of data acquisition by planning organizations in Nigeria and the level of awareness of remote sensing data for planning uses.

(iii) Demonstrate the application of remote sensing in the estimation of population and analysis of urban growth of the Federal Capital City (F.C.C.) phase 1 and Minna.

(iv) Provide general policy recommendations for application of remote sensing in urban and regional planning in Nigeria.

1.3 STUDY AREA

1.3.i MINNA:

LOCATION AND CLIMATE

Minna lies on latitude 9°37' North and longtitude 6°33' East on a geological base of undifferentiated basement complex of mainly gneiss and magmatite. To the North- East of the town a more or less continuous steep outcrop of granite occurs limiting urban development in that direction.

The town has a mean annual rainfall of 1334mm (52 inches) taken from an exceptionally long record of 54 years. The mean monthly temperature is highest in March at 30.5°C (87°F) and lowest in August at 25.1°C (77°F).

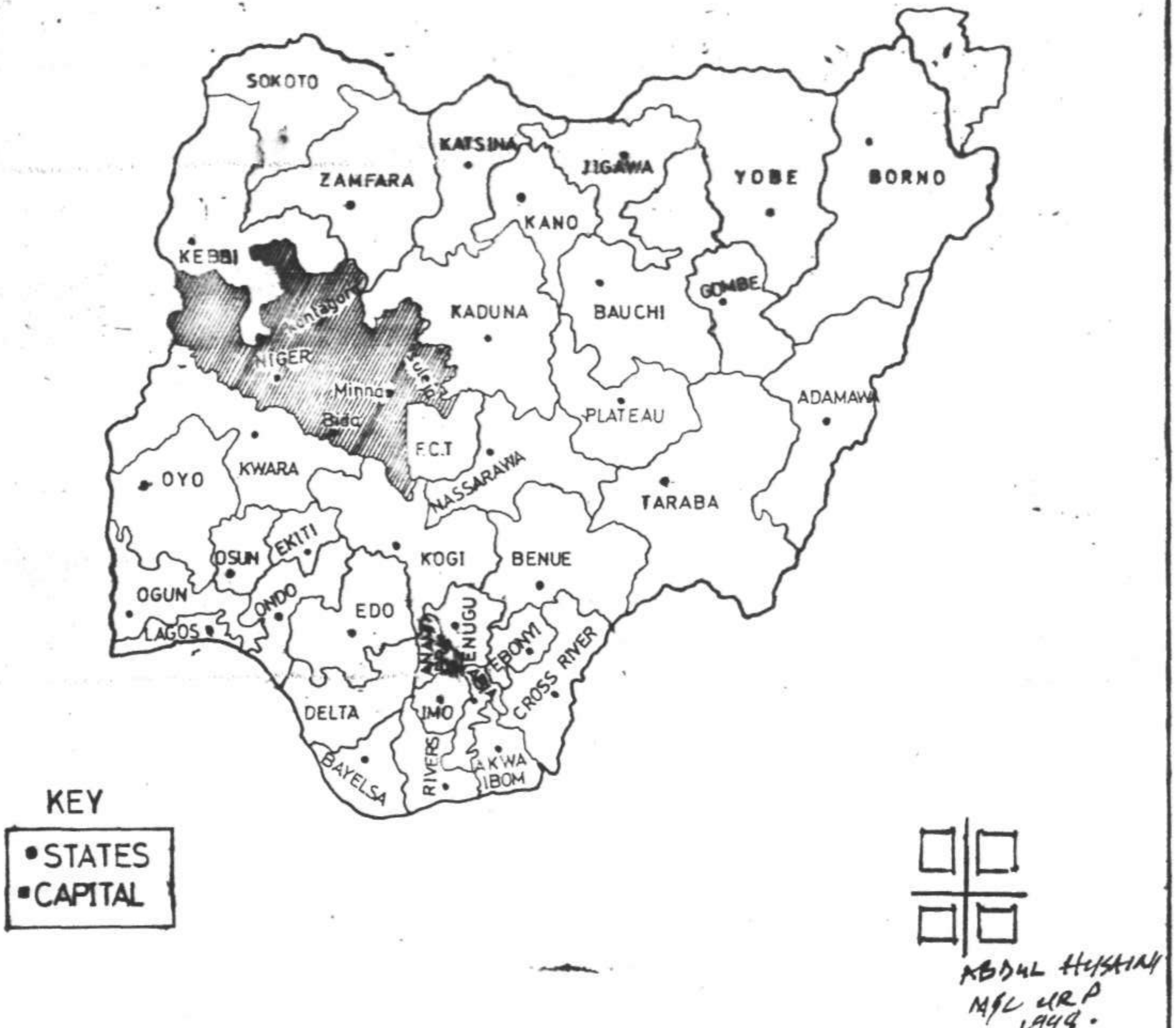
HISTORICAL BACKGROUND

Minna is basically a Gwari town and got its name from a ritual performed yearly by the Gwari Founders of the Town to observe the beginning of the new year.

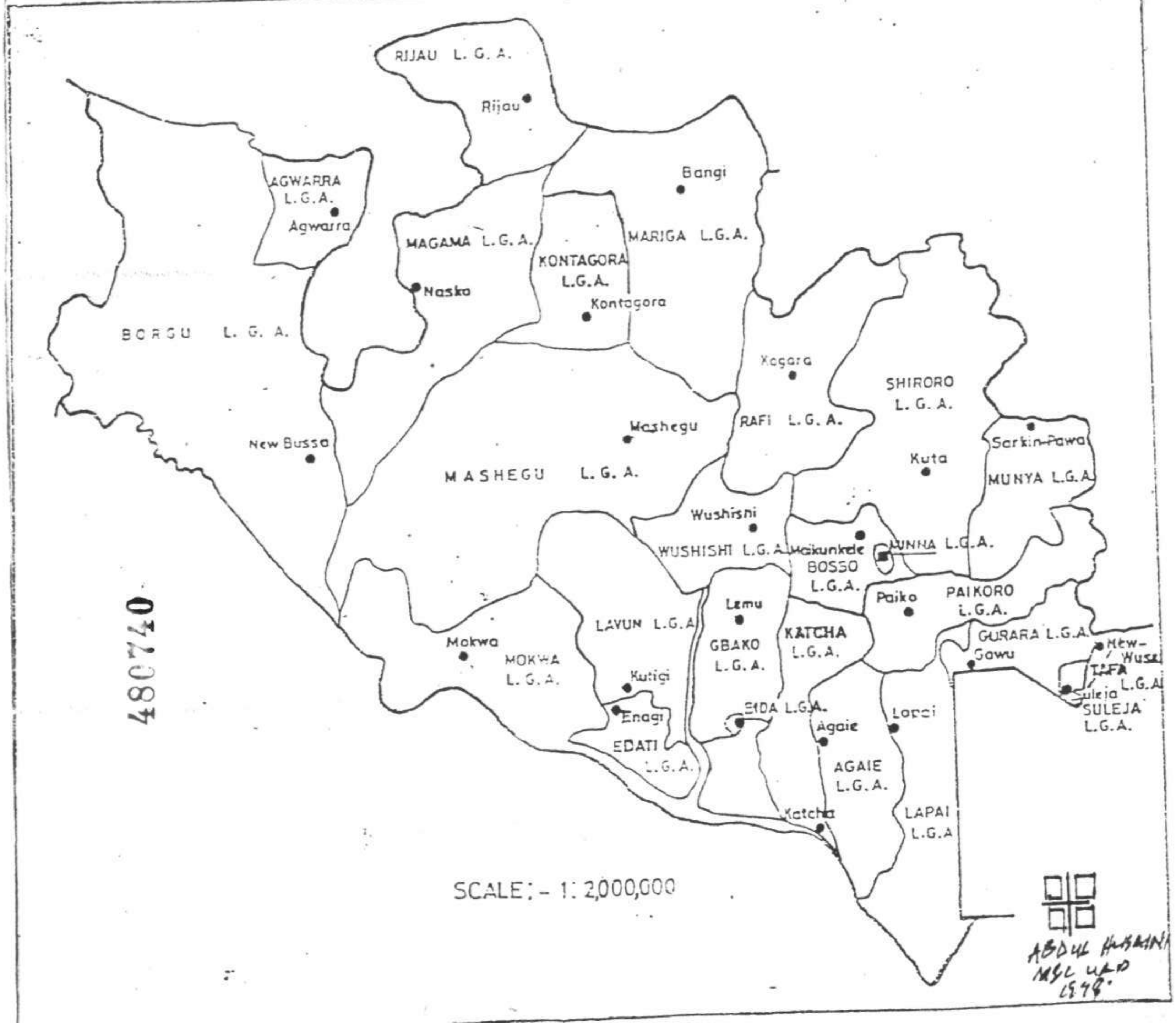
However, before the town became the modern city that it now is, it went through four metamorphosis (max lock 1979)

The first was in 1905 when the construction work of the rail line got to the area. As there was no local labour at that time the construction workers

MAP OF NIGERIA SHOWING THE POSITION OF NIGER STATE



MAP OF NIGER STATE SHOWING 25 LOCAL GOVERNMENT AREAS



SCALE: - 1: 2,000,000

were Gwari, Nupe and Hausa. The various groups were accommodated in different camps to ensure easy access and to prevent desertion. The Gwaris were at Keteren Gwari, Nupes at Kwangila and the Hausas are situated at Limawa.

In 1908, the second face lift for the town took place when an Alkali(Judge) was provided for the Camps. A house for the Judge was built and in it was provision for a prison. Later, the first contingent of Police was introduced.

The third metamorphosis was in 1910 when the Gwari inhabitants decided to move from the hill top to settle down on the areas of the present Paida.

In 1911 the construction of the main rail line within Minna had been completed and the first locomotive engine - WUSHISHI - arrived in the town. One of the first in Nigeria, it is now preserved at the Minna Railway Station by the Nigerian Railway Corporation.

The fourth change of status of the town came in February 1976 when it was made the State capital of the newly created Niger State.

The present town is widely dispersed along the main spine road from Chanchaga in the South to Bosso in the North, a distance of about 16 Kilometers.

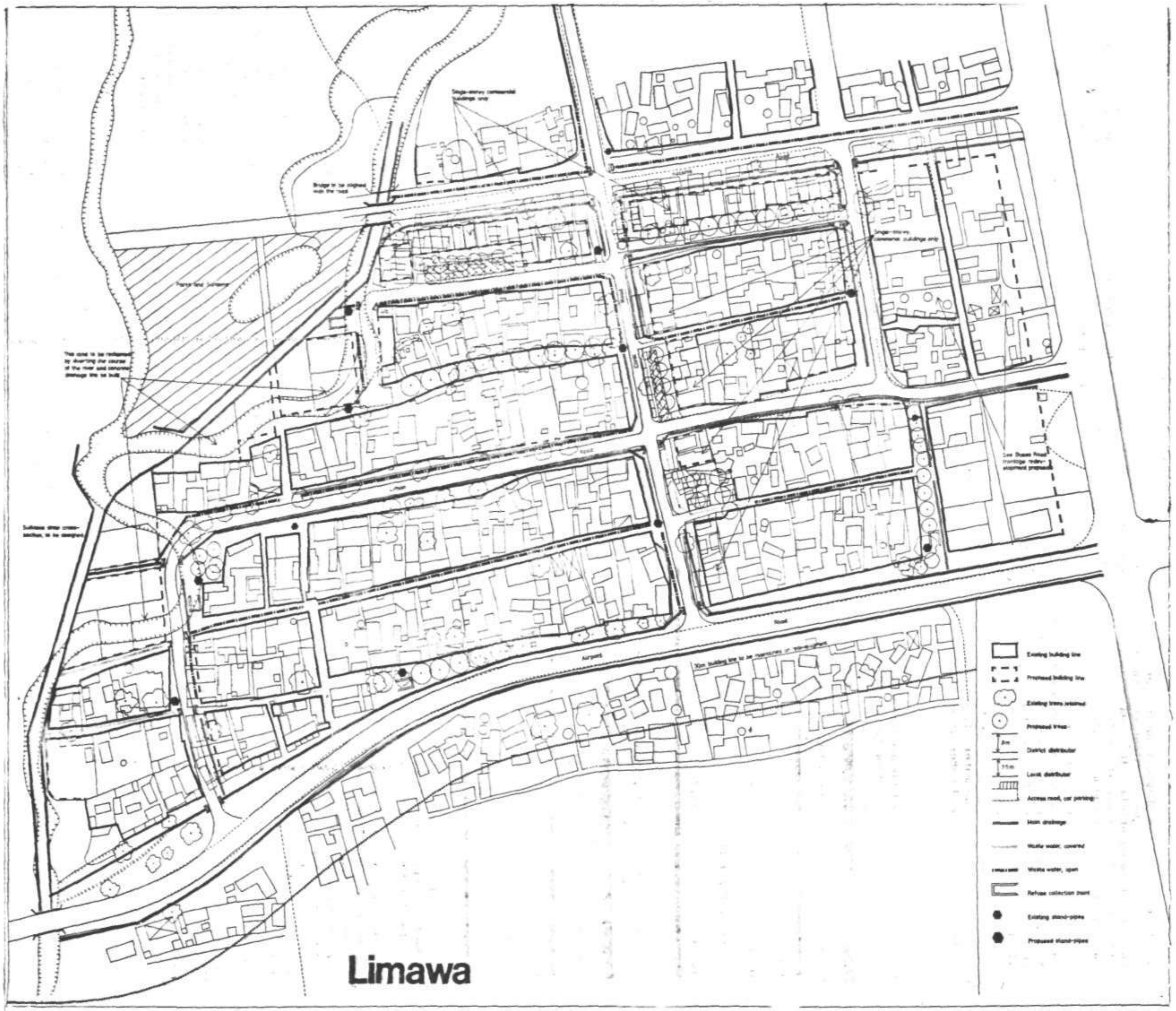
LIMAWA WARD

Limawa, one of the oldest wards in Minna, is situated between Airport Road and Katsina Road. It is bounded to the East by Bosso Road, to the South by Airport road to the West by River Suka and to the North by Katsina Road.

