TITLE PAGE

. APPLICABILITY OF AERIAL PHOTOGRAPHS to V1{BAN CHANGE DE1'ECTION IN NAiUGtrtA A1U:A OF THE .10S PLATEAU

By

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CEnTtfICATION

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DEDICATIoN

This work is dedicated to my beloved Sayyada Rahmat and to my patents; Alhaji Shehu Ahmad Adamu and Hajiya Jamila Shehu Adamu.

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ABSTRACT.

Urban areas grow upwards and outwards. These growth are accompanied by both positive and negative consequences on the environment as welt as the population living within. Problem such as poor road networks, poor health and sanitaty conditions, decaying social amenities, traffic congestion, in adequate housing, conflicting land uses etc. These are the results of poor urban planning and uncontrolled development, which characterized many towns and cities in Nigeria. To understand the present urban landscape, we have to discover why towns and cities have grown to theit present pattern. For this study aerial photographs of 1975 and 1991 were used to determine the extent and amount of change and the consequences on the study area, Naraguta ate a of Jos Plateau. These photographs were interpreted manually and a classification scheme was developed and used to classify the different urban categories. A change map produced from the overlay of both aerial photographs and the changes within the period was calculated frotn the statistics generated from the techniques employed. These changes wete graphically represented to show the distribution and change in the categories. these result showed that 8.384 hectres (45.8%) of the study area had changed over the period to 6.592 hectres (21.14%) which was a decrease in the under developed ateas. this study has demonstrated that remote sensing can provide the bio-physical information necessary for monitoring urban change detection.

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1.0 iNTRODUCTION

1.1 bACKGROUND TO TilE STUDY

One of the basic issues in the development process is resource aI1ocatioh and a major resource, which serve as a common base to the entire development efforts is land. Land is a fundamental necessity of life for it is the very framework on which the socio-political and economic activities of a people function. Thus, an essential prerequisite to any development effort therefore, according to Adeniyi, (1981) is the appraisal of the existing land use situation and how it has been changing overtime.

The term Land use relates to the human activities associated with a piece of land; (Lillesand and Kiefer, 1979), while land cover have been described by\ to, (1986) as the vegetational and artificial constructions covering the land sutface. Although landuse is usually not directly visible from the imagery, landcover is directly visible *from* the remotely sensed imagery. Landuse and landcover can be described as urban ot built Up lands which may be residential, commercial, industrial, transportation or institutional.

Urban areas can be described as those areas that constitute part of a town or a city. Urban areas have higher population density; they are centres of agglometation of socio-cultural and economic functions. They are devoid of primary economic activities and ate the center of political administration. Urbanization and modernization processes with the increase in demand for land, housing and transportation induced radical change In their pattern.

the technological advancement of the world today has reached a Jjoitlt where tnan cart disrupt and change totally the environment in which he lives. The occurrence of these

potentials to disrupt and change the environment has served to stimulate and focus public attention upon environmental issues. One major way ill which human activities easily disrupts the working of the environment is through urban development. To understand the extent of such disruptions, there is need for monitoring of changes occurring in ate a of urban development. A good way to carry out such a monitoring is to employ remote sensing techniques.

The application of remote sensing techniques for urban change detection, monitoring, mapping and analysis requires continuous acquisition of data for the formulation of policy and programmes. There is therefore an urgent need to have timely, accurate and cost effective source of data and this can be obtained through satellite imageries or aerial photographs.

Aerial photography for urban change detection and analysis can be facilitated through the use of zoom transfer scope or a video/graphic system as an aid to comparing photographs of two different dates with a map.

This study intend to take advantage of historical and sequential aerial photographs fot Naraguta, los area as an analytical tool to carry out change detection in the area.

1.2 PROBLEM STATEMENT

Cities are centres of attraction of large population concentration and tend to inctease due to specialization and diversification of industrial and other urban economic activities. The discovery of and mining of Tin in Jos was the initial putt-factor fot its population concentration. This, has since been overtaken by events.

