LANDUSE AND URBAN CHANGES IN JOS AND ITS ENVIRONS IN NIGERIA.

BY

BABA, SOLOMON
M.TECH/SSSE/2005/1390

A THESIS SUBMITTED TO THE POSTGRADUATE SCHOOL, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF TECHNOLOGY (M.TECH) IN GEOGRAPHY WITH ENVIRONMENTAL MANAGEMENT (NATURAL RESOURCES MANAGEMENT).

OCTOBER, 2008

DECLARATION

I hereby declare that this project is written by me and its original. It's the final presentation on my research titled "**Landuse and Urban Changes in Jos and Its Environs in Nigeria"** all source have been acknowledged by way of reference.

Signed _____ Date 30/3/09

Baba, Solomon

CERTIFICATION

This thesis Titled: **Landuse and Urban Changes in Jos And its Environs in Nigeria** by: **BABA, Solomon (M.Tech/SSSE/2005/1390)** meets the regulations governing the award of the degree of M.Tech. of the Federal University of Technology, Minna and is approved for its contribution to scientific knowledge and literary presentation.

Dr. P.S. Akinyeye
Name of Major supervisor

30/3/09
Signature & Date

Dr. P.S. Akinyeye
Name of Head of Department

30/3/09
Signature & Date

Prof. M.Galadima
Name of Dean, SSSE

21/04/09
Signature & Date

Prof. S.L. Lamai
Name of Dean, Postgraduate School.

1/12/09
Signature & Date

DEDICATION

To the glory of God, Almighty. He is Alpha and Omega

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CHAPTER ONE

INTRODUCTION

Technology has advanced to the point where man can disrupt and change totally the environment in which he lives. The occurrence of some of these potentials to disrupt and change the environment have served to stimulate and focus public attention upon environmental issues. The application of remote sensing techniques for urban change detection, mapping and analysis requires continues acquisition of data for the formulation of policies and programmes. There is an urgent need to have timely, accurate and cost effective source of data and these can be gotten through satellite image or air photographs.

Urban areas can be described as those areas that constitute part of a town or a city. These places have a higher population density and are places that are divorced from primary activities. They have high densities of buildings and contain diverse mixture of social and economic functions. The urbanization and modernization processes, with the increased demands for land, housing and transportation, introduce radical changes in the pattern of the area. Urban change detection mapping and analysis can be facilitated through the interpretation of aerial photographs. Air photo interpretation for urban change detection and analysis can also be facilitated through the use of Zoom transfer scope or a Video Image/graphic system as an aid to comparing photographs of two different dates in comparing a photograph with a map.

1.1 JUSTIFICATION FOR THE USE OF RAIN FALL IN THE STUDY

Remote Sensing is a set of techniques needed to obtain information about the earth surface and atmosphere at some distance from them, usually by means of radiation from electro-magnectic energy. The objective is to extract environmental and natural resources data which is related to the earth in order to:

1. Increase our knowledge of land surface
2. Improve on its use
3. Formulate better government policies and programs.

The information obtained is carried via the electromagnetic energy as wave lengths. It should be noted that the knowledge of our land features and resources is one of the main factors that need to be considered in making economic decisions and executing government policies and programs. There are various ways in which urban change detection can be monitored. One of such methods is through the use of overlays. This involves the use of two different maps of an urban area compiled at different dates to delineate any changes.

The field of remote sensing has been defined by different people. Colwell (1966) defined it as "Reconnaissance at a distance" Lintz Simmett (1976) defined remote sensing as "the acquisition of physical data of an object without touch or contact". The American Society of photogramentry defines it as "imagery that is acquired with a sensor other than a conventional camera, through which a scene is recorded, such as the electronic scanning

using radiation's outside the normal visual range of the film and camera microwave, radar, thermal infrared, ultraviolet as well as mulspectrol, special techniques which are applied to process and interpret remote sensing imagery for the purpose of producing conventional maps, thermatic maps, resources survey, etc in various fields of agriculture, archaeology, forestry, geography, geology and others".

1.2 STATEMENT OF PROBLEMS

Cities are centers of attraction of large population concentration and tends to increase due to the presence of industries and other urban economic activities. This influx has increased the tempo of activities and at the same time contributive to the social- economic and physical problems in Jos North area. For instance most of the problems in existence today are:

- competition for space
- overpopulation (congestion)
- Pollution noise, lan , air etc.
- Poor social amenities
- Housing problem
- Poor waste disposal facilities
- Traffic problem

These problems resulted due to poor planning and have in turn contributed to a general degradation of the environment. Many places in Jos North Area lack social amenities and services. These problems have risen due to the absence of any urban information collection and monitoring systems, which would have helped in the spread of development in this area. The focus of this study is to provide information about the unique characteristic of development and associated problems. Where urban change has occurred

from time to time. Urban planners and managers with the help of the available data can suggest how improvements can be executed

1.3 AIM AND OBJECTIVES

One of the major problems that confront managers is the acquisition and analysis of timely and reliable data. Urban data is the information upon which efficient administration of cities and towns depend. It also provides information for management and decision making for future generations. This study creates awareness within the Nigerian populace on the need and importance to adhere to regulations that guide, monitor and assess our immediate environment. The aim of this study is apply data collected through remote sensing technique to a wide range of other environmental sciences.

The objectives of this study include to:

1 asses and detect how much change has occurred in Jos North (Naraguta N/E) of plateau State.

2. Determine the implications (negative or positive) of this change on the urban area.

3. Produce urban change inventory maps of the study area for the year 1975 and 1991.

4. Suggest how improvement can be directed towards more positive directions and to act as guide for future policies.

1.4 JUSTIFICATION OF STUDY

One of the main aims of urban change detection is to determine how much development has occurred in area after a long period of time, the impact of the development (negative or positive) and alternative solutions to existing

problems caused by development of urban areas, and provide an accurate information collection system.

In this study it should be strongly noted that the inventory of urban changes within specific number of years of Jos North Area is very important for development processes to occur, particularly the unique characteristic of aerial photographs (which shall be used) as data collection tools, for a fast, accurate and economical data acquisition method, which fits well into urban information collection and monitoring systems. The use of remote sensing technique for this project is advantageous in the sense that real time analysis of an area can be done using air photo or satellite imagery. Aerial photograph is one of the oldest and most common techniques of remote sensing because it is cheaper and more readily available.

Remote sensing enables constant monitoring of change and developments in the environment. It also provides a permanent base on which situation on the conditions of the study area can be studied. Vertical photograph are the most widely used aerial photographs as they tend to have properties that are similar to those of a map with an approximately constant scale over the whole photograph and as result could readily be used for mapping and measurement Presently land inventory satellites are present in orbit and provide information about the earth surface phenomena at various ground resolutions, with multitemporal and multispectral features. It is thus regarded as a potentially effective means of data source for inventories and evaluation process, detecting problems planning and finding possible solutions to problems.

1.5 SCOPE OF WORK

The main focus of this study is on the detection of changes in the Jos North area using aerial photographs. The study covers the Naraguta; Dogon-duse, Agwan-rogo and Bauchi road areas which are within the vicinity of jos township; Aerial photographs of 1975 and 1991 will be used to determine the level of urban change in the study area. The project will involve photo interpretation, groundtruthing and the production of maps to show the rate of urban change.

Despite the problems facing development of remote sensing in Nigeria which include, high cost of remote sensing data, lack of trained personnel and lack of hardware and software facilities to handle remotely sensed data amongst other problems, this study was carried out with the use of black and white aerial photography's, which are the most popular remote sensing technique employed within the country, due to their availability, cost and the fact that they enable the detection of small scale features and also shows spatial relationships that will not be evident on the ground

STUDY AREA

Jos town located North-East of the River Niger is also known as the Tin city of Nigeria, and it is the capital of plateau state which is one of the thirty – six states of the Federal Republic of Nigeria. It is located in the middle belt region. Located at a very high altitude, the town is the site of many tin and columbine, minefields, which can be found at the outskirts of the town. Tin ore and columbine are major mineral and they provided a lot of income for the state and country as a whole before the discovery and exploitation of crude oil. Since then the activities of the mines have reduced so much that

they are now almost closed down, and the amount of revenue gotten from tin and columbine is almost negligible. Despite this fact the city itself is a beehive of activities such as industrial, commercial and education activities. Its location at a very strategic position in the country as well as foreigners. Most of the commercial activities of the thriving town, place along the major roads that link various points in the town.