The area is fairly flat, and slopes gently towards the River Suka on the Western side. The area under study covers about six hectares of developed (and Traffic is mainly along the Airport Road and Katsina Road. These two roads link the lowcost housing units to the core of the town.
Limawa was covered by the 1950 Minna aerial photography, which showed that the area was almost fully developed by then. The 1972 Photography showed that the remaining small parcels of open land along the banks of the River Suka (now channeled) had all been developed leaving no more open ground for development. The area had obviously been laid out originally in a standard Sabon Gari type of layout with back t back lines of 15m X 30m plots with 3m drainage line between.

1.3.2 ABUJA, FEDERAL CAPITAL OF NIGERIA

In october 1975, the federal capital Development Authority was established by Federal Decree and charged with the development of a New Federal Capital for Nigeria. This historic action was the culmination of several years of informal consideration and a detailed study by a special committee charged with an examination of the city's relocation.


Limawa
Existing building line
Proposed building line
Existing trees retained
Proposed trees
District distributor
Local distributor
Access road, car parking
Main drainage
Waste water, covered
Waste water, open
Refuse collection point
Existing stand-pipes
Proposed stand-pipes

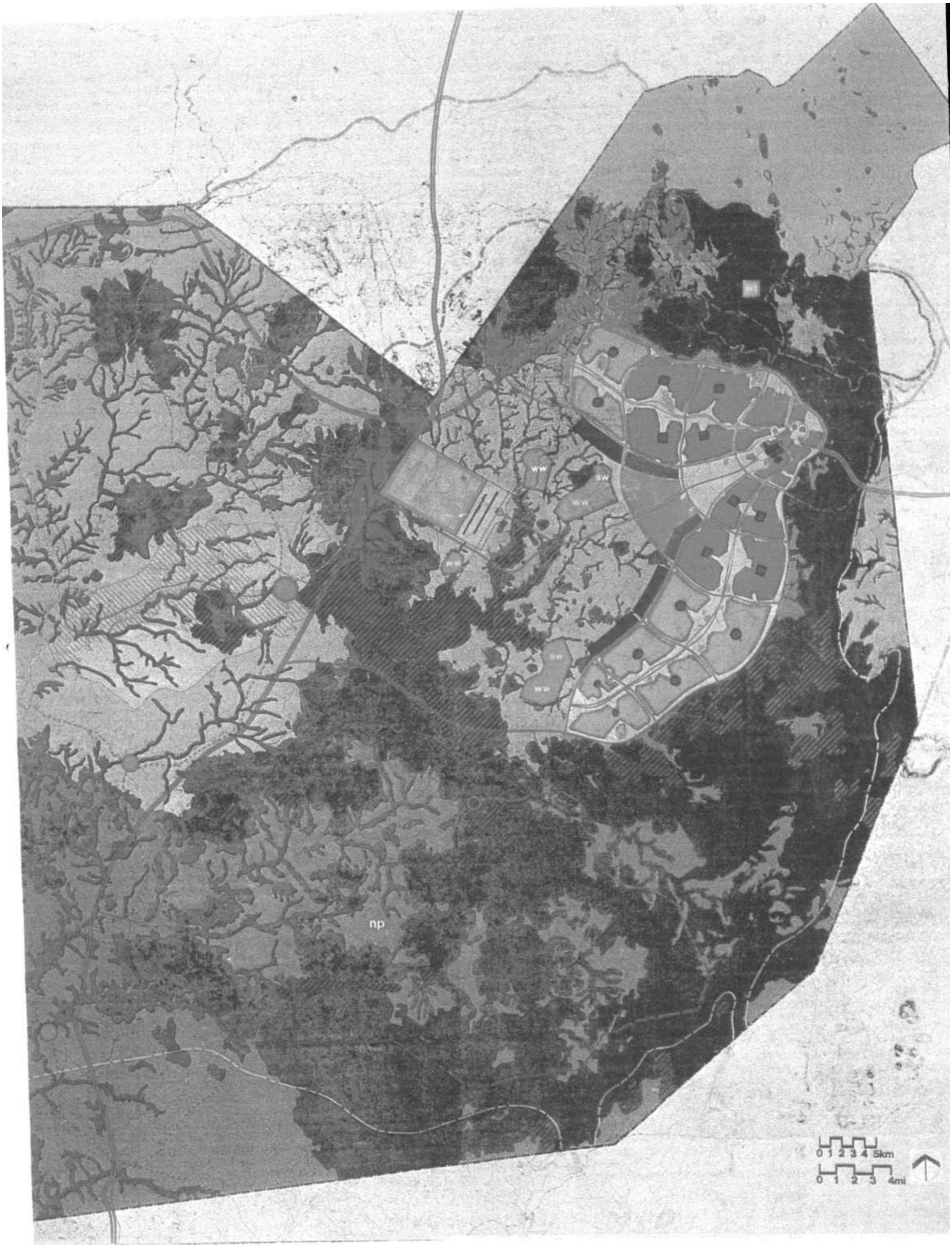


FIG:- MAP OF THE FEDERAL CAPITAL ABUJA

In accepting the committee's recommendations, the Government agreed that a centrally located Federal Capital in a spacious area with easy access to all parts of the Federation would be an asset to the nation and would help in generating a new sense of national unity.

Through the "Federal Capital Territory Decree of 1976" the Federal Government set into motion one of the nation's most important decisions since independence in 1960. Out of this policy commitment has come an accelerated program administered by the Federal Capital Development Authority for comprehensive planning and development of what is project to be one of Africa's capital and one of the world's great new cities (Abuja master plan 1979)

The site selected by the location committee and defined in the 1976 FCT Decree is an 8,000 square- Kilometer area South of Suleja surrounded by Niger, Kaduna, Nasarawa, Kogi State. The Federal Capital Territory is central to Nigeria lying just above the hot humid lowlands of the Niger/ Benue through but below the direct parts of the country lying to the North.

4 DATA COLLECTION AND ANALYSIS METHODS

The main source of data for this study are aerial photographs and spot images. Aerial photographs of 1979 was used in the estimation of population of Linawa Ward Minna. This area was chosen so as to demonstrate the applicability of remote sensing in population estimation.

The scale of the photographs used for the population is 1:15,000. Since this study involves the identification of houses, a larger scale map is needed for comparison and verification of details on the photographs.
A reproduced metric sheets at a scale of 1:1,000 published in 1988 were obtained. These metric sheets were produced from aerial photographs taken in 1982.

The information that is required from these aerial photographs and metric sheets includes the buildings. Those buildings form the basic backbone in the process of population estimation since it is on the basis of their number that we can estimate the population of the area.

Buildings form the backbone of a house and in this study a house refers to collection of buildings with a common entrance. The main house type in the study area is residential with few buildings along the major roads converted to commercial use.

For easy reference and comparison, the study area would be mapped out on the basis of information provided by the aerial photographs. Physical elements like roads, foot paths, stream and drainage channels would be used for delineating the area into smaller unit or enumeration areas (E.A's). These E.A's would form the working unit for this study.

The whole area will be enumerated so as to obtain the number of people per household. To have a complete coverage of the study area, the system of sampling to be used would be similar to the type used by

National Population Commission (N.P.C) during the Enumeration Area Demarcation (E.A.D) exercise conducted between 1988-1990. The reason for the adoption of this method is that it is simpler and easier to cross check and handle. During the demarcation exercise not all houses were counted but every house hold in an E.A is recorded and at an interval of five houses, the number of people in the sixth house are counted on the basis of Dejure and not defactor. In the process of the demarcation, all the houses are recorded and each enumeration are, (E.A) should contain between 350-400 people unless in special cases i.e institutions like schools, prisons, hospitals or locations separated by difficult physical features.

This study area is within a highly populated part of Minna. Therefore, we can adopt the above format with only little modifications. Instead of sampling each sixth house as in E.A.D exercise, the tenth house are sampled for the purpose of having a more manageable sample size. A population of between 750-1,000 people form unit instead of 350-400 used in the E.A.D exercise.

From the result of the ground sampling average number of people per house is obtained. While the total number of houses is obtained through the aerial photographs and metric sheets.

The other area of application of remote sensing in planning which this study attempts to employ is change detection in Federal Capital City phase 1. The main concern there is to detect the changes that have taken place over a given period. Change detection is an area well studied and where remote sensing had been applied extensively in some part of the world by geographers.

Change detection is the process of identifying differences in the state of an object or phenomena by observing it at different times. Essentially. It involves the ability to quantify temporal effects using multi-temporal data sets. One of the major applications of remotely-sensed data obtained from earth orbiting satellites is change detection because of repetative coverage at short interval and consistent image quality.

The basic premise in remote sensing data for change detection is that changes in land cover must result in changes in radiance values, and changes radiance due to land cover change must be large with respect to radiance changes caused by other factors.

The system of interpretation adopted for the growth change detection is the direct multi-date classification. In this method of interpretation the images of various dates of the areas are analysed using a simple instrument like stereoscope to delineate any change on the images. These changes are recorded on transparent overlay. The same method is repeated on all the Images.

There are some important things to note in visual interpretation. Some features (elements) on the ground change with seasons and therefore, the period of the year during which the image is taken is crucial in interpretation.

Litlesand and Kiefer (1987) classify interpretation elements into two

(a) static elements and

(b) dynamic elements.

The static elements appear the same in images whether they were registered in dry or wet season. Example of static elements are surface drainage patterns, land forms, buildings and roads. Dynamic indicators are the appearance of various land use activities such as the land cover which could be covered with grass during wet season or bare during dry season, drainage condition and climatic condition. This indicates the kind of feature at a particular time of the year.

During the interpretation, keys, transparent over lay, using tracing papers was placed on the images and the various features were extracted. The tracing of each piece of the photograph and images was conducted on the tracing paper identifying the various stages of development of the Federal Capital City from 1984 to 1994.

The Federal Capital City phase 1 is comprised of five districts namely; Wuse, Maitama, City Centre, Asokoro and Garki. The developed or built-up areas within the various districts and other areas under construction at various periods were measured using the zero- setting plani-meter to estimate the area developed within the period.

ZERO SETTING is the time saving feature of the plani-meter as all final reading represents the area desired.

Map odometer which is like the speedometer of a car is used to measure distance or length on maps by running the wheel along the track or routes and distance travelled by the wheel measures out directly on the graduated scale on the odometer . The distances are with respect to the scale of the maps or plans. It is handy and used to measure the length of all major roads constructed and under construction in the study area. To actually confirm the areas developed and under construction there is the need for ground truth.

5 LIMITATION.

Remote sensing, despite all its promises faces some serious problems especially in developing countries. These includes non availability of relevant data due to resource contraints. For instance in this work we were compelled to limit our selves to a relatively unchanged traditional settlement instead of a fast growing urban centre due to lack of access to current aerial photograghs which is excellent in population estimation. These aerial photographs were taken in 1979 but we used them because the main data (buildings) required could be found in them

The same problem is applicable to satellite images used to detect changes of the F.C.C phase 1. The current image at our disposal is that of 1994.

The other limitation is cost. Though these data can be obtained readily from some foreign agencies, the cost is outside the reach of individual researchers in developing countries.

Inspite of all these limitations, it is worth whlie to open up to these data gathering method in our daily planning activities.

CHAPTER TWO:

CONTENT, SCOPE AND APPLICATION OF REMOTE SENSING IN PLANNING.

2.1 Remote sensing refers to the group of techniques of collecting information about an object from a distance without physically contacting them. It is equally the term that includes the various tools and methods designed for collecting information about the enviroment from an airborne platform (plane or satellite), as well as the associated data processing. It is as old as camera (photographic camera). The use of black and whiote (otherwise known as panchromatic) photography for delimiting the city and for identifying morphological patterns has been used ever since cameras were carried aloft in balloons and aircraft. With the advent of massive bombing of cities during world war II, the identification of targets due to building and compound form was turned into a well studied but deadly art.

The second World War brought about a dramatic increase in the awareness of the potential of remote sensing in urban areas. In the sixties and early seventies, the conventional approach to remote sensing was dramatically changed by the introduction of colour, colour infra-red, multi-band, high altitude, and space photography. This was due to the increasing availability of products and data brought about by new technologies often developed for non- civilian purpose that were later declassified for general use.

Declassification of technology and data provided a major stimulus to the development of non - military application.

The development of remote sensing technology could be simplified into five arbitrary phases of an evolutionary process (Barret et al 1972).

Phase 1-pre1925: Some of the earliest photographs from air were taken of Paris in the last century from cameras strapped to the breast of pigeons.

Phase 2 – 1925 – 1945 the techniques of aerial photography saw wide–spread application in the inter – war period, particularly through topographic mapping from stereoscopic aerial photographs.

Phase 3- 1945 – 1960 aerial photography become more wide spread and the application of its products spread from topographic mapping to include applications in geology, agriculture, forestry and archeology.

Phase 4 – 1960 – 1972. The birth of satellite remote sensing with at first relatively primitive cameras and sensors.

Phase 5 – 1972 – present: This period has seen a maturity in satellite remote sensing, a development of high spatial resolution sensors from land applications, operational data collection of atmospheric information and the experimentation with the new sensor in a variety of wave band.