The decline in the Tin mining saw to the diversification of the economy of the people but it's physical effect have always been obvious on the land scope. Fot marty years, Jos Plateau has witnessed ince~sant soil degradation by mining operations. Mine failing,

neglected excavations, unfilled sample pits and hill of mine spoilt have dotted the scenery of tt once rich and beautiful region.

Naraguta is part of the metropolitan Jos but located at the periphery. The position of the topography of the area in relation to other parts of the metropolis have contributed to its influx of population and hence, activities. This, inconsequence therefote, contributed to the social, economic and physical problems of the los North. The problem existing today include over congestion of population and activities, competition for space, unplanned and haphazard urban development, environmental pollution, deterioration of social amenities.

So far research information is lacking on urban change detection using the temote sensing techniques on Naragula area of Jos. There is therefore the need for such teseatches on urban change detection to know what changes occurred in the area between 1975 and 1991. Where urban changes has occurred most frequently there is a great need to determine access and detect how much change has occurred from time to time. To achieved this, the use of remote sensing application techniques can provide a synoptic, timely, consistent, regular and reliable source of data for urban planners and managers and can determine how improvement can be executed.

1.3. AIM AND OBJECtIVES OF tilE STUDY

The study aims at using manual techniques to analysis urban changes ovet the period 1975 to 1991 with a view to understand the nature and extent of the changes in urban parameters ofNaraguta area of los.

(i) To assess and detect how much change has occutred in Nataguta area of Jos Plateau.

(ii) to determine the implications of this changes on the urban area.

(iii) To produce urban change inventory maps of the study area for the years 1975 and 1991.

(iv) To suggest how improvement can be focused towards more positive direction and to serve as a guide for future policy decisions.

(v) To make recommendations from the lise of remote sensing techniques in modem urban planning growth.

1.4. JUStIFACTION FOR THE USE OF REMOTE SENSlNG TO rna srunv,

One of the main aims of urban change detection is to determine how much development has occurred in an area afler a long period of time, the impact of the development and solution to the existing problems and also the provision of accurate information gathering system.

Inventory of urban changes within specific number of yeats is vety important if any meaningful development process is to occur. Therefore the use of retnote sensing technique is very advantageous in the sense that real time spatial analysis of an ate a can done Using either aerial photographs or satellite imageries or both, There is no doubt that satellite imageries as a remote sensing tool has advantages over aerial photograph.

Aerial photography is however, one of the oldest and most common techniques of remote sehsing used even today. It is economical, more readily available and has good spatial resolution with good stereoscopic capability. Vertical aerial photograph tend to have properties that are similar to those of map with an approximately constant scale over the whole photograph. Its result could readily be used for mapping and measurement of utbatt ateli! and hence, its very good for studies in urban change detection.

Due to the above and also "the non availability and access to the satellite imageries of the area, this study is relying on the manus! technique of aerial photographs of 1g75 and I9~1

to detect urban changes in Naraguta area of Jos. This study also tend to fill the research gap between 1975 and 1991 for there might not have been a study of change detection in the area over the period. The result of this study will provide a knowledge of the extent of urban changes in the area and a basis upon which further research can be conducted in urban change detection using satellite imageries

1.5. DESCRIPTION OF THE STUDY AREA.

1. 5.1. LoCAtION AND EXTENTS

10s plateau lies in the central part of the Nigeria and covers a total surface area of about 7, 762 km^2 (Awogbade, 1983). The plateau is located at latitudes 10° 11' N land gf) 55'N by latitudes 8°21' E and 9rJJO' E (fig 1.). The study area; Naraguta (fig 1) lies to the northern - part of the Jos metropolis and it covers total land area of about 25,536h.a