1.6 CLIMATE

Though situated in the tropical zone, the climate of plateau State is the nearest equivalent of a temperature climate in Europe and the United State of America. Mean annual temperature range from maximums of 28 centigrade to a minimum of 16 centigrade. While average annual rainfall varies from 131.75cm in the southern part to 146.00cm on the plateau, much like the situation in the southern part of the country. The months of December, February and January are particularly very cold due to the dry winds of the harmattan. Generally temperature on the plateau are several degrees lower than in the other parts of the country, but the area experiences its highest temperatures between the month of march and April. The Jos plateau has an invigoration climate-hence it has the largest concentration of resident expatriates in the former British West Africa today. Church missions and foreign affairs, still maintain offices in Jos.

1.7 RAINFALL

Relief is a significant factor in rainfall pattern of Jos. It has a total of eight month of rainfall from April to November. The jos plateau has a higher annual total of rainfall than the average, for its latitude. It is also termed as a mooson area due to its heavy rainfall. Orographic effects are also obvious in

the rainfall pattern and type. The study area has a total rainfall of 152-203mm, which is more than other areas on the same latitude. Jos is characteristic of a line squall area. It is noted significantly that in spite of the distance of the study area from the coast, fairly high probabilities of more than 24% of rainfall occur for some hours of the day during the raining season.

1.8 LAND USE PATTERN OF THE STUDY AREA

Urbanization and modernization processes with the increased demand they make for land, housing and transportation can affect significant changes in a settlement structure. Factors affecting this change could be attributed to changes in the land use pattern as well as changes associated with socio-economic development. These changes in socio-economic development bring about high expectations, change in taste and higher standards of living. For example improved transport and communication facilities play crucial role in the organization and changes of urban areas. Since the urban area is an area in transition, there is therefore a conflict between agricultural, residential and transportation uses of land. In the study area, high rise buildings are found mixed with bungalows and substandard structures. These residential types, lie side by side with other land uses such as transportation routes. Other built up areas, clustered residential land, transitional land, areas of commercial, parks and refuse dumps. Industrial and factory land uses in few instances might be found intermixed with the other land use types, despite the fact that specific land has been mapped out for industrial sites and factories. Agricultural land use patterns occur at places that are quite distant form the urban area. From the above mentioned land use characteristics of the land use pattern of the study area, it is quite

evident that planning problems abound and these problem include uneconomic use and waste of land, lack of basic data for planning purposes and lack of planning by the local authorities for urban growth . This results in many cases, for, productive land to lie idle for several years awaiting development or to be destroyed by being turned into a dumping ground for all kinds of refuse including industrial and domestic refuse.

1.9 GEOLOGICAL BACKGROUND

LAND FORM

The most wide spread rocks in the Jos area are the basement complex rocks. They are old, hard rocks chiefly made up of granites. Covering the basement complex rocks in some places are sedimentary rocks, which are much younger and consist of hardened sediments deposited millions of years ago. Volcanoes were once very active in Jos and volcanic rocks made up of lava and other materials were poured out from beneath the earth unto the surface. Since the rocks in study area are basement complex rocks, they are uplifted to form highland regions, and they will remain like that, because the old hard rocks which Jos highlands are composed of are difficult to wear down. High mountains and plateaus, therefore, rise steeply form the surrounding plains of Jos area. Weathering and exfoliation have also affected the land forms of the study area by producing numerous isolated granite hills called inselbergs on most of the plains. Due to the highland characteristics of Jos, it is a center of drainage dispersal for some rivers and they include Gongola, Kaduna and Sokoto rivers.

SOIL

The high intensity of microbial activities due to the climate of Jos has led to an abundance of humus and thus a high fertility rate of the soils. The soils of the study area range from dark to light brown in colour. Despite this fact, during the rainy season, the high altitude of the area has led to a lot of erosion, leaching and literate formation. Plants with shallow roots do well during the dry season and theses include tomatoes, lettuce, carbages, garden eggs and in general vegetables.

VEGETATION

The study area can be termed as Savannah region. This is because of the type of climate, rainfall relative humidity and temperature ranges, that encourage the growth of grass. Though some trees grow as well. In fact there were quite large occurrence of trees in the study area than could be seen now. This is because man and his animals have cleared much of the former vegetation, so that the existing trees and grasses that remained now are only survivals of the original plant cover.

CHAPTER TWO

LITERATURE REVIEW

The use of Remote Sensing as a tool for environmental analysis dates back to the 17th Century with the discovery of infra red by Sir Williams Herchel (1800). In 1839, Louis Dagure (1789-1851) publicity reported results of his experiments, which marked the beginning of the practice of photography. The use of photography to record an aerial view of the earth's surface from balloons dates as far back as 1858. These aerial images of the earth are among the first to fit the definition of remote sensing given previously though most of them were regarded as activities for curiosity rather than basic for a systematic field study. By 1973 the theory of electromagnetic energy was developed by James Park Maxwell.

The acquisition of aerial photography on a routine basis started during the World War 1 (1914- 1918). During the World War II (1939-1945) the use of the electromagnetic spectrum was extended to other regions most notably the infrared and microwave regions (beyond the range of human vision). The post war era saw the continued development of science and established capabilities found their way into civilian applications.

Amongst the most significant developments in the civilian sphere was the work of Robert Colwell which, was published in 1959, applying the colour infrared film to problems of identifying small grain cereal crops and their diseases. His work applied colour infrared aerial photography, first used widely during World War II to important problem in the sciences. At this early stage Colwell was bale to delineate the outlines of modern remote sensing and anticipated many of the opportunities and difficulties of the world.

Dunford et al., (1980) illustrated the effectiveness of remote sensing for rural development planning in Africa. The major aim of their study was to attempt to minimize time, money and personnel using a combination of remote sensing techniques for rural development planning. Using aerial photograph and existing reports on vegetation and soil conditions, they were able to provide land resource and land use information for rural development planning in Arusha region, Tanzania for a period of three months.

Rao (1994) used remote sensing data (aerial photography and imagery) and information obtained form the census department in India to estimate the growth of built up areas for the year 2001 in India. He also identified the variables which cause and using three techniques: casual modeling techniques, cross- classification method and rating method, he was able to forecast the future quantity of built up areas.

Khuoria (1993) applied remote sensing to detect vegetation and land use changes in rain forest ecosystem. Using the rain forest belt of northeast Edo state. Nigeria as his case study, he employed 1967 and 1977 black and white aerial photographs of the area. The results indicated that within a decade the ecosystem experienced drastic depletion of forested lands, rapid territorial expansion of settlements and tremendous increase in agricultural farm land.

Mattikali (1995) integrated sensed data with a vector based geographical information system to detect land use change. He used land use maps for 1931, 1963 and 1971 of the River Glen, catchments which, extends between Granthom , Bourne and Stanford in South Lincolnshire, England . His change detection methodology was specifically applied to six land use categories. These include arable, grass land, woodland, water, bare soil and urban categories. In every operation he employed two successive coverage's

which resulted in a total of five coverage and each coverage was analyzed for land use change. Through this he was able to determine the changes in total area and changes from one category to another over the 18 year period of data collected.

Omojola and Soneye (1983) also demonstrated the application of remote sensing techniques in the mapping and inventory of land use on land cover feature in the middle Sokoto River Area, North- western Nigeria. This study demonstrate the use of various remotely sensed data- historical aerial photographs and sport-KS/p in mapping the land use cover for 1962, 1977 and 1986 in the Sokoto close settled semi- arid area of Nigeria. Thirteen different land use and land cover categories were identified. The mapped land use and land cover was further digitized and analyzed by G.I.S. systems- personal computer, Arch info and Tydac spans. The results showed that Tudu (rained) agricultural land dominated the area during the periods of analysis 1962, 1977 and 1986. The rate of loss of this natural resource base was also 84.4ha/year between 11962 and 1977 and296.4ha/year between 1977 and 1986.

Hannah (1969), found that urban use data of the type normally required by Ashvile metropolitan planners: (Single family residential, multi family residential, retail commercial, light industry, etc), could be acquired more accurately form large scale photography than the field mapping techniques local planners currently were employing.