SPOT 1, a satellite financed by France, Belgium and Sweden, has been sending images with eight times the spatial resolution of LANDSAT and other civilian satellites. It produces data with a ground resolution equal to 10 meters in panchromatic mode, that is, black and white image and 20 times in multi-spectral mode (false colour image). Ten meter resolution is generally adequate for urban spatial planning and macro land management as it roughly corresponds to most urban physical features of concern: street width and lenghts, building and plot sizes, etc.

The main objective of earth observation from space is to provide data in order to understand the earth as a natural system. Only by means of satellite can we obtain global coverage. The global coverage, which satellites provide, is a definite advantage over other conventional method.

2.2 TYPE OF REMOTE SENSING

Remote sensing can be divided into two groups:

(a) - Low level remote sensing which includes the use of ordinary cameras, low flying aeroplanes and sometimes balloons. The maximum height of these sensers do not usually exceed 200km;

(b) High level remote sensing includes the satellite system used in acquiring environmental information from space. This satellite remote sensing is now the most popular used system in earth resource surveys. This is due to its synoptic coverage and temporal resolution.

There are two popular types of satellite remote sensing.

(1) Polar orbiters – These are satellites used in remote sensing placed at a height of between 200km – 1000km – above the earth surface. It is un-manned and carries sensors that operated at different wave lengths and

sends- down information every 18 days. Examples are SPOT and LANDSAT.

(2) Geo-stationary weather satellite: These are located above the equator at a distance of 35,900km. At this height, the speed of the satellite is about the same as that of earth rotation (i.e. 15^0 of longitude per hour) which makes it appear stationary above the same point on the surface of the earth and thus the name Geo-stationary. The geo-stationary orbit is the principal orbit for communications satellites. In December 1966 NASA took advantage of the launch of a communications satellite, the first application technology satellite (ATS 1) to orbit a spin-scan camera to demonstrate the capability of providing picture of a dise of the earth every twenty minutes.

A further demostration was flown into an operational programme with the launch of the synchronous meteorological satellite (SMS 1) in 1974 renamed Geo-stationary operational environmental satellite (GOES owned and operated by the U.S. National Oceanic and Atmospheric Administration (NOAA).

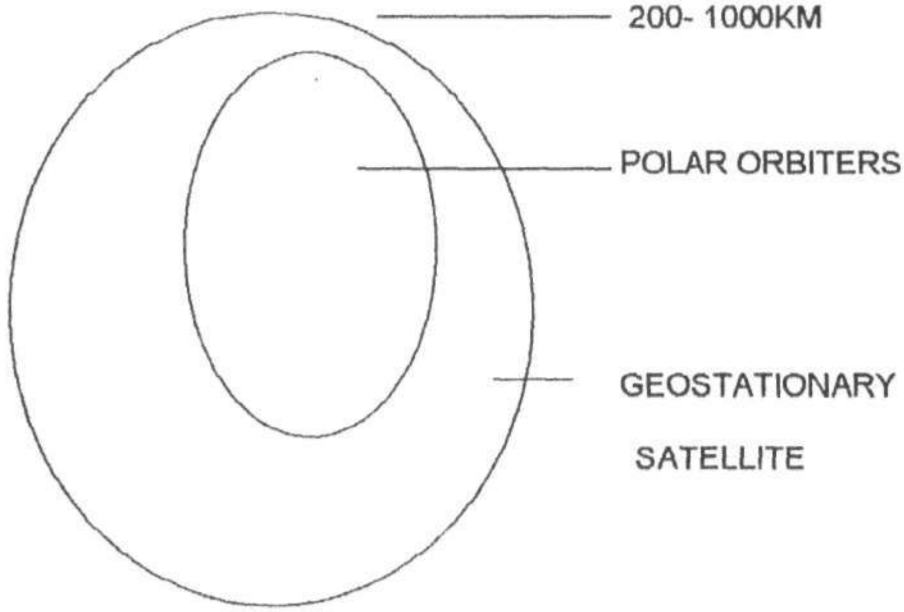


Fig. 1: **TYPES AND HEIGHT OF SATELLITE REMOTE SENSING**

An important advantage which geostationary satelite offers is the ability to see change with an image collected every 30 minutes, then analysis can be made of cloud movement and sea surface temperature changes. This is possible due to the height at which the satellites are placed. Information from these satelite is particularly important for monitoring the tracts and development of tropical hurricanes for strategic use.

Satellite remote sensing has several properties not found in aerial photography. As indicated above, the data are acquired regularly and have a temporal resolution counted in days instead of years. This makes the use of remote sensing in environmental survey and planning very crucial.

The subject on which survey activities are directed have been grouped into five earth related fields. Liquid, Solid, built-up, living and volatile earth (Audretsch et al 1981).

Table 1: **Relevance of Satellite Data For Surveying the Earth**

Surveying Activity / Field	STATIC Mapping and Inventory identification description Localisation	DYNAMIC Change detection, updating map studying processes civil defence/policy rescue and relief planning, DISASTER SURVEYING	DYNAMIC Monitoring of Natural resources for resource utilisation, crop yield prediction Environmental management of HUMAN ACTIVITY
LIQUID EARTH	X	XXX	XXX
SOLID EARTH	XXXX	XX	XX
BUILT UP EARTH	XXXX	XXXX	XXXX
LIVING EARTH	XXX	XXXX	XXXX
VOLATILE EARTH	X	XX	XX

Activities refer to: What is where/What has happened (What is going wrong/What is going on)

Legend Used:

XXXX	XXX	XX	X
Very relevant	relevant	partially relevant	slightly relevant

The initial limitation of the effectiveness of both LANDSAT and Spot in the tropics is their inability to penetrate clouds. But this is now overcome with the introduction of RADAR (Radio Detection and Ranging) system on these sensors. The peculiar characteristics of the RADAR that makes it suitable in humid tropics which are usually covered by cloud is that it can penetrate cloud and vegetation. This system is also independent of sun light; that is, it can operate in the night.

2.3 GROUNDS TRUTH

The general expectation of remote sensing is that it should ultimately remove the need for information gathered at the ground. Indeed, if asked to justify the expenditure on remote sensing systems, many might be tempted to respond in terms of savings on ground based surveys. This view would be misguided since surface information is required to interpret remotely sensed data in all except limited range of applications, such as those using pattern recognition, techniques where radiance values are not applied quantitatively. Indeed, the scope for environmental surveying and monitoring depend up by Remote sensing may well increase the total demand for surface information.

The ground survey data are required for several reasons:

(a) Remotely sensed data are subject to variations and distortions, particularly from the atmosphere. Atmospheric correction procedure have a limited precision.

(b) There is no general catalogue of spectral signatures; Most are unknown and many are ambiguous.

(c) There many only be an in-direct association between the subject of remote sensing (the spectral signature) and the object of the investigators inquiry. The modeled relation between subject and object may vary with the environmental context.

The chief advantage of the overview given by remote sensing is the provision of essentially synoptic samples of high spatial frequency on a large geographical scale. The under view provided by ground surveys cannot give synoptic coverage or sampling density on the same scale, but the sampling is performed at a higher spatial resolution and without appreciable effects of the atmosphere. A more significant difference, however, is that whereas remote sensing relies on radiometric data, ground data can also comprise other kinds of variable including context and class. It is this kind of information that brings the data into the domain of human cognition and justifies the use of the term 'ground truth'.

Thus ground truth data are complementary to the remotely sensed data. Their purpose is to standardise the data and to remove atmospheric effects, to define the surface context and to determine relations between the spectral and signature and the object of inquiry.

2.4 AREAS OF APPLICATION OF REMOTE SENSING IN PLANNING

Spatial planning depends on accurate data from wide ranging fields as population, land use, land cover, topography, socio-economic characteristic, etc. All of this information can be obtained through remote sensing data and it can serve as method of up dating the existing data generated using the conventional method. It is important to mention that remote sensing techniques cannot be 100% accurate but serves as a means of checking the accuracy of the already generated data or supplement the conventional methods.

2.4.1 **POPULATION ESTIMATION:** This forms the basic of any planning proposal and projection. In Nigeria this data is highly politicized. In the alternative, planners can apply remote sensing techniques to check the accuracy of the population data of any area of concern. Because of the importance of population in human activities, a lot of works have been done on how to estimate the population using remote sensing techniques.

One of the earliest works was by Tobler (1969) who applied a mathematical model to estimate the population of the Nile Delta area. He observed that, the built-up area of a settlement is proportional to the population. It is expressed in the following equation:-

$$r = aP^b$$

where r is the radius of a circle of the same area of the settlement, p is the population, a is a coefficient and b is an exponent. This formula is based on the law of allometric growth put forth by Julian S Huxley (1932) to describe the relationship of the growth of an organ or part of an organ to that of the whole organism.

To estimate the population, thermal infra-red data which shows the heat pattern of a city was used by the Defense Meteorological satelite programme (DMSP) of the U.S Air Force. This collects night-time images of the world in the thermal infra-red band of 8-15 UM at altitude of about 830KM. A comparison of a DMSP night-time image of eastern U.S.A with a population map of the same area produced by the U.S. Bureau of census clearly reveals the close co-relation between the two. Because built-up area is proportional to population size, it would be possible to think of the energy distribution pattern of a settlement as a dome in which the X,Y plane represents the illuminated urban area (IUA) and the Z axis the energy utilization.

As interest grew on population estimation using remote sensing some standard models were introduced by experts.

L o (1986) put forward four models of estimating population.

(i) Estimation based on measured Land area .

(ii) Estimation based on counts of dwelling units.

(iii) Estimation based on measured land use area, and

(iv) Estimation based on spectral radiance characteristic by individual pixels.

Nkambwe (1978) employed floor space rates to estimate urban population and its distribution.

Adeniyi (1987) applied the house count model to estimate the population of an area in Lagos. He based his work on the fact that most people live in buildings with specific physical structures and dwelling characteristics. It is assumed that the population of a settlement can be estimated by:-

(a) Identifying and classifying the residential buildings into appropriate groups.

(b) Counting the number of buildings on dwelling units in each residential class;

(c) Determining the average number of people per building or dwelling units:,

On the basis of these assumptions, he said, the population of a settlement can then be estimated thus:-

EP = (BP) R2 + (BP) R2 + - ------+(BP) Rn---(1)

Or

EP = (dp) R1 + (dp) R2 + --------+(dp) Rn----(2)

Where

EP = estimated population;

B = Number of building;

P = Average population per building;

D = Number of dwelling units;

P = Average population per dwelling unit

R-1----Rn = different residential types;

Based on this he came out with the estimate for the area

2.4.2 ANALYSIS OF SOCIO-ECONOMIC CHARACTERISTICS

Data on Socio-economic characteristics of an area can be obtained through indirect evidence of housing from aerial photography or satellite image. Green (1958) argued that human communities occupy physical space and facilities as a result of their interaction and adjustment to the environment. Thus, the directly observable physical data from remote sensing have meaningful sociological co-relations. In this way, a method of corrective photo interpretation on inventory-by-surrogate can be developed.

Similar work was done by Mumbow and Donoghue (1967) using large scale (1:10,000) aerial photography delineate urban poverty areas by co-relating it with such environmental features as structural deterioration of the houses, debris, lack of vegetation, work ways and paved streets.

They discovered that urban poverty was closely associated with residential areas located adjacent to the CBD, Industry and major urban centres. These were also found to be strongly correlated with low income, unemployment, low educational achievement, overcrowding, crime, low health status and lack of community facilities. However, ground survey work is required before accurate inference can be made concerning the socio-economic characteristic of population from remote sensing data.

2.5 LAND USE AND LANDCOVER MAPPING

Is one area that has received greater attention from researchers due to their role in spatial planning. The knowledge of land use and land cover is important for many planning and management activities. Medium to large scale aerial photographs and satellite images using RADAR has been utilised in land use and land cover mapping of large areas. Land use and land cover are different concepts, though they have sometimes been mixed up.

Land cover refers to the feature in existence on the surface of the earth e.g building, water bodies, vegetation, etc. Land use on the other hands relates to the human activities dominant on a specific piece of land like urban use, residential use, Agricultural use etc.

It is important to note that while land cover information can be directly interpreted from appropriate remote-sensing images, information about human activities (land use) may not always be inferred from remote sensing data, Lo (1986). For example, Hunting which is a land use (human activities could take place in forest or grass land which is a land cover, agric use (land use) can take place in forest (land cover). Therefore, supplemental information might be needed from outside the remote sensing image to supplement land cover data in order to infer land use from the remote sensing data.

Land use and land cover mapping are important in spatial planning and remote sensing provides the basic data. Because those data need further processing, the United States Geological Surveys (USGS) provide some criterion for interpretation of remote sensing data.

(i) -Minimum level of interpretation accuracy using remote sensing data should be at least 85%.

(ii) –accuracy of interpretation of several categories should be about equal.

(iii) –repetative results should be obtainable from one interpreter to another or from one time of the season to another.

(iv) –classification must be repeatable over extensive area.

(v) –categorization should permit land use inferred from land cover type.

(vi) –classification system should be suitable to use with remote sensing data obtained at different time of the year.

(vii) –categories should be divisible into more detail categories that can be obtained from large scale imagery or ground surface.

(viii) –Multiple use of land should be recognize when possible.

Based on the above criteria, the USGS suggested a classification system which has four levels of information. The higher the level the more detailed the information to be provided, for a land use \ land cover type.

Level I is used with a very small scale imagery e.g. LANDSAT; level II small scale aerial photograph; level III medium scale aerial photographs; and level IV large scale aerial photographs. For level III and IV supplemental information is needed for proper classification.