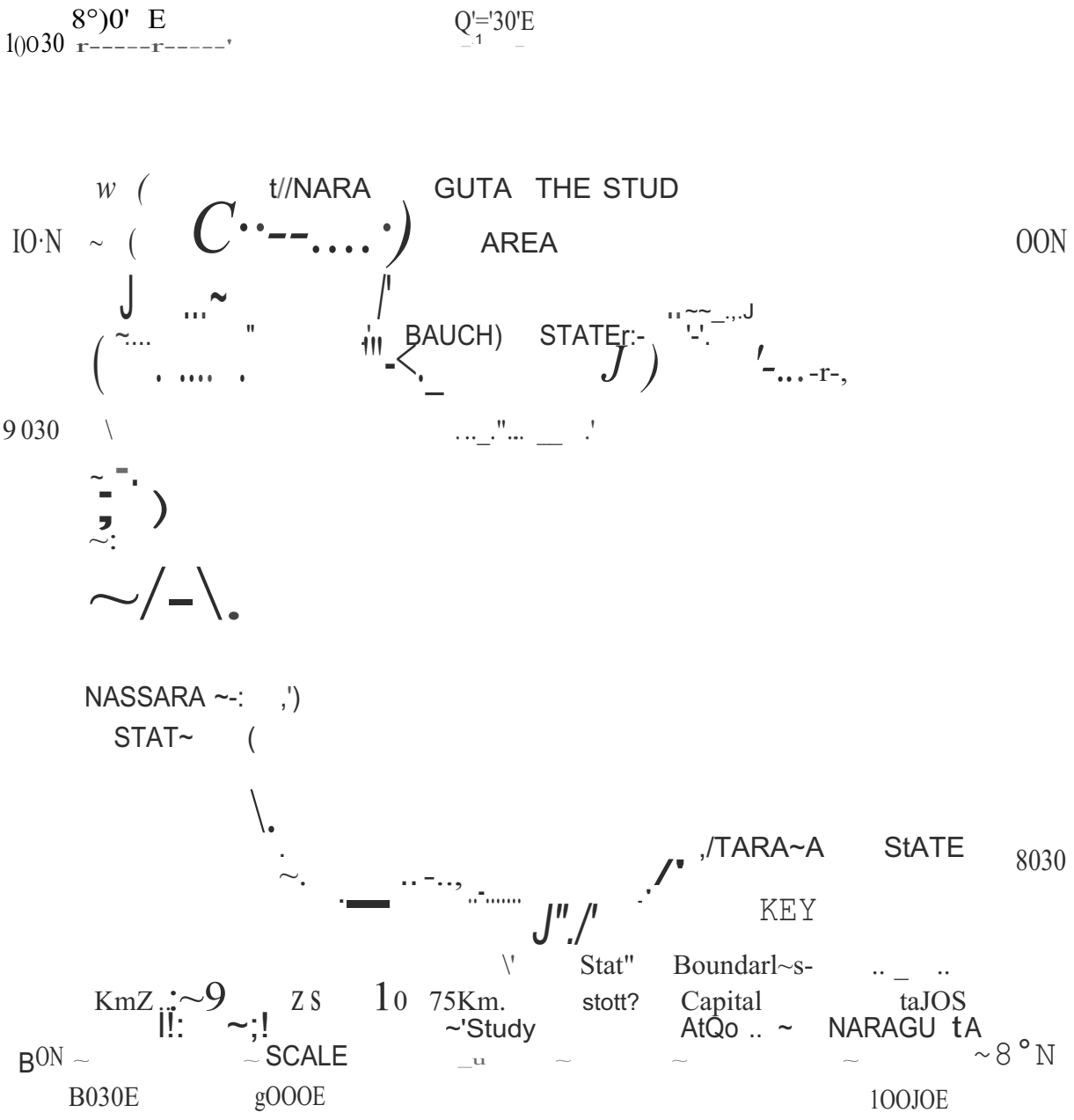


Fig. 2. PLATEAU STATE SHOWING NARAGUTA,JbS; THE STUDY AREA·

Source Aft(H' OkhimamhQ A (2000) with modifitotlon~·

· 5. 2. GttJLOGY

Geologically, the Jos plateau is representative of pre-Cambrian basement complex; the ancient group of crystalline rocks which form part of the main African continental mass (Buchanan, 1995). The crystalline shield ot rocks are of two main categories: metamorphic and igneous (John, et al 1977). However, after the period of continuous erosion, volcanic activities in the mid-tertiary period resulted in vast deposit of basaltic materials, filling alleys and burying tin-bearing alluvium. Naraguta area of Jos lies to the North - West of the Shete hills.