Simpson et al, (1970), their study of Boston used aerial photographs at a scale of 1:120,000 to prepare land use maps and computerized data for the entire metropolitan region. The land use map was compiled directly from the photographs (over lays).

In 1970, Geological survey Geographical Application programme (GAP) developed procedures for monitoring current land- use. They used satellites and high altitude photography as the primary source of information. They were also able to relate land use to other environmentally and socio-economic data which were recorded in a computerized data bank. the programme makes use of the classification system developed by Anderson et al., (1976) , on coloured infrared photography at a scale of 1:100,000 or 1:120,000 depending on the altitude of the air craft .

Lo et al; (1990) carried out a study on Geographic Information System (GIS) approach to land use change dynamics detection. This was applied to assess the impact of new town development in Twen Mon, New territories, Hon Kong, on the environment through integration of past current aerial photographs which were taken in 1976 and 1987 at a scale of 1:25,000 and 1:40,000 respectively. Image overlaying and binary masking techniques were used. A low cost micro-computer based GIS IDRISI was used in land use change detection. The result showed that the binary masking method reveals the dynamic of land use change. It was also revealed that the Government of Hong Kong had some success in controlling the spread of eroded bad land with reforestation as the intensity of urban land use increased. In 1976 the Federal Government of Nigeria, through the Ministry of Forestry Commissioned a radar survey of the whole country, with the requirement of produce a series of land use and vegetation maps of the country. Side-looking Airborne Radar (SLAR) imageries were acquired by Motorola (MARS) Limited between 2nd October 1976 to 31st March 1977, using a real aperture X-Band. The Slar imageries acquired were interpreted and mapping of the various vegetation cover was done with the production of land use maps. This project was the first ever SLAR survey project

carried out on African continent and second largest to the RADAM project in Brasil

Adeniyi (1980) carried out a change detection of Lagos Nigeria using sequential aerial photographs. The study area encompassed urban built up area, urban vacant land and non-urban land. He devised nine major land-use land cover categories with 45 sub-categories. The nine major categories he used were residential, commercial, industrial, institutional, transpportional an utilities, recreational and open spaces, vacant land, non-urban land and water, using aerial photographs of 1962 and 1974 the land use change revealed the rapid increase to the residential land use and a strong lateral expansion of the urban area of Lagos state.

Avery (1965) Focused attention on detection of land use change. He used aerial photographs taken between 1944 to 1960 to evaluate land use and land cover changes in Dark country, Georgia.

There is little doubt to the ability of aerial photography to supply the land use data sought or as to the heavy dependence placed on aerial photography as a data source. Application of photographic Remote Sensing in environment impact assessment of land-use changes will help in future planning.

This study will also serve as a contribution to the effectiveness of this technique in the study of urban, land use and change detection in Nigeria. Although the aerial photographs will be manually interpreted and classified, it will provide a change map suitable for future planning.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 DATA COLLECTION

Aerial photograph are one of the best sources of land use change detection of urban areas at different time intervals, this is due to the advantages which it offers over sources such as the on-ground observation. Two sets of aerial photographs taken in 2005 at a nominal scale of 1:10,000. The 1975aerial photographs were numbered as follows 76626-110, 76626-111. To a large extent the photographs were of good quality, the only problem that was noted on the aerial photograph was that they were exceptionally whitish (bright) and thus there were some problems in the delineation and identification of features. The 2005 set of aerial photographs were numbered as follows 8748, 8749, 8750 and they were of extremely good quality. These sets of photographs were obtained from the photogrammetry department of the Ministry of Lands and Survey Jos. Complementing these photographs were pictures of the study area, and field work. Materials were also extracted from relevant literature.. Some of the equipment that aided the study includes mirror-stereoscopes, graph sheets, transparent, light tables, rotary pens and stencils.

3.2 METHODOLOGY

Aerial photographs have been employed, sequentially by planners to detect urban changes over a period of time in an environment. The advantages of aerial photographs is that when taken as overlapping pairs they can provide a three-dimensional view (stereoscopic view) of the earth surface.

An interpreter systematically examines the photograph and frequently, other supporting materials such as photographic maps and subsequently, reports. Exact characteristics, useful for any specific task and the manner in which they are considered, depend largely on the field of application.

3.3 DATA EXTRACTION

The primary data extraction and interpretation was done using both the pocket and mirror stereoscope. Each set of aerial photographs were then arranged accordingly taking note of the fiducial points and flight lies to produce a mosaic. The mosaic for each of the years were traced unto transparent and finally unto tracing papers. Since the scale of the 1975 aerial photographs were smaller than that of the 2005 photographs, the 1975 aerial photographs had to be enlarged to correspond to the scale of the 2005 aerial photographs. This was done using the square grid enlargement method, thus there was a transfer of information from the 1:10,000 mosaic to the 1:8,000 mosaic. The process possed little problems in the delineation of changes that took place within the period in question due to the differences in scale. Basic photo interpretation elements size, shape, shadow, tone, texture, association pattern were employed during the visual interpretation process. Urban changes detected and delineated were field checked by ground truthing. Pictures of the study area were also taken to aid the interpretation process.

4.4 DATA ANALYSIS

Overlaying the land use maps prepared from the two different sets of aerial photographs, an urban change map was then produced for the year 1975 – 2005.

Quantitative aerial data analysis for the urban change categories were then compiled for the study area. This was achieved by placing a transparent square grid of 5mm x 5mm cell over the map to measure areas of urban change.

3.5 FIELD CHECK

To check the accuracy of the interpretation of the aerial photographs, field check was carried out. All the areas involved in the study were visited and photographs of these areas taken. Areas visited included parks, the Federal School of Forestry Jos, the University of Jos, Race course and other areas of interest to the study area including commercial and residential areas. All these areas are considered as samples and represent the rate and type of change in the recent years.

CHAPTER FOUR

RESULTS

TABLE 4.1: URBAN CLASSIFICATION SCHEME

Level I	Level II
1. Built up Areas	1.1 University of Jos
	1.2 Federal School of Survey
	1.3 Commercial Areas
	1.4 Residential Areas
	1.5 Industrial Areas
	1.6 Senior Staff Quarters
	1.7 Parks
	1.8 Race course
2. Underdeveloped Areas	2.1 Bare Land
	2.2 Rock Features

* Note: urban Classification Scheme by Author

TABLE 4.2 Distribution of Urban Change Categories and Magnitude Between 1975-2005

Urban land categories	1975 (km^2)	Area in Ha (A)	1991 (km^2)	Area in Ha (B)	Magnitude of change in Ha (b-a) = c	Remarks
1. university of Jos	0.9	900	1.792	1792	892	Increase
2. School of Forestry	0.7	700	1.536	1536	836	Increase
3. Race Course	2.1	2100	1.088	1088	-1012	Reduction
4. Senior Staff Quarters	1.5	1500	3.264	3264	1764	Increase
5.Parks	-	-	0.384	384	384	Increase
6. Built up Area (Developed)	4	4000	10.88	10880	6880	Increase
7. Underdeveloped Areas	14	14000	6.592	6592	-7408	Reduction
Grand Total	232	23200	25.536	25536	19.76	Increase