2.6 CASE STUDY OF A LAND USE CHANGE DETECTION IN NIGERIAN CITIES

In an earlier land use change study of Lagos (Adeniyi 1976) it was noted that Agege (N-IW of Lagos) is one of the urban fringe areas where rapid changes are occurring. Within the area, a sample site of 400 hectares was selected for this study. Sequential aerial photographs for 1974 (1:20,000) and for 1976 (1:25,000) were acquired from the Federal Surveys Department. The photographs were used as the main source of data.

In the analysis, mirror stereoscope was used. A transparent overly was placed on the photographs and the photographs was divided into grid (one hectares in size). The data recorded for each cell include:

(a) total number of competed buildings.

(b) total number of buildings under construction and

(c) the specific use of cells without any structure.

The data collected is summarised in the table 2 below The information from this study combined with other socio-economic data would provide vital planning information.

Table 2: **A Summary of Photo-Derived Data on the Rate of Building construction in Sampled Area NW Lagos**

	1974	1976	Absolute Change 1974-76	Change %
Total No. of Completed Buildings	2265	3558	1293	37.1
Total No. of Buildings Under Construction	625	510	142	-21.8
Total No. of Structures (1+2)	2917	4068	1151	39.5
No. of Cells Already Prepared for Building	6	6	0	0
No. of Cells Used as Farmland	44	15	29	-65.9
No. of Cells Covered by Bush/secondary Forest	59	28	31	-52.5

Adopted From Adeniyi (1978)

An important aspect of this illustration is the time spent on the interpretation. According to Adeniyi (1978) the interpretation of the 400 hectare on the 1974 (1:20,000) photograph took an average of five hours and fifty minutes (or an average of 0.87 minutes per hectare). Similarly, the interpretation of the 1976 (1:25,000) photograph took an average of six hours and thirty-five minutes (nearly one minute per hectare).

It was also noted that the larger the scale of the photographs, the faster the interpretation. Apart from the scale factor the orderly spatial arrangement of buildings enhances the speed and accuracy of interpretation. Apart from obtaining the relevant data within a "reasonable" time, the method is cost effective. It might be argued that the cost of procuring the photographs might increase the project cost substantially. This argument does not necessarily hold as the remotely sensed data are capable of being used for different purposes; hence, the cost of procuring the imagery can be shared by the user institution or organizations.

In urban growth assessment, two approaches are normally employed. Those approaches were used extensively in the studies on Ibadan by Oyelese (1968) and Lagos by Adeniyi (1978 & 81).

The first approach was based on the comparative analysis of sequential photographs, that aerial photographs taken at different years, while the second approach is the comparison in the field of the urban land scape at any point in time with the aerial photographs of the area at some time in the past.

It is important to mention that remote sensing has been widely applied in transportation more than any other part of the physical element of urban growth. Aerial photographs have been used to pinpoint areas of rapid city growth and congestion and to provide information on traffic flow in these cities (Estes & Sengen 1974).

CHAPTER THREE

CONVENTIONAL METHODS OF PLANNING DATA COLLECTION, AND AWARENESS OF REMOTE SENSING DATA

3.1 CONVENTIONAL METHODS OF PLANNING DATA GENERATION:

Adequate data is one of the requirements of successful spatial planning . In Nigeria, bodies charged with the responsibility of organising the physical environment are faced with problems of inadequate data. Planning organizations depend largely on conventional methods, in sourcing their data. In some instances they rely on other professions for their basic data requirements.

Planning in Nigeria has remained in the public domain and has concentrated only on a small area of planning – land sub-division and development control. Other important areas are left un-attended and it is these areas that professional planners outside the government could have come in.

Since the attention of planners is revolving round land sub-division and development control, the basic source of data in the ministries is the topographical maps\sheets at a scale of either 1:2,500 or1:50,000. These maps are produced by the Surveys Department from aerial photographs of 1963, 1979 and 1982. On these maps a lot of information crucial for any effective planning are missing or inadequate. Yet planners are expected to provide plans at various levels for overall development of towns, cities and the country at large through the design and preparation of layout plan, master plans and regional plans.

In some cases, reconnaissance surveys, are conducted to-up-date the existing maps and surveyors are assigned to carry out perimeter surveys of the area so as to show the extent of the proposed area. Still yet, many important details are overlooked. Some features shown on the topo sheets might have been overtaken by events. This occurs because up dating of these maps usually takes place only in areas of interest.

An essential pre-requisite to any development effort, therefore, is the appraisal of the existing land use situation and how the situation had been changing over time. Land use information is not only essential for the planning of agricultural, residential, commercial, industrial and transportational development. It serves as a major input for any programme for the avoidance of environmental hazards and for the enhancement of equitable distribution of resources. This can only be done with up-to-date population information, land use information, etc, which conventional methods cannot provide in good time.

Furthermore, urban planners are concerned with not only development control approval of building plans and layout design but more importantly with other urban phenomena like urbanization, traffic problem, etc. These is common feature of most Third World countries and they need more advance method of coping with them.

According to Simmonette's (1966) settlements change forms and function than conventional measurement can monitor.

3.2 AWARENESS OF THE POTENTIAL OF REMOTE SENSING

Despite the potentials of applying remote sensing in planning activities, planning offices are yet to embrace the direct use of this techniques. For instance, in Niger State, the planning office depends completely on the work of surveyors through the use of metric sheets at a scale of 1:2,500. These sheets form the basic data source for planning. Land sub-division is carried out at this scale based on the information provided.

Until recently, reconnaissance survey was not carried out. This survey becomes necessary due to the frequency of complaints from allotees that their plot is on borrow-pit, steep slope etc. These can hinder physical development and since the basic data used were produced a long time ago, these developments are not depicted on the maps.

As a result of this, the planning offices after obtaining the surveyors' work sheet, go to the site and up-date it. There is also a limitation to how far this up dating can go. Lack of funds and manpower plays an important role in this regard and makes the planning office to use some of the surveyor's work without necessarily going to the field. This is common; if the site involved is far and large.

During the course of this study 20 professional and sub-professional planners were asked on their awareness about remote sensing, and level of utilization.

CATEGORY OF PLANNERS	NO	HEAD OF R/S	APPLY IT IN PLANNING	AVAILABILITY OF R/S EQUIPMENT
PROFESSIONAL PLANNERS	10	Yes	Yes	No
SUB-PROFESSIONAL PLANNERS	10	No	No	No

FIELD WORK, 1998

The table (table 3) above is the response of the interview held with some selected planners. Twenty planners were chosen randomly from Niger state and out of this, ten are professionals. That is, those with B.Sc planning or M.Sc planning while the sub-professionals are those with H.N.D. planning.

The questions asked are direct and on the issue of whether they have heard of remote sensing. The ten professionals all claimed to have heard of it and the younger planners that have a geography background said they heard of it while in their undergraduate years while the older ones come across it through seminar and conferences. The sub-professionals' group on the other hand, are ignorant of it. They never come across it.

On the application, the professionals claimed to have applied it in one way or the other only by the use of aerial photographs to provide base maps for areas that do not have it or the topo sheets that covers it is missing.

The sub-professionals on the other hand claimed that they have never applied it in their work and despite the availability of aerial photographs in their offices, they only display it for students on work experience(SIWES). The explained that this was done by the Cartographers in the department and thus they assume it is their field.

On the availability of remote sensing data and equipment, the two groups agreed that there is none. The professional planners accepted the potentials of remote sensing but without processing equipment no one can use it. They, also raised the issue of cost arguing that it is high and out of the reach of the planning offices. The professionals also felt that even where there is the urgent need for current data, there is a problem where to get it in good time.

A respondent who was an Assistant Chief Town Planning Office (ACTPO) explained that during the Colonial era and some years after independence, Town planning departments were multi-disciplinary department headed by a planner. He pointed to me that there used to be surveyors, engineers, estate agents in the department so that anything needed, by planners were provided by these professionals. On the other hand, now we have surveyors, engineers, land officers and planners all having separate heads and perform their functions separately. This greatly affects the effectiveness of planning offices and brings down the high position planning had in those days.

The general attitude of planners in the states and F.C.T is that map making for planning work is the sole responsibility of the surveys department and there is no deliberate attempt to have a way of checking and up-dating the maps in the planning offices through the use of remote sensing data. The implication of this is that planners are always blamed for including physically undeveloped areas in their design. In this situation, planners and surveyors point accusing fingers at one another.

3.3 COST OF ACQUIRING REMOTE SENSING DATA

The cost of acquiring remote sensing data varies according to scale and quantity required. The initial cost of launching a satellite into orbit or flying a plane is expensive.

It is important to mention that despite the high cost of obtaining this data, it is comparatively cheap when other variables are considered. Remote sensed data are capable of being used for different, purposes; hence, the cost of procuring the imagery can be shared by the user organizations.

Let us consider the cost of some popular remote sensing images as provided by a renown remote sensing commercial outfit, Swedish space corporation (S.S.C.). This price list include that of other facilities like the image is in a computer compatible tapes. This means it can be used directly into computers, it has been corrected with legend etc.

The price of a full scene of spot image (Scene size of 100 km x 100km) is:-

(a) Spot panchromatic (P) data per scene: is

$3,000 or = N255,000

at $1 = N85

(b) Spot Multi spectral (xs) data per scene

$3,000 or = 255,000

The prices for satelite image maps of both SPOT panchromatic and multi spectral at different scales varies according to the quantity ordered. i.e

Scale	No of Sheets	Ordered
	1	20-49
1:10,000	$3,789	$ 766
	(N322,065)	(N65,110)

While the price for land sat (TR) is as follows:

Scale	No of Sheets	Ordered
	1	20-49
1:50,000	$4,822	$1,489
	(N409,870)	(N126,865)

From the above price table, it can be seen that it is cheaper to purchase more than only a few one. The wealth of information provided is enormous. With the aid of relevant equipment, and expertise, other valuable information can be derived.

CHAPTER FOUR

DATA ANALYSIS

4.1 POPULATION ESTIMATION

In the course of this study we obtained some population figures of Limawa for a period of 10 years (1976-1985) from N.P.C. In 1976, the population of Limawa was 17,681 while by 1985 it had risen to 23,161 people (Table 4.1). This means that during the 10 years period an increase was about 6,000 people,

Table 4.1: POPULATION OF LIMAWA 1976-1985

YEAR	POPULATION
1976	17,681
1977	18,219
1978	18,774
1979	19,346
1980	19,935
1981	20,542
1982	21,168
1983	21,813
1984	22,402
1985	23,181

Source: N. P. C Minna.

But the estimate of the Enumeration Area Demarcation (E.A.D) exercise by N.P.C that took place between 1988-1990 put the population of Limawa at 13,750 people.

FIG :2 AERIAL PHOTOGRAPH SHOWING THE STUDY AREA

The final result of 1991 census was released in 1997 and the population of Minna was given as 140,854 people (1996). Minna as recorded by N. P. C. comprised of seven wards namely- Nasarawa, Limawa, Paida\Sayaco, Sabon-Gari, Kwangila, Tudun Wada (Tunga) and Dutsen Kura. The population of each ward is given below.

Table 4.2: **BREAKDOWN OF FINAL CENSUS FIGURE OF MINNA**

WARD	POPULATION (1991 CENSUS)
Nasarawa	14,000
Limawa	12,000
Paida/Sayako	10,054
Sabon Gari	35,800
Kangila	11,400
Tudun Wada (Tungu)	30,000
Dutsen Kura	27,600
TOTAL	140,854