The study area Naraguta area of Jos is not geological unit fot it cannot be demarcated on a distinct geological criteria it is purely a morphological ot relief unit with elevation above the ground level as a feature distinguishing it from the rest of the crystalline shields.

1.5.3. cttMAtE

The Jos plateau is one of the coolest regions 111 Nigeria. the region is characterized by four to five months of dry season and seven to eight months of wet season. The dry and wet seasons in the area as in other parts of the country ate greatly controlled by the annual migration of Inter Tropical Zone of Convergence (I T Z C). In the Jos plateau the influence of the northeast trade wind Is strong particularly during the months of November and March when the harmattan; a sttong dry and dusty wind prevails.

The dry tropical continental air mass arrives the country from the north till October and by January, its effect is felt in almost every part of the country as the dry and cold hannattan season. It retreats in March and by July it s completely out of the country.

The dry season is characterized by the dust laden hamattan wind coming from across the Sahara desert. This occur between November to Match to area where relative humidity is low, night temperature is cool, vegetation growth decreases to minimum, the soil dries out.

The wet season set in by the month of May and lasts till September. It is characterized by frequent storms, which coincides with the planting season. During this period the moist south-westerly wind brings rain.

1.5.3.1 RAlNFALL

Relief is a significant factor in the rainfall pattern of Jos it has a total of eight months of rainfall from April to November. The Jos plateau has a highet annual total of rainfall than the average for its latitude. It is also termed as a monsoon 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 between 1520mm to 2030mrn per annum, which is more than other areas on the same latitude. los is characteristics of It line squall area. It is noted that in spite of its distance from the coast, the study area has fairly high possibility of more than 24% of rainfall occurring fot hours during the day in raining season.

1.5.4. LANDtJSE

Urbanisation and modernisation processes with the increased demand they pose for land, housing and transportation can effect significant changes in the 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 brings about high expectations; change in taste and higher standards of living. Improvement in transport and communication facilities plays a crucial role in the organisations and changes of urban areas. Since the urban area is an area of transition, there is therefore a conflict between agricultutal, residential, commercial and transportation USesof land.

In the study area, high-rise buildings are found in the midst of bungalow and substandard structures. These residential types lie side by side with other land uses such as commercial, institutional and transportation routes. Other built-up areas, clustered residential lands transitional land, areas of commerce, park or open spaces and refuse dumps. The result is that of a mixture of urban landuses and refuse dumps. lridustries and factories in few instances are found intermixed with othet landuse types in spite of the fact that specific areas are designated for industries and factoties. Agricultural landuse occur at places that are quite distant from the residential areas

From the above charactetistics of the landuse pattern of the study area, it is evident that planning problems abound and these 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 in most cases result in productive land lying idle for several years awaiting development or being destroyed as sewage or refuse dumps including industrial waste.

1.5.5 son,

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 large-scale erosion, leaching and laterite formation. Plants with shallow roots do well during the dry season and these include Lettuce, cabbages, garden eggs and vegetables.

1.5.6 VEGETATION

The study area can be termed as Savannah region. This is because of the type of climate, rainfall, relative humidity and temperature ranges, which encouraged the gtowth of grasses. Though some trees grow well in the study atea in the past, but the activities of man and animals have destroyed much of the natural vegetation. Ptesently, the existing trees and grasses seen are only survivals of the original plant cover.

1.7 StRUTURE OF TilE PROJECT

This project work is divided into five parts or Chapters. Chapter One tilled, "introduction" presents the introduction of the project topic, statement of research problem, aim and Objective, Justification fot the use of remote sensing technique to the study, description of the study area and the structure of the thesis itself.

Chapter Two titled "Literature review" deals extensively with the relevant and related literatures consulted in the study.

Chapter three titled Research materials and Methodology" comprtses the materials used, principle of interpretation, types of interpretation; Aerial photograph interpretation and growth.