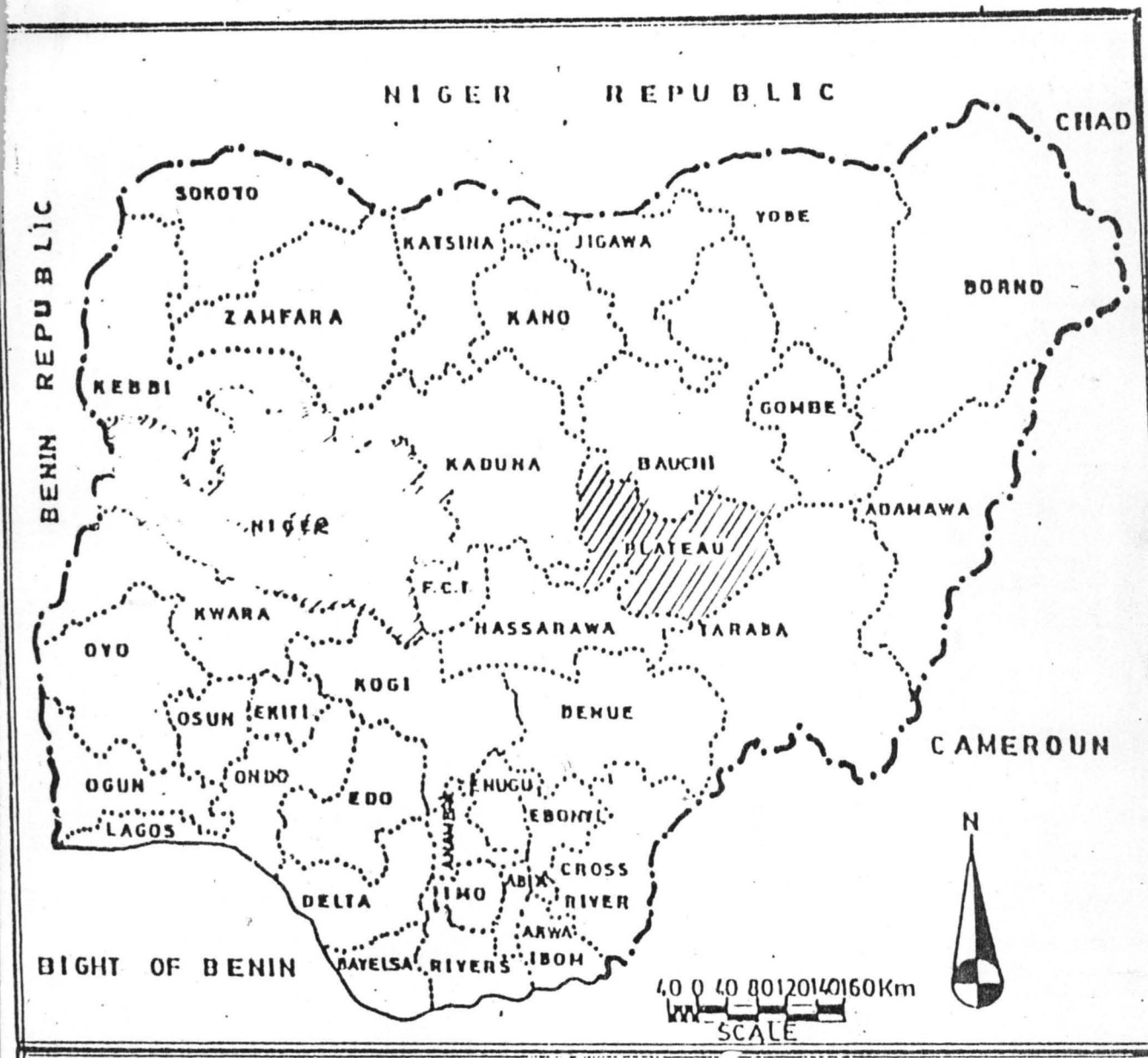
Source : compiled by author

Table 4.3 Percentage Distribution of the Urban Categories

(A) Urban categories	(B) 1975 percentage Distribution	(C) 2005 percentage distribution (%)	(D) Percentage change (C-B) %	rema
University of jos	3.87	7.0	3.13	
School of Forestry	3.0	6.0	3	
Race Course	9.05	4.26	-4.79	
Senior Staff Quarters	6.46	12.78	6.32	
Park		1.5	1.5	
Built Up Areas	17.24	42.60	25.36	
Underdevelopment	60.34	25.8	-34.54	
Total	100	100	-	

Table 4.4 Proportion of change of each urban categories class to the overall change.

Urban Categories	Magnitude of Change (c) (Hc)	Change % of Each Class (c Total c100)	remark
University of jos	892	4.65	
School of Forestry	836	4.35	
Race Course	-1012	5.27	
Senior Staff Quarters	1764	9.19	
parks	384	2.00	
Built Up Area (developed	6880	35.87	
Underdeveloped Areas	-7408	38.63	
Grand Total	19175	100	



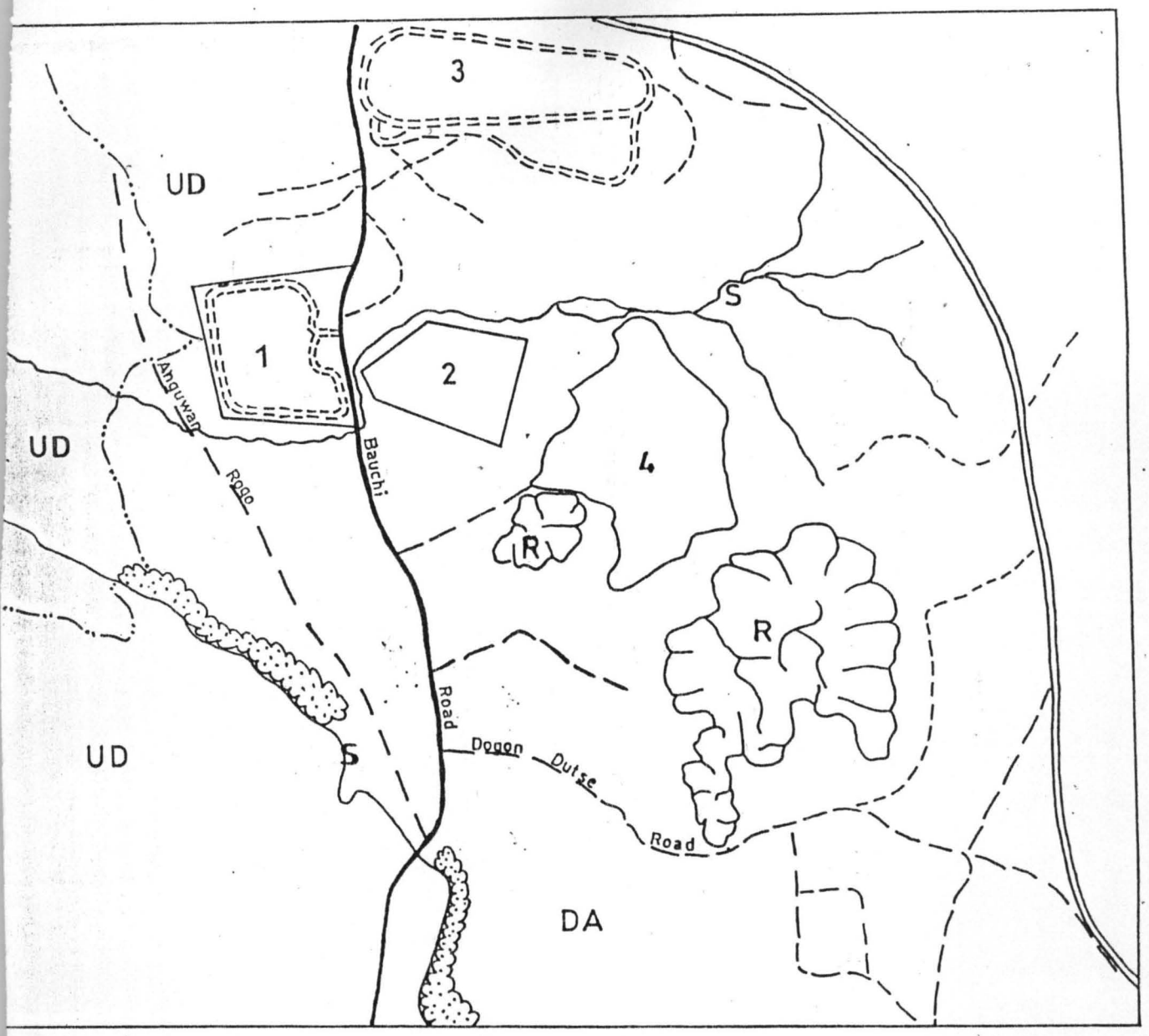
LEGEND

National Boundaries . . . . . —•—•—

State Boundaries . . . . . ••••••••

Study Area . . . . . 