Source: N.P.C

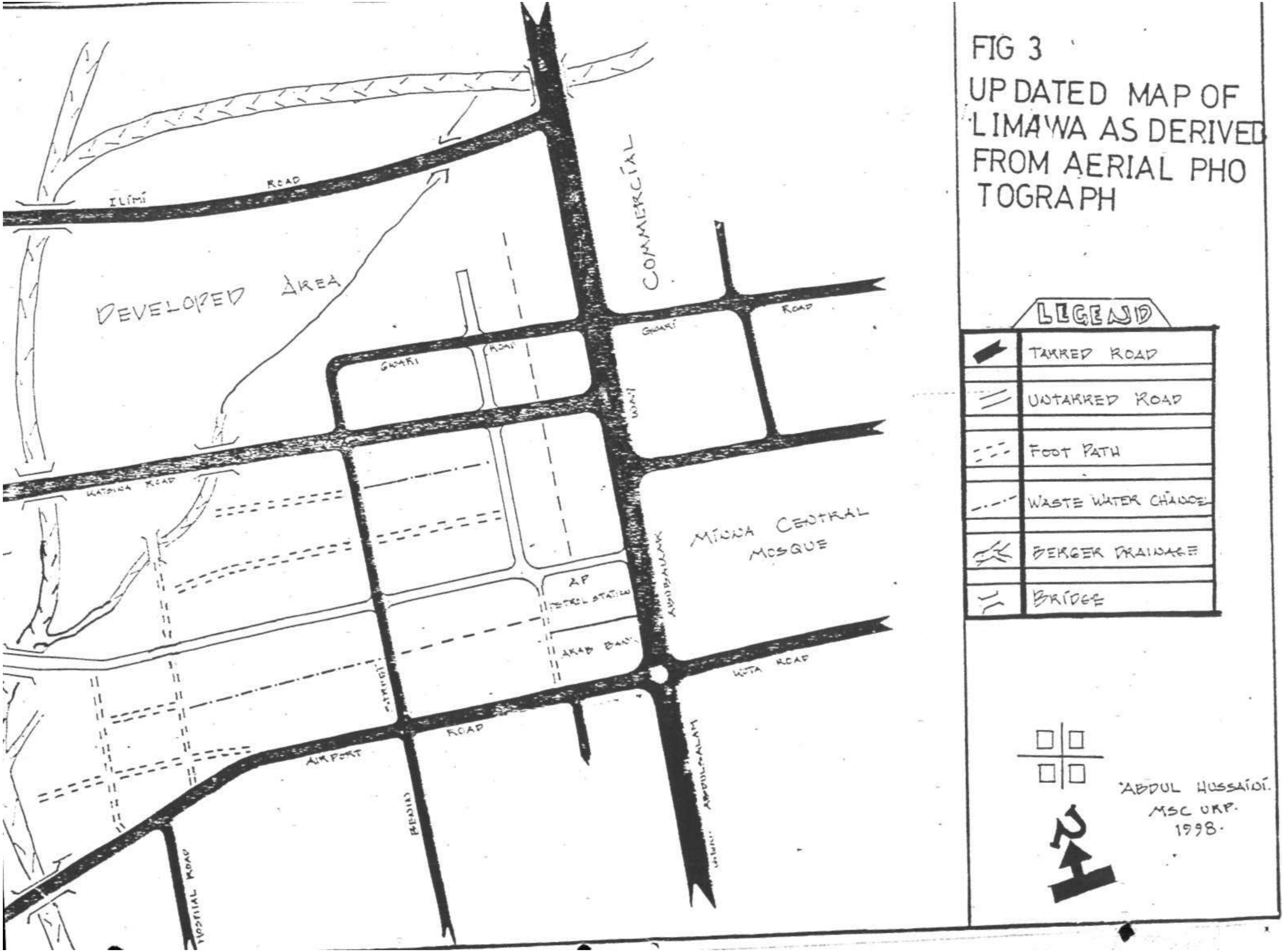


FIG 3
UPDATED MAP OF LIMAWA AS DERIVED FROM AERIAL PHOTOGRAPH

During the field work a total of 225 houses was enumerated in order to obtain the average number of people. Since the number of houses can be inferred from the aerial photographs, (Figure 2) the other important factor in population estimation is the number of people per house. A house in this content is group of buildings with a common entrance. This clarification is necessary since one house in this set-up is made up of different buildings occupied by individual households but they share a common entrance. Based on field work, the average number of people in each house is 51.8.

Below is th e breakdown of the field work result:

TABLE 4: BREAKDOWN OF VARIOUS SAMPLING BLOCK WITHIN LIMAWA

BLOCK	NAME OF BLOCK	NO OF HOUSES IN BLOCK	AVE. NO. OF PPL. BUILDING	AVE. NO OF PPL. IN THE BLOCK
1	SARKIN TURKE	19	70	1,350
2	GIDAN MAKAFI	50	50	2,500
3	MAIGISHIRI	32	50	1,600
4	SIRI SIRI	53	60	3,180
5	A. A. BOSSO	27	50	1,350
6	MAIBEZA	44	60	2,640
	TOTAL	225	340	12,620

Source Field Work 1998

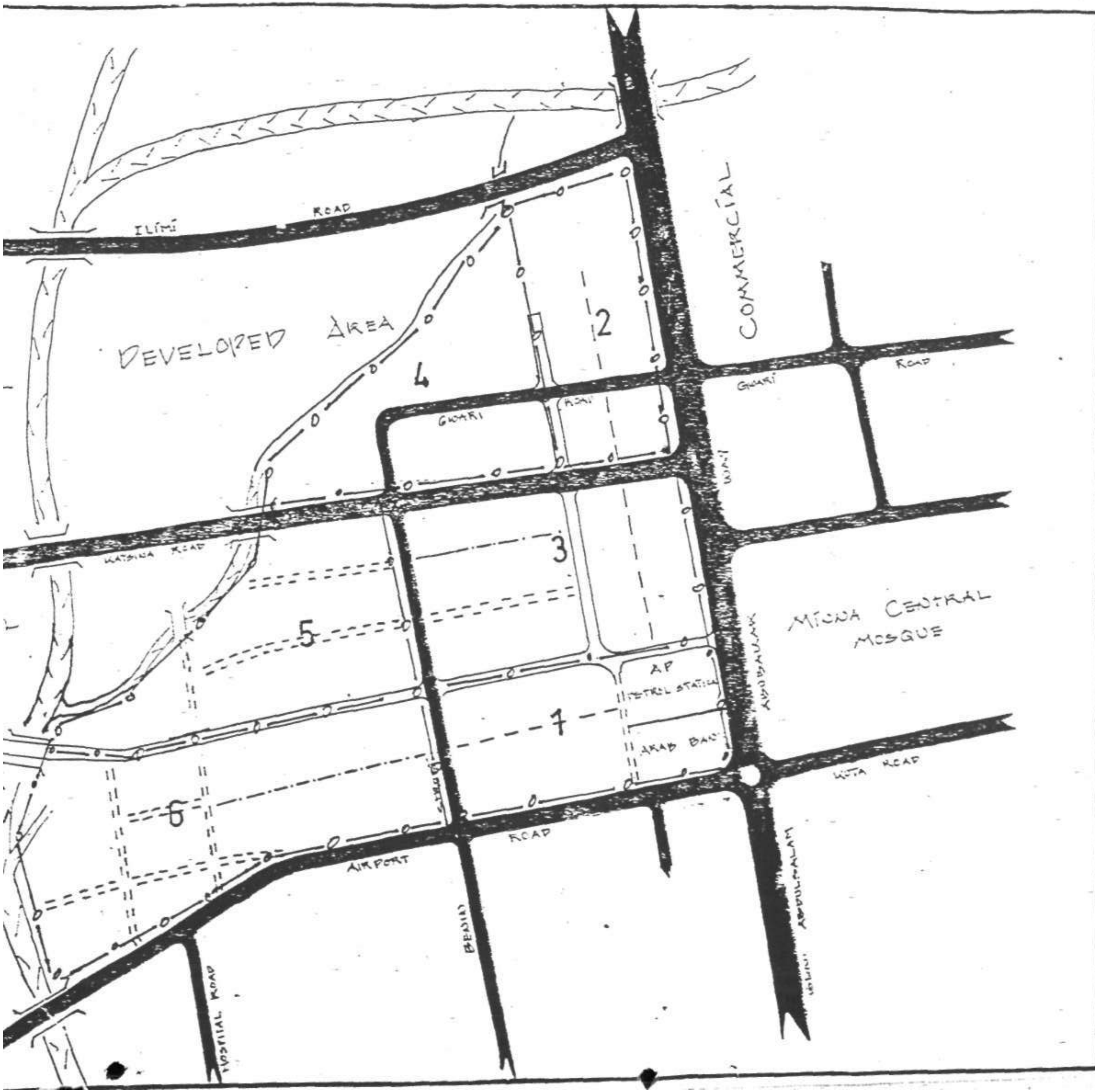


FIG 4

MAP OF LIMAWA SHOWING THE VARIOUS SAMPLING BLOCKS

LEGEND

	TARRED ROAD
	UNTARRED ROAD
	FOOT PATH
	WASTE WATER CHANNEL
	BERGER DRAINAGE
	BRIDGE

-o- SAMPLING BLOCK BOUNDARY.

ABDUL HUSSAINI.
MSC URP.
1998.

Applying the framework used by Adeniyi to estimate the population of an area in Lagos we obtain the number of people in Limawa as about 11,700

E. P. = (BP) R + (BP) R2 + -----+(BP) Rn

Where:

E. P = Estimated Population

B= Number of building (House)

P= Average Population per Building

R1---Rn= Different Residential types where applicable

Since there is only one in of the study area, our formula would be:

EP=BP

Since the number of buildings (is 225 and the average number of people per building is approximately 52 people, the population of Limawa can therefore, be estimated using the above formula

The estimate population of Llimawa is thus:

EP= 225 x 52

= 11,700 people.

Comparing this estimated population figure of 11,700 with our E.A.D exercise figure of N.P.C which is 13,750, there is a difference of 2,050 people which is about 15%. While the estimate from the field work 10^{th} house sampling is 12,620 that is there is a difference of 920 or 7.2%

TABLE 6: COMPARISON OF THE VARIOUS POPULATION ESTIMATE OF LIMAWA

METHOD OF ENUMERATION	POPULATION	PERCENTAGE
E.A.D	13,750	15%
Field work sample	12,620	7.2%
1991 Census	12,000	2.5%

From the above table we can see that the difference between the figures ranges from 15% and 2.5%. The E.A.D figure and field work sampling were base on the same method in which full enumeration takes place in either the sixth or 10th house depending on which of the two exercises. These enumeration was done on a de-jure basis that is head of the household can give the number of his family without necessary bringing them physically.

The 1991 Census on the other hand is a full head count therefore; each household is counted on defector basis. While our remote sensing method of estimation depends on only the average number of people which can be obtained through sampling while the houses are inferred directly from aerial photographs.

We could add that remote sensing provides invaluable material to a census in four areas:

(a) Identification of Settlements

(b) Settlement size and ordering

(c) Demarcation of enumeration areas

(d) Intercensal population estimation

It is important to stress that population estimate through remote sensing may not be error free. It is common to have under counting and the estimate obtained should serve as a basis of projecting or, supplementary to some existing figures.

4.2 ANALYSIS OF URBAN GROWTH OF THE F.C.C PHASE 1

The main concern of this part of the study is to apply remote sensing the estimating urban growth of the Federal Capital City. The main data source for the work are SPOT images and aerial photograph covering a period of ten years 1984-1994. The aerial photograph of 1980 was used to show the zero development of the area at that time as physical development commenced in 1984.

Each image was manually analysed to detect the level of development at different levels over the years. These changes are recorded on tracing tape and their value was obtained using planimeter and odometer to measure the area on the images.

Below are the tables and figures showing the changes that has taken place over the period 1984-1994. Figures 3-6 are showing the changes that occurs over the period as derived from aerial photograph and SPOT Images. Tables 6-14 are showing the changes sqkm and percentages from 1984-1994.

TABLE 6: LEVEL OF DEVELOPMENT IN VARIOUS DISTRICTS OF F.C.C PHASE 1 (MARCH 1984)

DISTRICT	AREA DEVELOPMENT.		AREA UNDER CONSTRUCTION	
	M^2	Sq km(APPROX)	M^2	Sq km(APPROX)
WUSE	2,559,900	2.6	417,500	0.4
MIATAMA	-	-	168,400	0.2
CITY CENTRE	344,500	0.3	591,800	0.6
ASOKORO	-	-	173,700	0.2
GARKI	2,888,500	2.9	-	-
TOTAL:	5,792,900	5.8	1,351,400	1.4

SOURCE: FIELD WORK 1998

TABLE 7: LEVEL OF DEVELOPMENT AS AT JANUARY 1988

DISTRICT	AREA DEVELOPMENT.		AREA UNDER CONSTRUCTION	
	M^2	Sq km(APPROX)	M^2	Sq km(APPROX)
WUSE	3,478,750	3.5	118,750	0.1
MIATAMA	591,250	0.6	93,750	0.1
CITY CENTRE	360,000	0.6	1,712,500	1.7
ASOKORO	316,250	0.3	-	-
GARKI	3,703,750	3.7	175,000	0.2
TOTAL:	8,450,000	8.5	2,100,000	2.1

SOURCE: FIELD WORK 1998

TABLE 8: LEVEL OF DEVELOPMENT (APRI L 1992)

DISTRICT	AREA DEVELOPED		AREA UNDER CONSTRUCTION	
	M^2	Sq km(APPROX)	M^2	Sq km(APPROX)
WUSE	4,312,000	4.3	2,462,500	2.5
MAITAMA	4,375,000	4.4	2,143,250	2.1
CITY CENTRE	1,003,750	1.0	3,292,500	3.3
ASOKORO	843,750	0.8	676,250	0.7
GARKI	4,606,250	4.6	390,000	0.4
TOTAL:	15,141,250	15.1	8,964,500	9.0

SOURCE: Field Work, 1998

TABEL 9: LEVEL OF DEVELOPMENT (APRI L 1994)

DISTRICT	AREA DEVELOPED		AREA UNDER CONSTRUCTION	
	M^2	Sq km(APPROX)	M^2	Sq km(APPROX)
WUSE	6,275,000	6.3	4,325,000	4.3
MIATAMA	6,775,000	6.8	2,450,000	2.5
CITY CENTRE	2,675,000	2.7	7,475,000	7.5
ASOKORO	1,600,000	1.6	-	-
GARKI	6,652,500	6.7	3,825,000	3.8
TOTAL:	23,977,500	24.0	18,075,000	18.1