Chapter four title "Discussion of result" presents analysis, discussion and results

Chapter five titled" Summary, Conclusion and Recommendations" of the research

CHArTER TWO

0 LtTEIU TURE REVIE\V

.1 A number of studies have shown that landu e mapping for various purpose and at widely varying degrees of detail is possible through remote sensing techniques. Assessing overall landuses on small-scale imagery first because popular with the advent of astronaut photography and mote recently, land sat imagery.

The urban land is always in a dynamic state, thus to keep tracks of developmenl requires a teal-time system of analysis. In examining the development of urban areas, the cohventional tnethods are not flexible in monitoring the trends in the growth of urban environment, hence this research advocates the uses of remote sensing techniques.

Research into the application of aerial photography and other remotely sensed itnageries to urban studies dates perhaps from the late forties (Adeniyi, 1984) in developed countries some development have been made in methods of estimating dwelling units (Eyre,1970); Lindgren, 1971 and Hsu, 1971) estimation of population density (Nkambwe, 1983; Adeniyi, 1984), the estimation of characteristics of tesidential buildings (Adeniyi, 1984) to the estimation of building construction as indication of spatial urban growth (Ajayi 1981).

Dunfard,(1980) illustrated the effectiveness of remote sensing fot rural development planning in A frica. The major aim of their study was to attempt to minimize the time, cost and personnel using a combination of remote sensing techniques for rural development planning. Using aerial photography and existing reports on vegetation l1f1d

soil conditions, they were able to provide land resources and landuse information fot rural development planning in Arusha region, Tanzania for a period of three months.

Rao, (1994) used remote sensing data (aerial photography and satellite imageries) and information obtained from the Census department in India. He also identified the causal variable and using three techniques: Causal modeling techniques, cross-classificatioh method and rating method, he was able to forecast the future quantity of built up areas.

Sogunle, (1990) studied the landuse/land cover of Ibadan area by spot image of 1986 with aerial photographs taken ill 1993: A six category landuse scheme was adopted for use ill the interpretation. The SPOT image was manually interpreted at a scale of t:50 000 using prom-2 projector. Identification of landuse/land cover type was based upon characteristics of the signature observed.

The results showed that the city has witnessed a tremendous urban expansion largely concentrated along the central strip of the study area where urban landuse increase by 173% from 8.33km2 in 1973 to 22.74km2 in t986. The urban expansion has serious consequences on the soil in terms of exposure to hazardous torrential rainfall, severe erosion and run-off, high soil compaction due to excess human traffic and surface sealing. This study is applicable to this present research work becaUse one of the objectives is to assess and detect how much change has occurred in Naraguta area of los.

Adeniyi, (1980) used a combination of computer and sequential aerial photographs of 1962 and 1974 at a nominal scale of 1:40 000 and t:20 000 respectively to detect changes in land use of Lagos. The study ate a encompassed urban built UP areas,

urban vacant land and non-urban land. A landuse classi fication scheme was deviced as well as a minimum mapping unit for interpretation and subsequent storage of landuse data by computer. The result shows that the lancluse change revealed the rapid increase of residential landuse and strong expansion of the urban area of Lagos. This study is also relevant to this research for one of the objectives is to detect urban change in the study area.

Lo, (1972) also used sequential aerial photographics at a nominal scale of 1;20 000 to study the landuse changes in Clarke county, Georgia between 1970 and 1983. By using a simple technique, he matched two landuse maps compiled for two different dates over a light table to delineate landuse changes the resultant map shows an increase in the urban or built up land particularly in residential, commercial and services as well as a decrease in the agricultural land and forest. This study is also relevant to this present research for one of the objectives is to detect urban changes and also to provide a map showing the changes.

Adeniyi, (1981) used sequential aerial photographs fot 1974 and 1976 at a nominal scale of 1:20 000 and 1:25 000 respectively using simple visual method to derive timely and quantitative data on the rate of building construction in a rapidly Urbanizing areas of Lagos. Agege, one of the urban fringe areas was used as a case or study, Grids of one hectares in size were carefully drawn on stable transparent film and super imposed on the right hand photo of a pair of stereo-photographs and then reproduced photographically prior to interpretation. Two interpreters using a mirtot stereoscopes were used to record data on each of the cells. Such as the total number of completed

buildings under construction, total number of completed buildings and the specific Uses of cells without any structure.