Fig:4.0 NIGERIA MAP SHOWING THE STUDY AREA



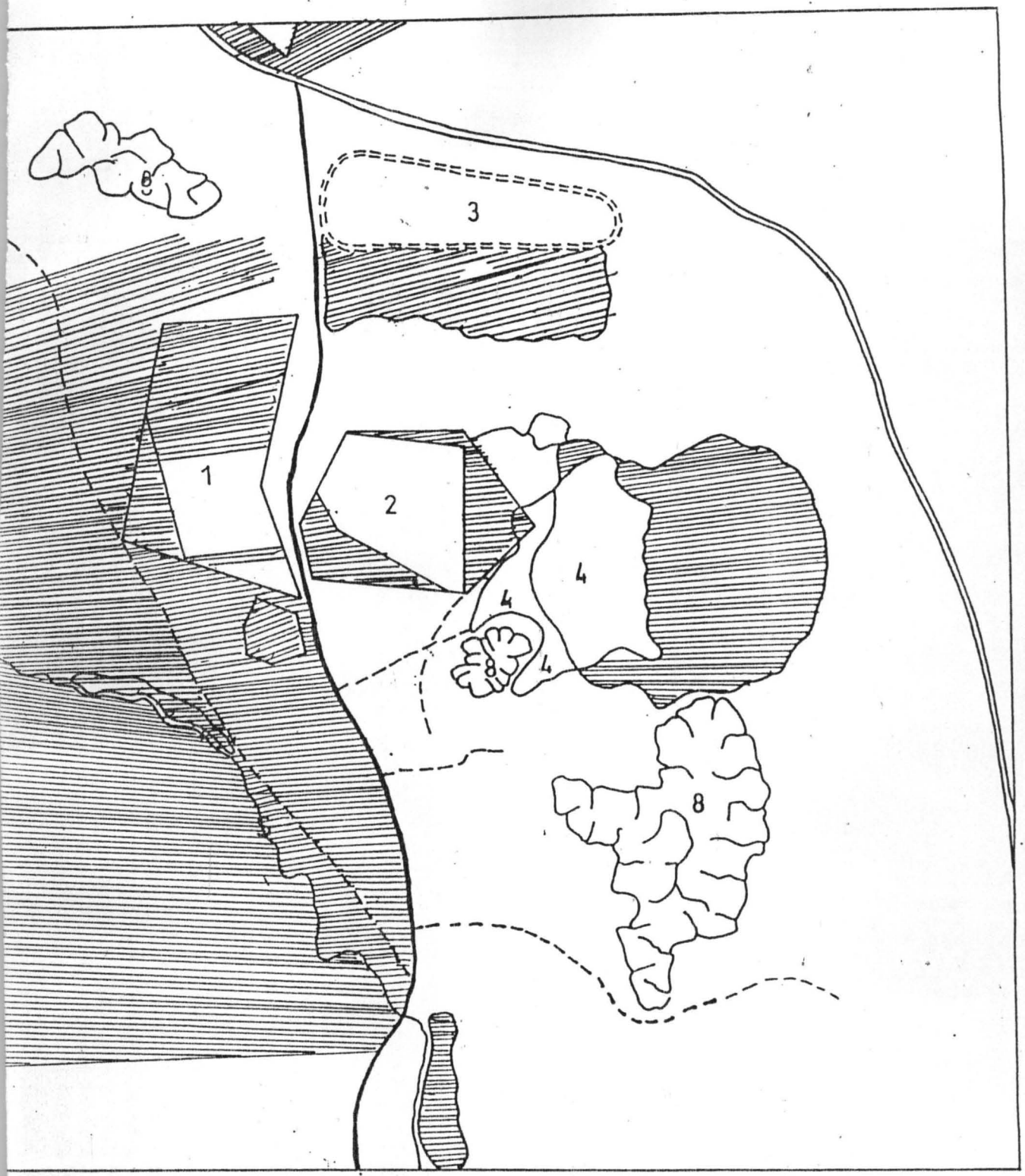
LEGEND

1	UNIVERSITY OF JOS
2	FEDERAL SCHOOL OF FORESTRY
3	RACE COURSE
4	SENIOR STAFF QUATERS
UD	UNDEVELOPED AREAS
S	STREAMS
	VEGETATIONS
	FOOT PATHS
	TRACK ROADS
	MAJOR ROADS
R	ROCK (HIGH LANDS)
	MINOR ROADS
DA	DEVELOPED AREAS

N

REPRODUCED BY: MARTIN SAMUEL .C.
YEAR 2005. GEOGRAPHY DEPT F.U.T. MX.

MAP SHOWING PART OF JOS METROPOLIS (NARAGUTA N.E.)



LEGEND

1 UNIVERSITY OF JOS
2 FEDERAL SCHOOL OF FORESTRY
3 RACE COURSE
4 SENIOR STAFF QUARTERS
8 HIGH LANDS
S STREAMS
V CHANGED VEGETATION

☐ CHANGED AREAS
MAJOR ROADS
EXPRESS WAY
YEAR 2005

N

SOURCE : AUTHOR
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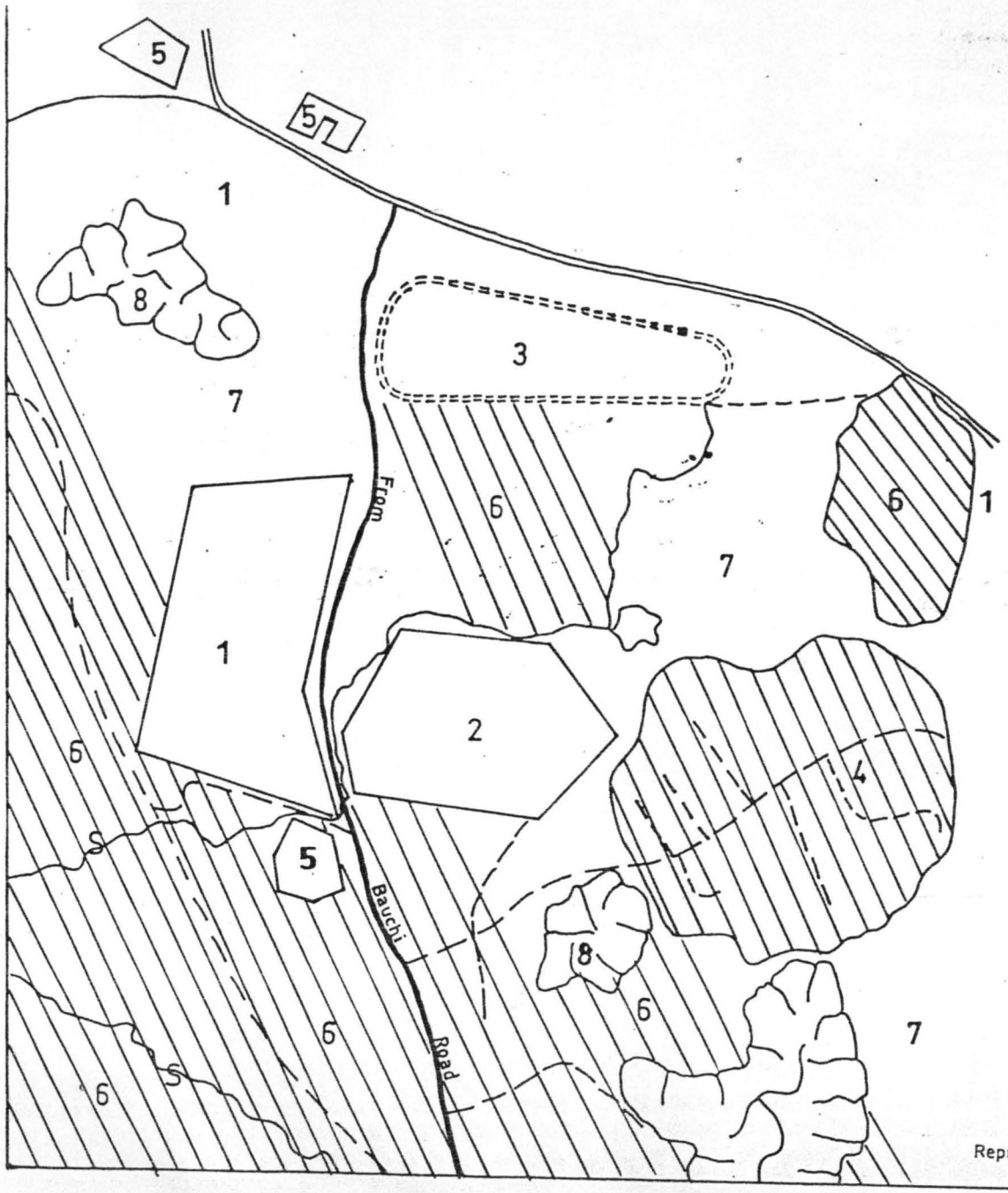
G: 4.3. **URBAN CHANGE MAP OF JOS (NARAGUTA N.E.)**



LEGEND

═══	EXPRESS WAY
1	UNIVERSITY OF JOS
2	FEDERAL SCHOOL OF FORESTRY
3	RACE COURSE
4	SENIOR STAFF QUARTERS
5	PARKS
6	BUILT UP AREAS (DEVELOPED)
7	UNDER DEVELOPED
8	HIGH LANDS
S	STREAMS
- - - - -	MINOR ROADS
———	MAJOR ROADS
YEAR	2005
SOURCE	AUTHOR

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URBAN MAP OF JOS NARAGUTA N.E

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 SUMMARY OF FINDINGS

The interpreted map of the study area, which was obtained directly from the photographs by the author, is shown in figure 4.1. The results of the interpretation showed that the underdeveloped areas made up of the largest categories in the classification covering a total area of 14000 hectares (60.34%) (Fig. 4.1) (UD). The interpreted data showed that there were no motor-parks. The major road (Bauchi road) was quite narrow. It was also noted that the senior staff quarters was quite small and occupied an area of 1.5 hectares (6.46) (fig. 4.1) (4). It was also noted that it was surrounded by bushes.