FILED WORK 1998

TABEL 10: TOTAL AREA DEVELOPED

YEARS	M2	Sqkm (APPROXIMATELY)
1982	5,792,900	5.8
1988	8,450,000	8.5
1992	15,141,250	15.1
1994	23,977,500	24.0

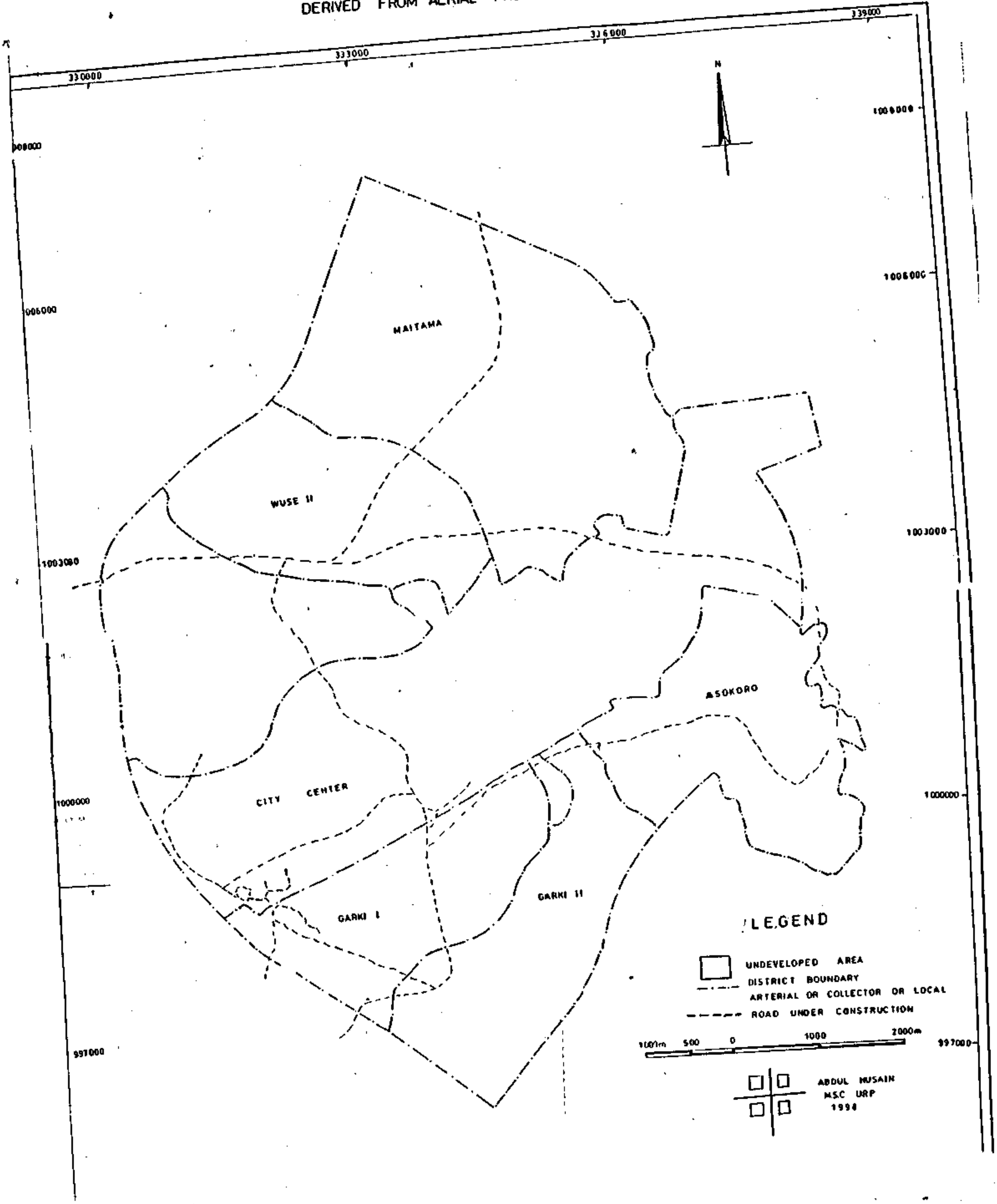
SOURCE: Field Work, 1998

TABLE 11: TOTAL AREA UNDER CONSTRUCTION:

YEARS	M2	Sqkm (APPROXIMATELY)
1984	1,351,400	1.4
1988	2,100,000	2.1
1992	8,964,500	9.1
1994	18,075,000	18.1

FIELD WORK 1998 G

MAP SHOWING URBAN DEVELOPMENT OF THE FEDERAL CAPITAL CITY, PHASE 1, ABUJA AS AT MARCH, 1980 DERIVED FROM AERIAL PHOTO MOSAIC AND FIELDWORK



EIG 5

MAP SHOWING URBAN DEVELOPMENT OF THE FEDERAL CAPITAL CITY, PHASE 1, ABUJA AS AT MARCH. 1984 DERIVED FROM ORTHOTOGRAPHY MOSAIC AND FIELDWORK

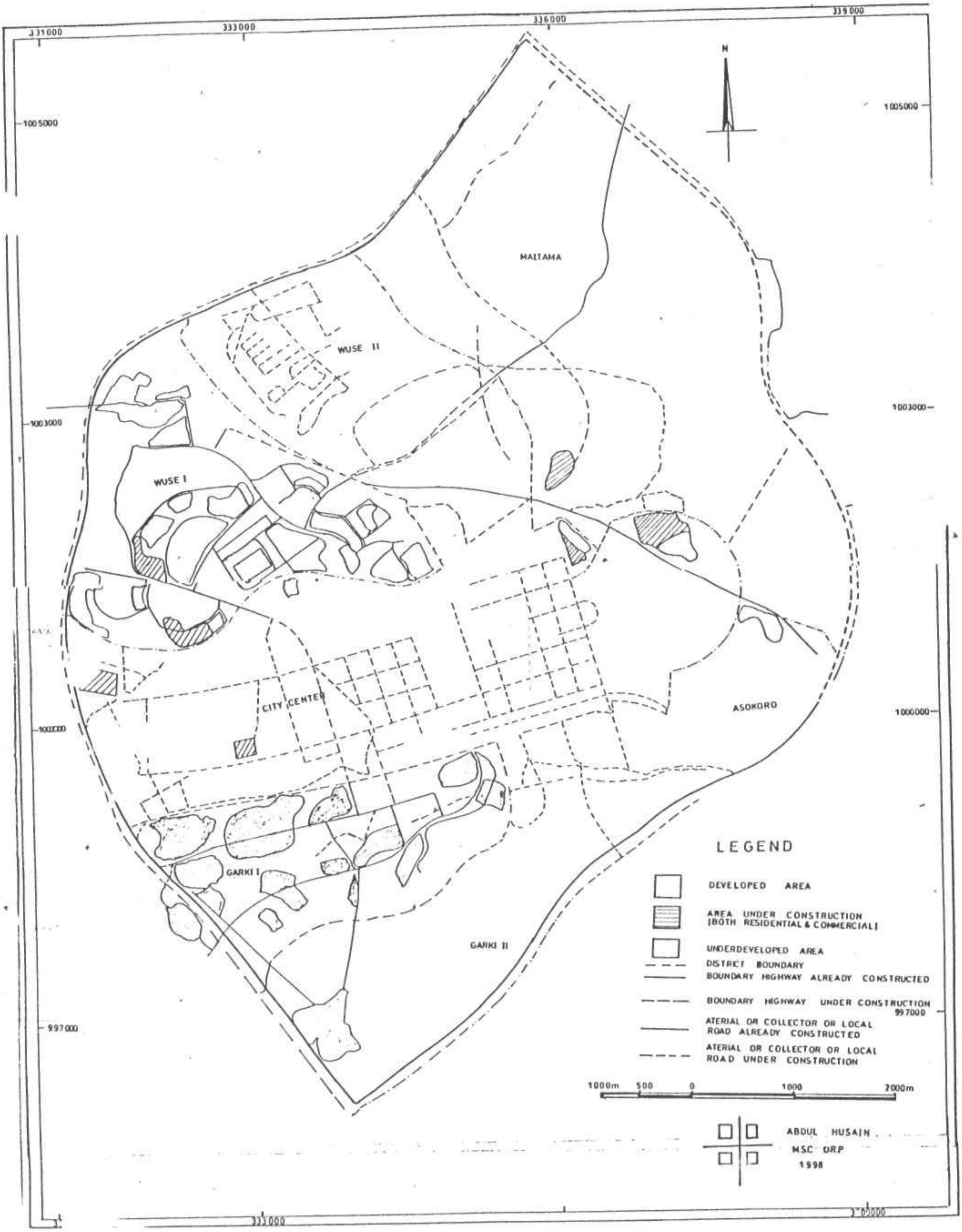


FIG 6

MAP SHOWING URBAN DEVELOPMENT OF THE FEDERAL CAPITAL CITY, PHASE 1, ABUJA AS AT JAN 1988 DERIVED FROM SPOT SATELLITE IMAGERY AND FIELDWORK

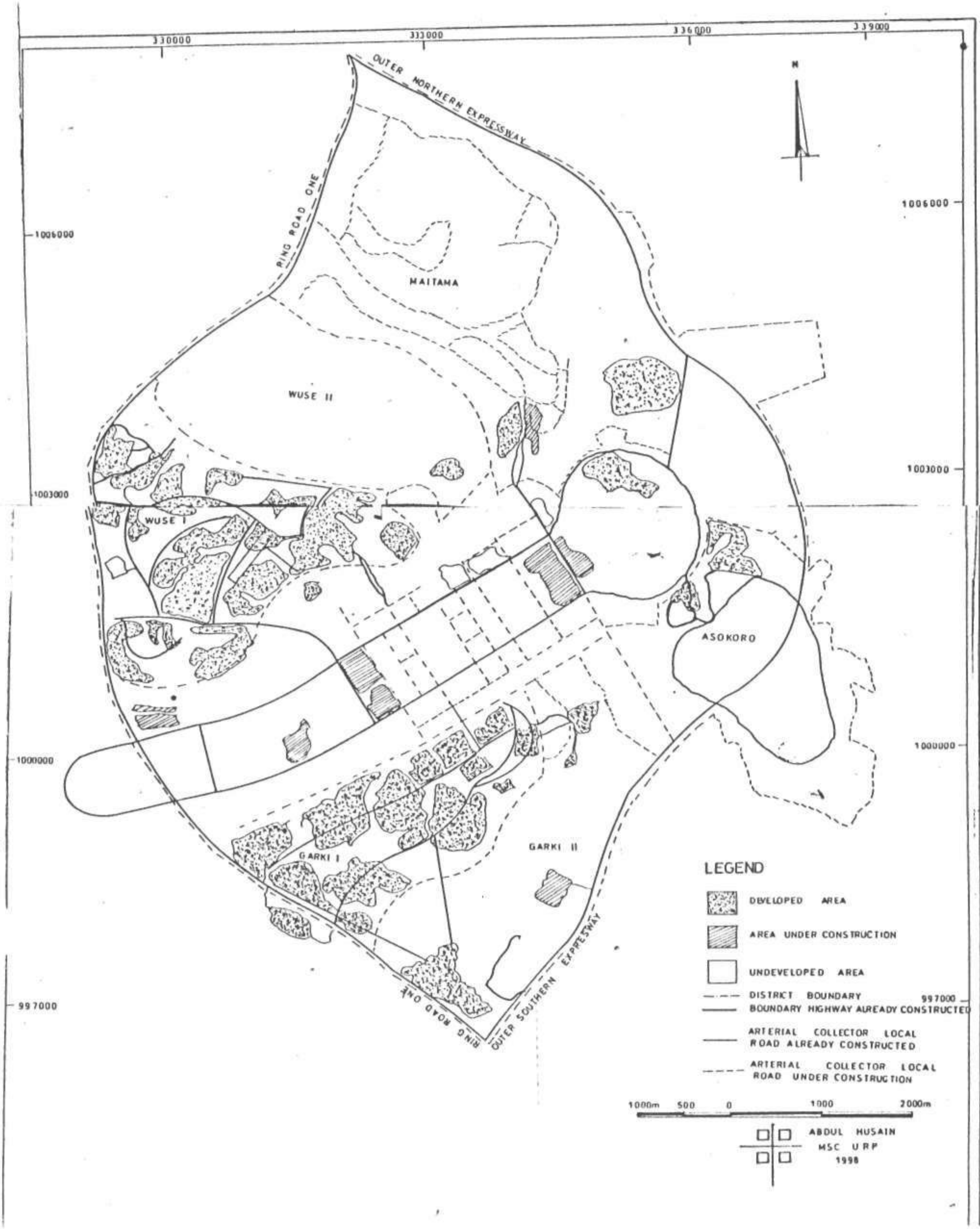
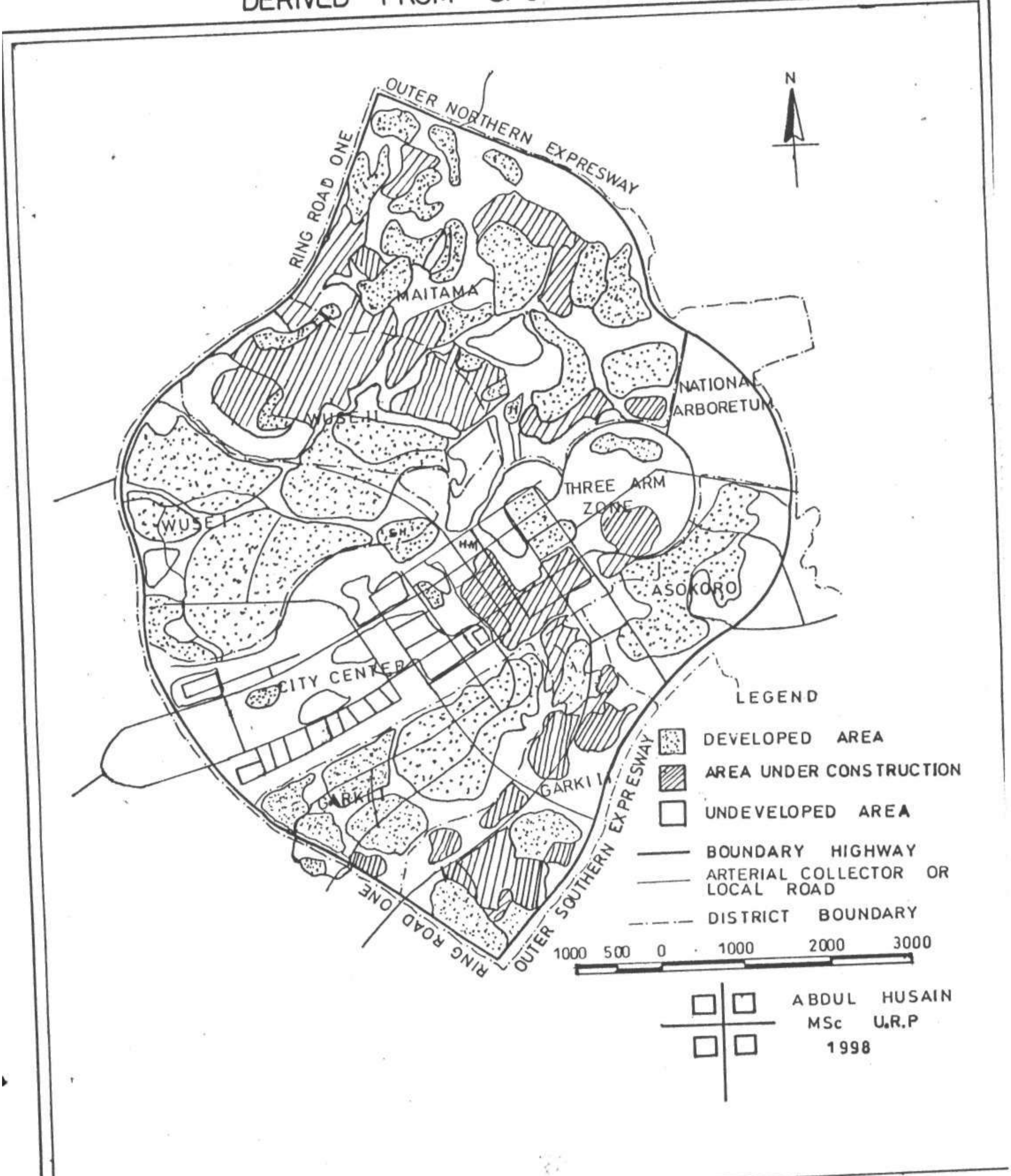