The result shows an mcrease 111 the rate of building construction of 37.1% between 1974 and 1976. It also shows the speed at which such type of data could be obtained over the conventional methods. This study is also relevant to this research for it shows that there are some changes in the urban landuse in the form of building constructions both completed and uncompleted when compared with the previous aerial photographs of the study area.

Nkarnbwe, (1984) used multi-date aerial photographs for the study of physical urban growth of Ile-ife. Sequencial aerial photo graphs of 1950, 1960 and t970 at a scale of 1:3 600, 1:9 600 and I: 10 000 respectively were used to obtain data on the extent of the build up area of the town total floor area above the ground and the total floor area on the ground for the Study periods. The data was obtained by a combination of the three s~ts of aerial photographs with the aid of a mirror stereoscope. the result shows three forms of physical growth in the study area, these are, the lateral growth the vertical growth and, the intensification or infilling of spaces between buildings with buildings. this study is also relevant to this research for it how changes are detected in the study area in form of urban growth.

Ikhuoria, (1993) applied remote sensing techniques of sequential black and white aerial photographs to study the vegetation and landuse changes in a rainforest ecosystem of northeast Edo State.

· The result shows that within a decades (1967 and 1977) the ecosystem experienced a drastic reduction or depletion of forested lands rapid territorial expansion of settlements and tremendous increase in agricultural lands.

Okhimamhe, (1993) also carried out a study using *SPOT* HRV acquired in 1986. A combination of Satellite imageries with aerial photographs of 1974 was used to detect the changes in the landuse/landcover in the Burum/Tiga area over a period of 1 years of after the construction of Tiga dam. The result shows that 38,897 hectares of changes have taken place where crop/pasture land, wooded shrub land had increased by 104 percent. The study also showed that the sanely area has increased which are indicatots of desertification.

Roger, (1985) carried a study to assess the change in the land s~rface occurring as tesult of the activities of man or climatic variability. Land sat MSS imageries of 1970 and 1979 covering St. Lawrence Valley in Quebec Canada were used in a time series analysis to monitor seasonal and long term changes in the landuse and land cover. the result showed that deforestation occurred and there was significant decrease in farmlands and a marked increase in urbanisation

Avery, (1980) utilized aerial photographs at 1:20 000 scale in 1954 and 1960 to evaluate landuse changes in Georgia, U.S.A. For each period, a landuse map was determined with the aid of grid. The study discovered a shift of the agricultural pattern of the dark country from heavy emphasis on cotton to poultry production, Livestock farm wood tot management while ctop land was reverted back to fotest land as esult of the influx of manu faduring industry to provide employment.

Lo 'and Shipman, (1990) carried out a study on Geographical information system (O.1.S) approach to landuses change dynamics detection. This was applied to assess the impact of new town development in Twen Mon, New territories, Hong Kong through integrating of past and current aerial photographs which were taken in 1976 and 1987 at a scale of 1:25 000 and 1:40 .000respectively image overlaying and masking techniques were used. A low-cost tnicrocomputer based GIS JDRISI soft ware was used in landuse change detection. The result shows that the binary masking method reveals the dynamics of landuse change.

Owolabi (1998) used sequential aerial photographs of 1982 and 1988 at a nominal scale of 1:la 060 and 1:4 000 respectively to detect changes in urban landuse of Victoria hiland, Lagos over period of 16years. Using a binary masking techniques and ovet laying of the two aerial photo mosaic with a manual interpretation technique he was able map a total land area of 268.0ha of the area. The result shows that about 102.64ha (38.3% of total area coveted) was the changes discovered over the period 1982 to 1988. He identi fy the causes and consequence of the urban growth of the area.