On the aerial photographs, a better and well maintained racecourse was also detected and was also large in size. It covered an area of 2100 hectares of land (9.05%) (Fig. 4.1) (3). this can be strongly associated with the presence of expatriates who used the racecourse for recreational purposes. These expatriates maintained racecourse properly.

The University of Jos covered only an area of 900 hectares (3.87%) (fig. 4.1) (1) While the Federal School of Forestry covered 700 hectares (3.0%) (fig. 4.1) (2) From these figures it can be seen that developments in terms of structure and institutions were slow. In general, built up areas accounted for 4000 hectares (17.24%) (Fig. 4.1) (6). A stream which cuts across the Bauchi road flowing from Dogon-dutse area down to Angwan-rogo had lots of thick vegetation cover along its bank and was also quite large. On the left side of the University of Jos there were vegetation. There were no farms and also little sign of human existence. There were also no incidence of lesser traffic, which to large extent suggested that there was

incidence of lesser traffic, which to large extent suggested that there was little amount of population and thus development. The houses on the aerial photograph especially those in the senior staff quarters and Dogon-dutse area were well spaced out and arranged in rows, due to a lesser demand for space.

The road network was well connected but narrow and most of them were untarred. The occurrence of footpaths on the photographs shows the stage of development of the study area. People either moved on foot or on animals and footpaths appeared in almost every area of the study area.

Most of the tree cover on the photograph was well arranged and demarcated from themselves reasonably, especially in a place like Dogon-dutse, which suggested that there was a Government Reserved Area at that place then. The drainage pattern of the study area also was very prominent in the photograph of 1975.

5.1.2 INTERPRETATION OF 2005 PHOTOGRAPHS

These set of Aerial photographs show a great deal of contrast of what was the study area in 1975. a lot of development had now taken place. Petrol stations now lined the boundary of Bauchi road, which had been expanded with street lights. Other roads which led into the major parts of the town had also been expanded and tarred. River Bauchi had shrunked to less than half of its original size and there was an absence of vegetation on either side of its bank. This was because refuse had been dumped in most parts of the bank of the river while at other areas of the bank; structures had been erected there, which led to the removal of vegetation. Most of the footpaths had disappeared. A much wider and better network had appeared almost in every part of the town.

A new park was now in place (Bauchi Park) covering an area of 384 hectares (1.5%) (fig. 4.2) (5). The University of Jos had also expanded to account for 1792 hectares (7%) (Fig. 4.2) (1).The School of Forestry opposite the University of Jos also had expanded and covers an area of 1536 hectares (6%) (fig. 4.2) (2). It was also noted both on the photograph of 1991 and in the process of field work there now existed newer and modern structures. The senior staff quarters of the University of Jos had also been expanded and occupied an area of 3264 hectares (12.78%) (fig. 5.2) (4). Houses of the different architectural design had sprung up and the developed or built up area accounted for 10880 hectares (42.6%), while the underdeveloped area covers 6592 hectares (25.8%). The express way to Bauchi state, (Bauchi Ring Road) had also been constructed and completed. A large incidence of cars were noted on the photographs which indicates fast acceleration of development. The drainage system had also been displaced to a state of insignificance.

The Race course had shrunk in size due to lack of maintenance and the fact that people were now cultivating and building on it. It now accounts of only 1088 hectares (4.26%) (fig. 4.2) (3). A lot of the underdeveloped areas had been used up for farming and building.

5.1.3 CHANGES BETWEEN THE PERIODS OF 1975- 2005

In this study, urban changes refer to the reduction or increase of various urban categories used in the classification scheme. Table 5.1 and 5.2 show the percentage distribution of each category, the total for each of these categories in the study area is clearly recorded. This makes change analysis easy and much more simply. Table 5.1 shows the amount of change recorded while table 5.2 and 5.3 represented the percentage change. As can be seen in table 5.2 the underdeveloped area recorded the highest amount of change from 60.34% to 25.8%, and it was closely followed by developed area, which also increased, from 17.24% to 42.6%. This indicates a large change in terms of development of the urban area. More land has been used up, buildings expanded, considerable structures have also been constructed and roads expanded. These changes are shown in change map fig. 5.3. The University of Jos recorded a percentage change increase from 3.8% to 7%, a percentage increase of 3.13% (7.0- 3.87). The race course however recorded a negative change (shrinking) from 9.05% to 4.26%, a percentage decrease of -4.79%. The reason for this negative change is because most of the land is now used for other purposes. The senior staff quarters had also witness an increase from 6.46% to 12.78% which also indicate a change in population and other activities in the town and hence, inevitably, changes occur. From the ground truthing carried out the rate of development is increasing very fast, as can be seen in fig. 5.3.

5.2 Recommendation

For proper collection, storage, retrieval and use of remote sensing techniques in urban change detection or studies, the following recommendations must be carried out.

i The initiative should be taken to institute a comprehensive survey of the actual operational use of remote sensing especially for urban purpose, specifically with regarded to urban change detection, which is the basic ingredient for organized or positive development of urban areas.

ii Inclusion of urban remote sensing application in educational programmes of geographers and town planners as compulsory subject.

iii Greater attention should be given to the training and research in urban photo interpretation so that it is adjusted to the particular needs of Nigeria.

iv reporting on operational applications of aerial photography and remote sensing to urban problems, by imagery hardware and software development should be intensified and systemized. Publications and international exchange of research findings should be stimulated as much as possible

v The national Remote Sensing center in Jos, plateau state, should be fully equipped so as to be able to handle remote sensing classification/interpretation approaches.

vi There should be co-operation between the Nigerian society of remote sensing and other agencies, such as the European space agency, Earth

observation satellite, America society for photogrammetry remote sensing and others, to enhance adequate flow of knowledge.

vii the government should provide funds/grants for research institutes for carrying out researches into the application of remote sensing techniques to the Nigerian environment.

viii It is also recommended that a standard working group on urban remote sensing should be established by towns and urban planning and management divisions at the state ministries concerned and at the federal level.

To this end it can thus be concluded that the use of remote sensing, to urban applications is very eminent especially in this era of technological advancement

5.3 CONCLUSION

The origin of urban applications of Remote Sensing Technique in Nigeria can be traced back to 1976, when the federal Department of Forestry with the Federal Government awarded a contract for the acquisition of SLAR (side looking Airborne Radar) Imagery of Nigeria to a North American company called Motorola Aerial Remote Sensing Incorporated (MARS), a separate contract was also awarded to interpret the imagery of towns, cities and other principal built up areas to Hunting Technical Services Limited, a British firm of consultants in Land and Water resources planning. The Remote sensing system utilized was the radar technique using the side looking airborne radar (SLAR) on board air crafts.

In 1945, Arthur Clarke predicted that by 1970, there would have been satellite in space. Fred Holy (1948) while postulating over the possibilities of exploring the earth from space, declared that "once a

photograph of the earth taken from the outside is available – once the sheer isolation of the earth become plain – a new idea as powerful as any history would let loose". The prediction were rebuffed by critics.

However today, judging from the comprehensive portraits of remote sensing technology being used now around the world, they have been vindicated because earth observations as well as communication from space have become a routine. Between 1972 and date, over sixty satellites and other space borne platforms carrying a variety of sensor have been launched. More satellites are still being planned for launch before the turn of the century.