FIG 8 MAP SHOWING URBAN DEVELOPMENT OF THE FEDERAL CAPITAL CITY, PHASE 1, ABUJA IN APRIL, 1994 DERIVED FROM SPOT SATELLITE IMAGE & FIELDWOR



GRAPH SHOWING THE LEVEL OF DEVELOPMENT OF THE F.C.C.

1980 – 1994.

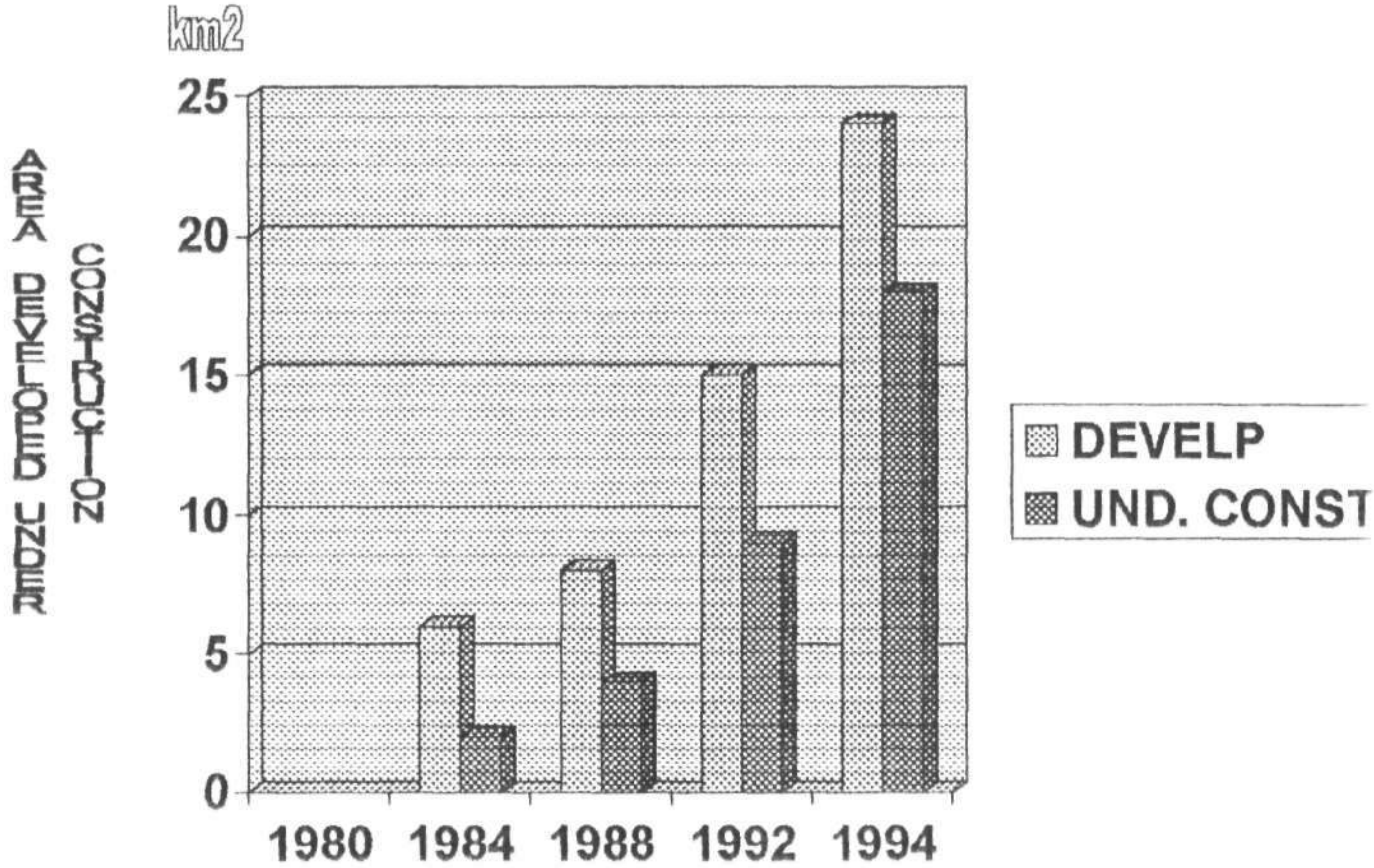


TABLE 12: SEQUENTIAL CHANGE RATE OF BUILT –UP AREAS OF F.C.C PHASE 1.(1984- 1994)

						CHANGE RATE B –A/A X100			
NAME OF DISTRICT	1980 AREA Sqkm,%	1984 AREA Sqkm, %	1988 AREA Sqkm, %	1992 AREA Sqkm, %	1994 AREA Sqkm, %	1980–84	1984 – 88	1988–92	1992 -94
WUSE	- 0 %	0.4Sqkm 3.5%	0.1sqkm 0.9%	2.5Sqkm 21.9%	4.3sqkm 37.7%	0	-75	2400	72
MAITAMA	- 0 %	0.2 sqkm 1.7%	0.1sqkm 0.9%	2.1sqkm 18.1%	2.5sqkm 21.6%	0	-50	2000	72
CITY CENTRE	- 0 %	0.6sqkm 403%	1.7sqkm 12.2%	3.3sqkm 23.7%	7.5 sqkm 54.0%	0	-50	2000	19.0
ASOKORO	- 0 %	0.2sqkm 6.3%	- 0%	0.7sqkm 21.9%	- 0%	0	-100	0	100
GARKI	- 0 %	- 0 %	0.2sqkm 1.8%	0.4sqkm 3.6%	3.8 sqkm 34.5%	0	0	100	850
TOTAL	- 0 %	1.4sqkm 2.7%	2.1sqkm 4.1%	9.0sqkm 17.6%	18.1 sqkm 35.4%	0	50	328.6	101.1

TABL13: SEQUENTIAL CHANGE RATE OF AREAS UNDER CONSTRUCTION PHASE I - (1984-1994)

						CHANGE RATE B –A/A X100			
NAME OF DISTRICT	1980 AREA Sqkm,%	1984 AREA Sqkm, %	1988 AREA Sqkm, %	1992 AREA Sqkm, %	1994 AREA Sqkm, %	1980–84	1984 – 88	1988–92	1992 -94
WUSE	- 0 %	2.6sqkm 22.8%	3.5sqkm 37.9%	4.3sqkm 33.7%	6.3sqkm 55.3%	0	34.6	22.9	46.5
MAITAMA	- 0 %	- %	0.6sqkm 5.2%	4.4sqkm 37.9%	6.8sqkm 58.6%	0	0	63.3	54.5
CITY CENTRE	- 0 %	0.3sqkm 2.2%	0.4sqkm 2.9%	1.0sqkm 7.2%	2.7 sqkm 19.4%	0	33.3	150	170
ASOKORO	- 0 %	- 0%	0.3sqkm 9.4%	0.8sqkm 25%	1.6sqkm 50%	0	0	166.7	100
GARKI	- 0 %	2.9sqkm 26.4%	3.7sqkm 33.6%	4.6sqkm 41.8%	6.7 sqkm 60.9%	0	27.6	24.3	45.7
TOTAL	- 0 %	5.8sqkm 11.35%	8.5sqkm 16.6%	15.1sqkm 29.5%	24.0sqkm 47%	0	46.6	77.6	58.9

TABLE 14: RATE OF GROWTH FOR THE VARIOUS DISTRICT BETWEEN 1984 - 1994

DISTRICT	PROPOSED USE IN MASTER PLAN	EXISTING USE	1984 AREA	1988 AREA	1992 AREA	1994 AREA	CHANGE RATE 1984-1994	AVERAGE GROWTH RATE PER YEAR
WUSE	RESIDENTIAL	RESIDENTIAL	0.4sqkm	0.1sqkm	2.5sqkm	4.3sqkm	975%	97.5%
MAITAMA	RESIDENTIAL	RESIDENTIAL	0.2sqkm	0.1sqkm	2.1sqkm	2.5sqkm	1150%	115%
CITY CENTRE	COMMERCIAL /OFFICE	COMMERCIAL	0.6sqkm	1.7sqkm	3.3sqkm	7.5sqkm	1150%	115%
ASOKORO	RESIDENTIAL	RESIDENTIAL	0.2sqkm	-	0.7sqkm	-	250%	25%
GARKI	RESIDENTIAL	MIXED	-	0.2sqkm	0.4sqkm	3.8sqkm	1800%	180%
TOTAL	-	-	1.4sqkm	2.1sqkm	9.0sqkm	18.1sqkm	1193%	119%

4.2.1 GROWTH RATE OF PHASE

Growth rate is the percentage incremental measurement and assignment of level of fully developed areas or areas under construction between two periods. The model for its computation is given by Adeniyi (1988):-

$$(B-A)/A \times 100$$

where A Is the value of development in square kilometres for the beginning or reference year and B is the successive year(s).

The growth rate in all the districts of F.C.C phase 1 in 1980 is zero percent, as there is no tangible development recorded in 1980. Development started as from 1984 and that forms our base year.

4.2.1.1 WUSE DISTRICT

The result of the analysis of the data shows that Wuse district recorded a progressive growth rate with a decreasing growth rate of 22.9% between 1988-1992 from the previous value of 34.6% in 1984-1988. The highest growth rate of developed area in Wuse district was recorded between 1992-1994 with a rate of 46.5% over the previous level of development obtained in 1988-1992.

Similarly, Wuse district had negative growth rate of –75% in areas under construction between 1984-1988 which was followed by a massive change rate of about 2,400% between 1988-1992. This accounts for the highest single growth rate in the development process in all the five districts for the period of study. The corresponding rate of growth in areas under construction between 1992-1994 was found to be about 72%

4.2.1.2 MAITAMA DISTRICT

The highest growth rate for fully developed areas, occurred in 1988-1992 with about 633. %. The two previous periods (1980-1984 and 1984-1988) recorded 0% growth rate respectively. However, the growth rate fell from 63.3% to 54.5% in 1992-1994 though still a positive growth, but decreasing-increasing growth rate.

Areas under construction in Maitama district had a negative growth rate of 50% in 1984-9188 and an accelerated growth rate of about 2,000% in 1988-1992.

4.2.1.3 **CITY CENTRE**

The district exhibited a high progressive and consistent growth rate in the positive direction. The growth rate of developed areas rose progressively from 33.3% in 1984-1988 to 150% in 1988-1992 and finally to about 170%. In the case of areas under construction the pattern was not maintained as it shows 183.3% in 1984-1988, 94.1% in 1988-1992 and to 127.3% in 1992-1994.

4.2.1.4 **ASOKORO DISTRICT**

This district recorded no growth rate in 1984-1988, but with a drastic rate of developed area of 166.7% in 1988-1992. It later fell to about 100% in a decreasing-increasing growth in 1992-1994. For areas under construction, Asokoro district recorded a negative growth rate of –100% in 1984-1988 and 0% in 1988-1992 and with another –100% growth rate in 1992-1994

4.2.1.5 **GARKI DISTRICT**

Garki district recorded a growth rate in developed area in the sequence of 27.6%, 24.3% and 45.7 in 1984-1988, 1988-19992 and 1992-1994 respectively. In areas under construction, Garki recorded growth rate of 0% in 1984-1988, 100% in 1988-1992 and 85% between 1992-1994.

From the above discussion, it is obvious that three residential districts namely:- Wuse, Maitama and Garki exhibited the fastest and concentrated growth rate over the years (1984-1994).

Garki and Wuse Districts were the first to be inhabited in the dispensation of the Federal Capital City, phase1 development. The City Centre is mainly occupied by offices and commercial uses. The development of

Asokoro was not as accelerated as that of the other three residential areas of the FCC.