The dynamic process of change and development has reached such a dimension that scientific analysis and professional knowledge are in dare need for dealing with the manifold and complex problems of urban management. For this efficient and effective method of data collection and analysis of the physical, social and economic features of urban phenomenon are indispensable. The only answer to all these and other factors lies in remote sensing techniques.

Efficient monitoring of these changes are essential to ensure sound planning and management of the development so that protection measures can be better planned, implemented and monitored.

In line with stated objectives, this study has shown clearly the extent to which air-photo interpretation techniques can be of help in providing adequate information necessary for monitoring and assessing the environmental impact of urbanization.

On the basis of research conducted so far and related literatures reviewed, it appears that remote sensing would continue to play important role in any urban information system.

Remote sensing thus offers unique capabilities to provide data about any important aspects of urban growth and change.

This is also a positive trend in urbanization, and it is due to the high rate of development.

PLATES va, vc

Showing the erection, construction and presence of new structures emphasizing high rate of development as against the past.

REFERENCES

Abiodun, J.O. (1985) Urban and Regional Planning Problems in Nigeria. Published by University of Ife Press Ltd. Ile-Ife.

Avery T.E. (1965). Measuring land –use changes on USDA Photographs.

Brisco. B., Ulaby, F.T. and Dobson, M. L; (1973) Space –borne synthethic Aperture Radar Data for Land-use classification and change Detection. International Geo-science and Remote Sensing Symposium (IGARSS)

Chrisman, N.R., (1987). The Accuracy of Map Overlays: A Reassessment landscape and urban planning, 14:427-439

Collins, W.G, and EL-Beck,A.H., (1971). The acquisition of urban land use information from aerial photographs of the city of Leeds photogrammetric 27:71-92

Curren, P.J (1985) Principles of Remote sensing. Published by Longman group limited, Singapore.

Dunfard. C (1985). Remote Sensing for rural development planning in Africa. ITC Journal.

Faulkener, E. (1968). Land use changes in Parkway School District. Photogrammetric Engineering, 31:620-624.

Forster,B,C. (1985). An examination of some problems and solution in monitoring urban areas from satellite platforms. International journal of remote sensing, 6(1):139-151.

Hathout, J.R., (1988). Landuse change analysis and protection of the sub-urban corridor of Winnie peg. Journal of environment management, 27:325-335.

Jensen,J.R (1981). Urban change detection mapping using land sat data. The American cartographer, 8:127-147.

Lillesand, T. M. and Kiefer R.W., (1979) Remote sensing and image interpretation third edition published by John Wiley and sons. Inc.

Mannion, A.M.(1991) Global Environment change. Published by Longman scientific and technical.

Okhimamhe, A.A. (1993) Assessment of Environmental impact of dam contraction in Nigeria. Unpublished master thesis, Geography department, F.U.T. Minna, Niger State. Nigeria .

Onokerharaye, A.G. (1985) Population Studies. Published by the University of Press limited, Benin

Onokerharaye, A.G. and Omuta G.E.D (1986) Urban Systems and Planning, published by the University Press Ltd., Benin. Photogrammetric Engineering 31:620-624.

Rao, K. M. (1995) Remote Sensing for land-use Planning. International Journal of Remote Sensing Vol. 16 N0. 1, 53-60.

Remote Sensing notes by Japan Association on Remote Sensing (1995)

Richter, D.M., (1969) Sequential Urban Change. Photogrammetric Engineering and Remote Sensing 35:764-770.

Rudd, R.D. (1974) Remote Sensing: A better view, published by Duxbury Press. Belmont.

Subin, F.F. (1987) Remote Sensing Principles and Interpretation Freeman and Company Press.

Ventura, S. J. and Horris, P.M. (1993). A comparison of Classification Techniques and Data source for Urban land-use Mapping. Geo Carto International 9 (3): 5-14.

Plate ia Evidence of negative impact of urbanization

Plate ib once large and well maintained race-course

Plate ic Evidence of negative impact of urbanization

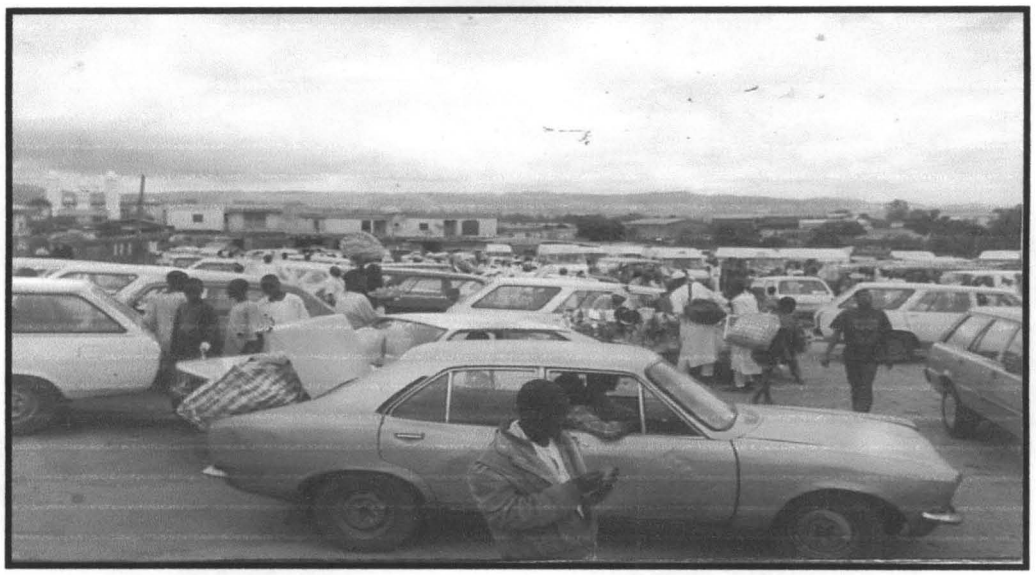

Plate iia Bauchi pack high percentage of development

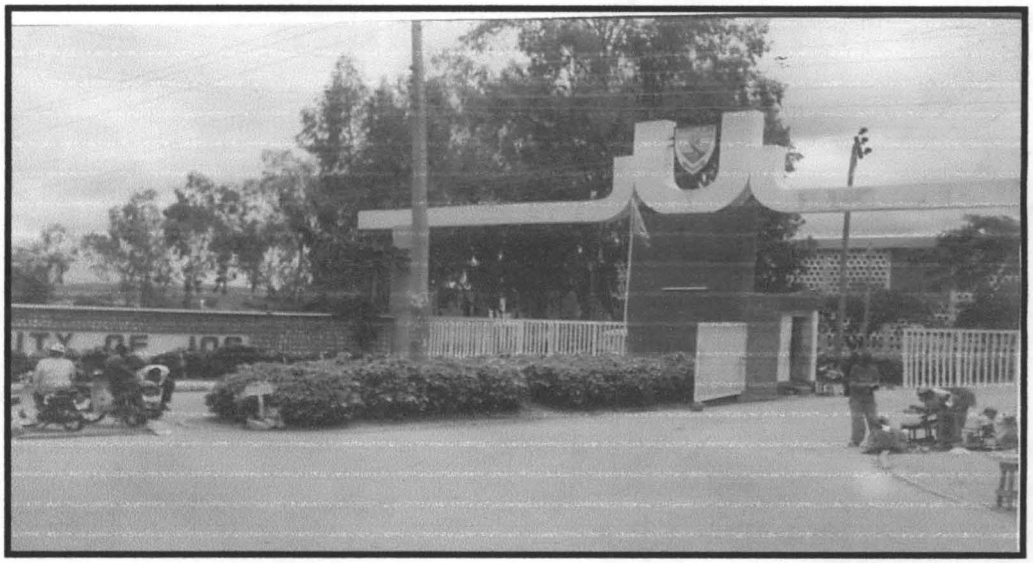

Plate iib positive landuse system in the study area

Plate iic more organized pattern of parking space

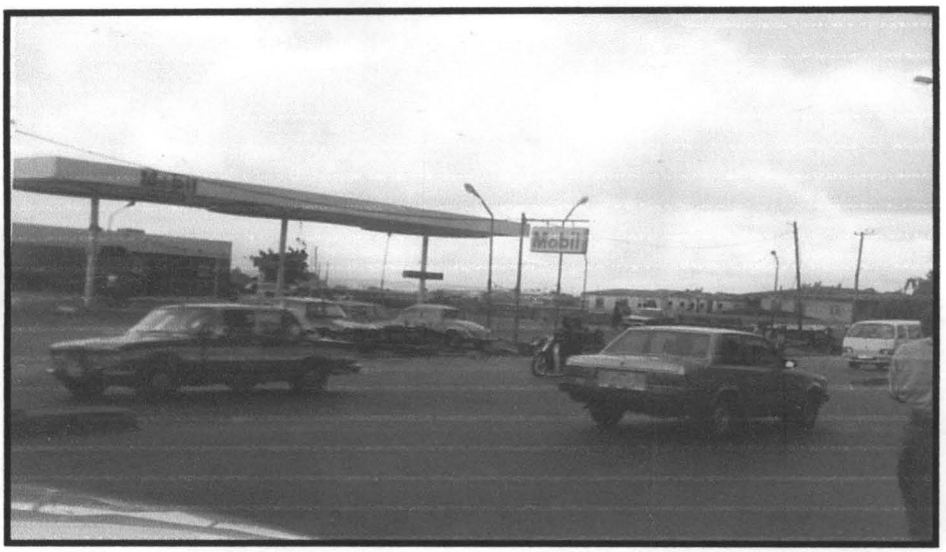

Plate iiia wider and better road network

Plate iiib wider and better road network

Plate iiic wider and better road network

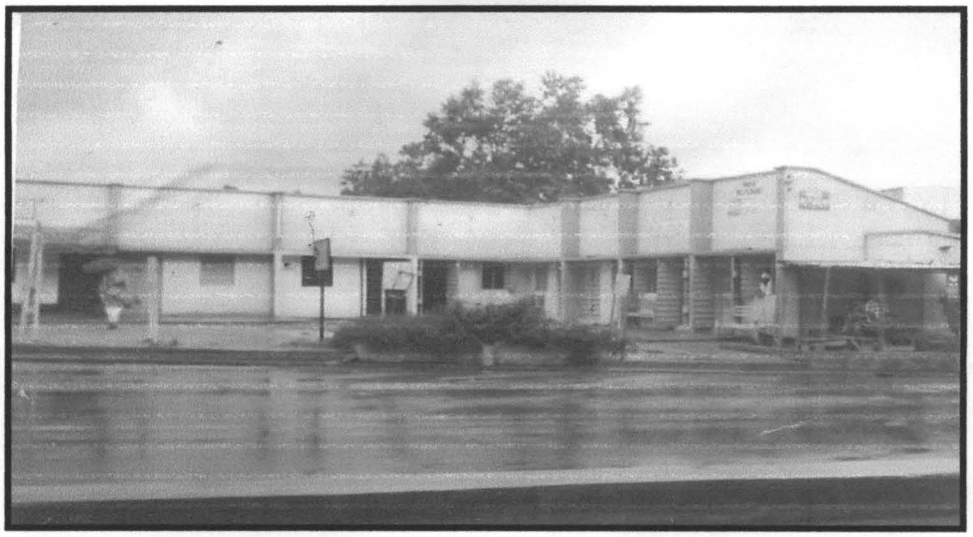

Plate iva commercial areas

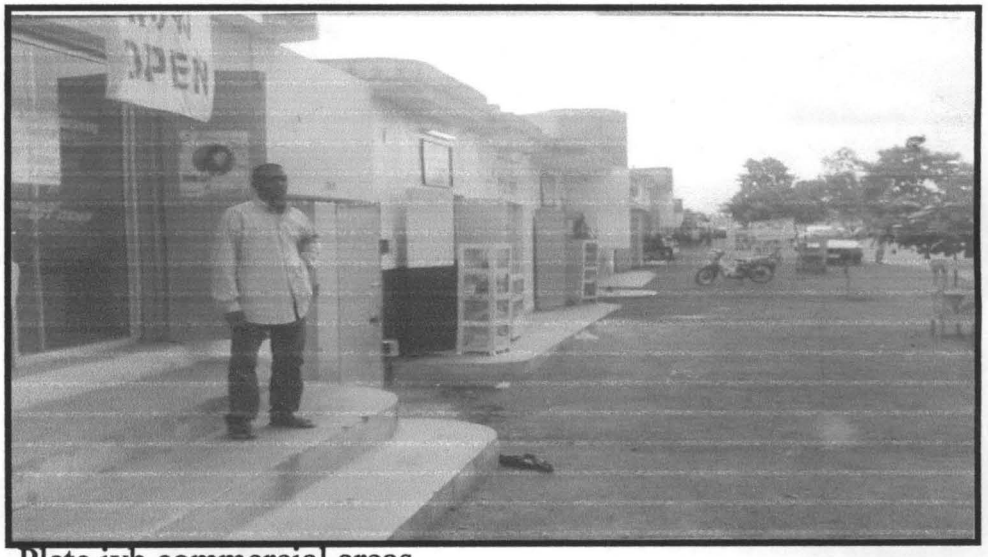

Plate ivb commercial areas

Plate ivc commercial areas

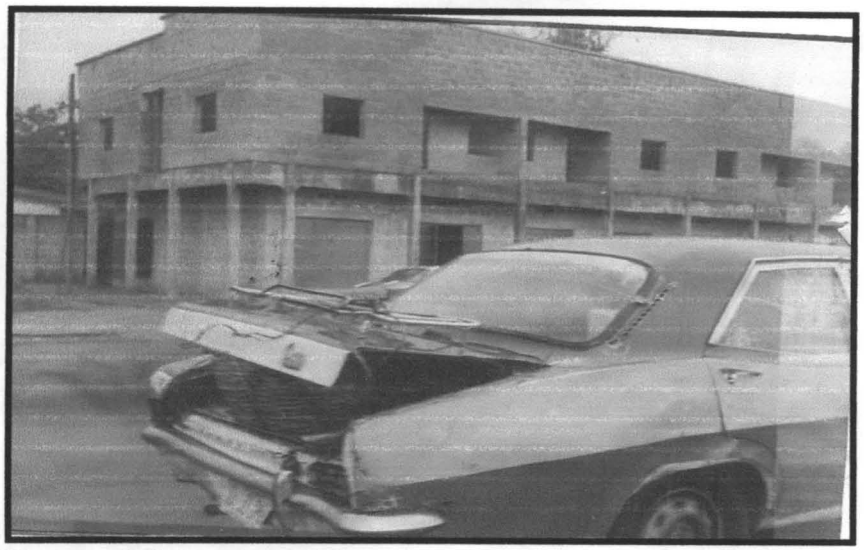

Plate va High rates of dev. Against the past

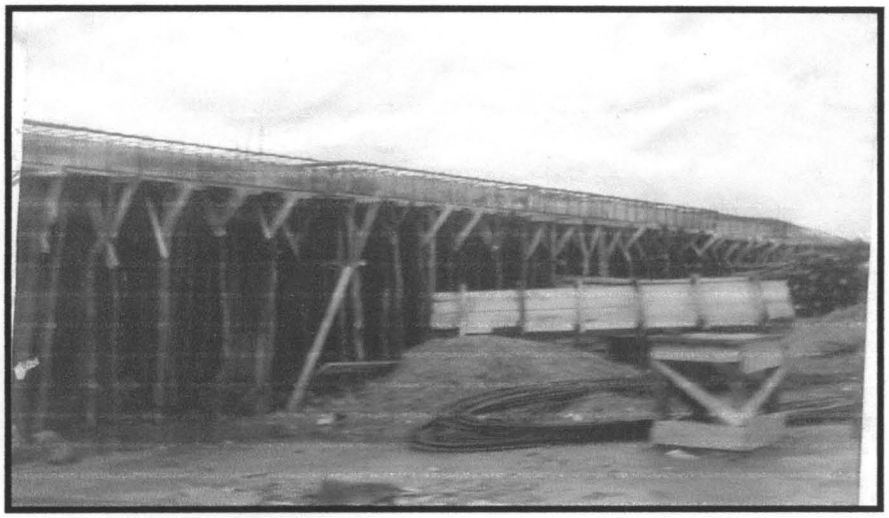

Plate vb High rates of dev. Against the past

Plate vc High rate of dev. Against the past