It is important to note that the rate of growth of phase I one is so rapid in both physical terms and population. This consequently led to pressure on the available infrastructure. According to the provision of the master plan, Abuja is to be developed in phases with a total population of 1.7 million people by the year 2,000AD The population of phase 1 was projected at 230,000 people.

However, figures obtained from the Federal office of statistics shows that the population of phase 1 alone as at 1998 had reached a figure of almost half a million (451,857) representing an increase of about 100% over the projected figure of 230,00

4.3 ROAD DEVELOPMENT WITHIN THE FEDERAL CAPITAL CITY PHASE 1 1984-1994

The dominant structural element of the capital city development is the transport system. The major elements of this system consist of a series of peripheral and transverse freeways/parkways forming a highway grid system bounding the major development sectors and four radial transit spines connecting the centres of all development sectors to the central area as well as to each other.

The longest of all the roads within the F.C.C phase 1 is the Nnamdi Azikwe way followed by Ibrahim Babangida and Yakubu Gowon ways. These are the major expressways within the city.

The combination of peripheral roads and penetrating transit ways is directed towards achieving the following objectives (Abuja Master Plan 1979).

(i) Maximize public transportation for those residents who do not own cars.

(ii) Maximize the ultilization of public transportation for those residents who have cars.

(iii) Maximize traffic movements passing through the various development sectors.

(iv) Provide multiple highway paths between network bottlenecks.

(v) Achieve maximum self-containment.

The table below shows the length of highways or roadways required to serve the estimated 1.7 million residents of Abuja out of which phase 1 has about 451,857 people.

TABLE 15: LENGTH OF ROAD REQUIRED FOR ABUJA RESIDENTS (1.7 MILLION PEOPLE)

TYPE OF FACILITY	LENTH (KM)
Parkway	96
Freeway	59
Arterial	226
Collector	289
Local	1,038
Total	1,708

Source: Abuja Master plan(1979)

Table 16 on the other hand shows the length of road required in 1986, the length of road actually constructed by F. C. D. A as at 1992 and then the estimate from satelite image for 1984, 1988, 1992 and 1994.

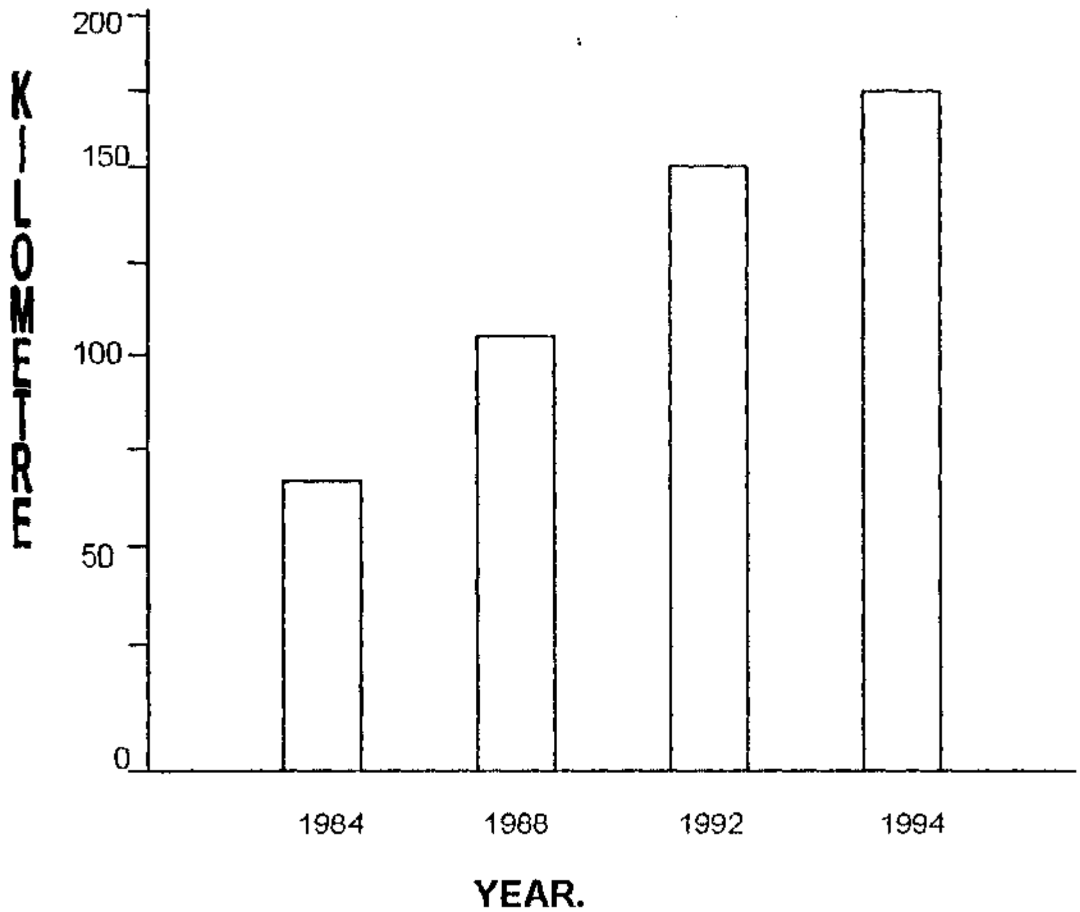
In 1986 the length of expressway required is 35km but only 32km, was completed in 1992. Arterial road on the other hand required in 1966 was estimated at 40km but as at 1992 only 50km was provided and local/collector roads required in 1986 according to the master plan was 130km but as at 1992 only 150km was constructed.

Comparing this with the estimate from this study, in 1984 a total of 19.1km of expressway was constructed; it rose to 28.5km in 1988, 1992 and 1994. This shows a shortage of about 3.5km when compared with the actual figures provided by the F.C.D.A for 1`992.

TABLE 16: MAJOR (HIGHWAYS, ARTERIAL AND COLLECTORS) DEVELOPMENT LEVEL AT THE PHASE 1 1984-1994

TYPE OF FACILITY	LENGTH REQUIRED 1986 IN KM	LENGTH CONSTRUCTED AS AT 1992 IN KM	LENGHT OF ROAD ESTIMATED FROM SATALLITE IMAGE (KM)			
			1984	1988	1992	199
EXPRESS WAY	35	32	19.1	28.5	28.5	28.5
ARTERIAL	40	50				
LOCAL/ COLLECTOR	130	150	46.2	6505	128	149

FIG 10: BAR GRAPH SHOWING THE LEVEL OF ROAD CONSTRUCTION WITHIN THE F.C.C. PHASE 1 (1984 – 94)



As regards arterial and collector roads, these are combined and in 1984, from this study, 48.2km of these category of road was constructed, it rose to 65.5km in 1988, 128km in 1992 and 149.5km in 1994.

4.4 DISCUSSION OF THE RESULTS OF ANALYSIS:

From the above exercise we have been able to extract some vital urban data which are significant in physical planning.

4.4.1 THE LIMAWA WARD POPULATION ESTIMATION

The population figure we obtained from our field work for Limawa ward - Minna is on the conservative side. It is 11,700 people, the E.A.D figure is 13,750, and fieldwork sample 13,750 and 1991 census is 12,000. But the population figure initially (1985) obtain for Limawa 1976-1985 is23,181 people well above what we have in 1998. The explanation for this difference lies in the fact that since 1963, the annual growth rate was added to the initial figure without necessarily considering that the area as far back as 1963 was fully developed. Areas that remain are those pockets of land near the stream, which are now drainage channels.

Therefore, the population estimate through the use of aerial photographs has given us an insight into the population of Limawa. This could be extended to other areas with similar characteristic without going out for sampling to obtain the average number of people per house. The technique becomes easier to use in a single family apartment like government quarters with a well planned layout and building.

4.4.2 URBAN GROWTH ANALYSIS

From the analysis of physical growth data from remote sensing, we have seen how the F.C.C has developed over a ten year period. Out of all the five districts the area with least growth rate is Asokoro which has 25% per annual growth. The other area with the highest growth rate is Garki which has a growth rate of 180%. Even though the district was designed for residential use a lot of commercial activities compete for space with residential use. This greatly increased the demand for land tthus consequent speed in the growth of the district.

Other areas with equally high growth rates are Maitama district and City Centre. Maitama, which is a residential district has to maintained its status with little intrusion of commercial and non residential uses. This area houses most of the important government functionaries.

The Abuja City Centre on the other hand is purposely designed for Commercial / Business activities. It has grown so fast that the most commercial activities are now forced to locate in areas outside the CBD.

Wuse district is growing at about 97.5% per annum and is also characterise by dominantly residential use and non-residential activities.

On the whole, the phase 1 of the F.C.C is growing at about 119% per annum. This is a fairly rapid growth which need to be assessed. The implication of this on the city is obvious. It includes traffic, accommodation, recreation problem, etc. There is therefore, the urgent need to arrest this growth by opening up other areas.

4.5 SPEED OF INTERPRETATION

An important aspect of this study is the time spent on interpretation, cost and level of accuracy. These are very hard to provide especially cost since we got the data use free of charge. However, as mentioned in chapter three cost of a sheet of SPOT panchromatic image is $3,789 or approximately =N=322,065. This is not within the reach of most planning offices. But the cost could be reduced by purchasing more quantity and sharing the cost with other users.

The level of accuracy of the methods applied is about 51%. The important focus is to at least provide an insight into the application of remote sensing in two crucial areas of planning interest-population and urban growth.

The speed of interpretation is very important. In the study of urban growth we use multiple images. Tracing of features could be time consuming especially for a non-professional cartographer. For this work, five cartographers were employed to trace every detail from the images on to a tracing paper. This requires a good cartographic skill. It took them five days to trace the five images and bring out the details.

For the population, only two people were employed to assist during the sampling to obtain average number of people per house. This is the only difficult aspect Using the aerial photograph and enlarged metric sheet, it is very easy to count the houses with few mistakes.

On the whole, nine people including the researcher where involved in the whole exercise and it took two weeks (eight days for urban growth analysis and six days population estimation), to complete the field work. All the analyses were done manually.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 SUMMARY

The main concern of this study is to understand the nature of remote sensing and areas it can be applied to complement conventional data sourcing for physical planning.
We have traced the growth of remote sensing from the pre-world war 1 to the birth of satellite remote sensing. We have also referred to other works on remote sensing applications.

Remote sensing, as a technique has meaning only if applied to a field. We have seen areas where remote sensing has been applied to estimate population, and urban growth, detect land use/land cover change, etc.

We have also applied remote sensing data to estimate the population of Limawa ward in Minna and the urban growth rate of the Federal Capital City (F.C.C) phase 1 from 1984-1994.

5.2 CONCLUSION

Physical planning is a field of study that is facing serious competition from other professions like Architecture, Estate management, Surveying, etc, and the planners are gradually becoming out of touch with more serious areas of spatial planning. In the offices, planning jobs are being taken over by other professions. For instance it is on record that a former Minister of the F.C.T once *transferred the development control department to land* department. This resulted in serious distortion of the Abuja master plan.

The main reason for this development is the non-challant attitude of planners towards more crucial areas of physical planning like conduct of research into urban phenomena, developing and enforcing standards, monitoring urban development, etc. These are all backed by the decree 88 of 1992 which specified the functions of not only planning but the responsibilities of the three-tiers of government in physical planning.

For planning to regain its status, planners must open up to new techniques and emphasise the importance of standards in urban management. This could be done by embarking on studies about urban phenomena like detection of the growth of towns, settlement studies etc. This could be done using remote sensing techniques. This way conventional data sourcing can be complimented and analyses can be more precise and quickly executed.

The choice of Limawa, Minna for demonstrating the applicability of remote sensing in population estimation is the availability of a good data and the relative stability of the area over a very long period. This is because it is one of the traditional areas of Minna and has a fairly high concentration of population. This makes our choice of the ward a bold attempt to see how remote sensing could be applied in a typical set up with multiple households in a house.

Abuja as the seat of government on the other hand is experiencing high influx of people and activities. This became more intensified in 1992 when the government decided to transfer the seat of government to Abuja. This has resulted in increased development of the physical infrastructure and it can be said that most of these developments are concentrated in phase 1. This led to rapid increase in population and pressure on infrastructure.

To monitor such growth, planners need to devise means of quick assessment and we have demonstrated the value of remote sensing in it. We have seen how the rate of growth changed from zero percent in 1980 to 50% in 1984-1988, 328.6% in 1998-1992 period and 101.1 percent in 1992-1994 period. The greatest change occurred during the 1988-1992 period. This could be due to the change of the government seat to Abuja in 1992. On the other hand areas that are under construction was zero percent in 1980-1984, 46.6%. In 1984-1988, 77.6% in 1988-1992 and drop to 58.9% in 1992-1994.

5.3 RECOMMENDATIONS

(i) Planners in both public and private practice should up-date their knowledge with the developments that are taking place in the planning profession all over the world.

(ii) Planners within planning departments should emphasise the importance of planning by conducting researches and carrying out exercise that would make them relevant to the society, rather than concentrating on land sub-division and approval of building plans.

(iii) Planning offices should be provided with the most current data to conduct their work.

(iv) If remote sensing data are to be obtained, interpreted and applied. Planners must be educated in the properties and interactive processes of the natural environment. In addition, decision makers and politicians must develop an awareness of these properties and interaction so that the significance of the data obtained may be understood and applied in the context of economic, social and political constraints.

(v) The above could only be achieved through training so as to be able to analyse the data. Remote sensing courses should be added in our schools curriculum so that our planners would be able to utilise remote sensing data effectively in their planning work.

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