Ojigi (1997) used a combination of multi-temporal SPOT satellite imageries (Panchromatic) and aerial photographs (mosaic) of 1980, 1984, 1988,1992, and t994 to manually produce the sequential urban growth maps of Ahuja and identified the growth tate of five districts of the Federal Capital Territory using urbanization curves and histogtams. the result based on graphical and multiple regression analysis revealed that Ahuja has growth substantially over the years and that urban development and growth is a function of financing

Lo and Dale (2000) used a combination of Landsat TM and sequential aerial photographic imageries for 1973, 1979, t983, t987, 1992 and 1997 with computer to detect a dramatic changes iii landuse and landcover of Atlanta metropolitan area of Georgia, U~A: the

.sult shows a dramatic change in landuse and landcover with loss forest and cropland to urban se. In particular, low density urban use, which include largely residential use, has increased by ver 119% between 1973 and 1997. These landuse and landcover changes have drastically ltered the land surface characteristic of the area.

From the foregoing review of literature, it is discovered that some of the techniques applied by various studies are also applicable to this present reseatch. The attempt made in this study is to take advantage of the advance in remote sensing application technology as shown in the case studies described in the teview to further enhance our knowledge on urban change detection in Naraguta area of Jos.

The application of remote sensing techniques in monitoring, evaluating and detecting changes in urban landuse in Nigeria is still at its embryonic stage. Problems of remote sensing applications in developing countries including Nigeria are; Manpower shortage, high cost of product acquisition, inadequate finance and lack of institutional support on the part of the govetntnent.

CHAPTER TIIREE

0 tmstAkcH MEtHODOLOGY AND MATERIAL

.1 tHE RESEARcH MA1'ERtALS USED

Aerial photographs are one of the best sources of data for landuse change detection in urban areas at different time intervals, This is due to the advantages which they offer over other sources such as the on-ground observation.

Two sets of aerial photographs of the study area acquired from the photograrnmetry department of the Ministry of Lands and Survey, Jos was used. Those of 1975 have a nominal scale of I: 10 000 while those of 1991 have a nominal scale of 1:8 000. The t975 sets were numbered as follows; 76626-I09,76626-1 i0 and, 76626-1t 1. The 1991 sets were numbered as follows; 8748,8749 and 8750.

The quality of the 1975 sets of aerial photographs was fair, the problem was that they were exceptionally whitish (bright) and thus, there was some difficulties itt delineation and identification of features. The 1991 sets of aetia1 photographs on the other hand were of good quality and thus, delineation and identification was much easiet.

Other materials used include; mirror stereoscope, graph sheets, light table, cartographic (rotrin) pens and lettering stencils. Also complementing these aerial photographs were still pictures of some scenes (urban features) of the study area and fieldwork.

/ PRINCIPLES OF INTERPRETA-rtON

The characteristics used in analyzing and interpreting remote sensing data had helped in recognizing, differentiating and qualifying objects on the aerial photographs. Using such elements as size, tone, texture, locational site, shape and shadows were so useful for the interpretation.

The sizes of buildings were used in determining the type of building. Fot example, in differentiating between schools, and residential houses. The texture; roughness and smoothness of objects were used to differentiate rock out crops from a bare soil and among other features such as racecourse open forest.

The pattern which refers to the arrangement of structure were used In differentiating university lecture halls from student hostels and staff quarters more accurately because of familiarity with the area.

The location of objects or structures in relation to others had also helped to ascertain many relevant features. Association of elements was very important here because the areas with residential quarters were never associated with cultivation.

Shades casted by features such as sta ff quarters, lecture halls, residential compounds, student hostels, mosques and churches due to their sizes have also assisted in the interpretation. The shades casted by trees had helped in diffetentiating them from open ground or rock out crops.

.3 MEtHoDOLOGY

Aerial photography have been employed by planners to detect changes over a period of time in a region. The advantage of aerial photographs is that when it is taken as overlapping pairs it can provide a three-dimensional view (stereoscope view) of the earth's surface .

In this study, each set of photographs were sequentially arranged ort table according to their fudical points and flight line to overlap each other by 60%. This gave a stereoscopic view of the features contained in the pair of photographs. These arrangements made possible the production of mosaic of the study area for the two periods under study. The mosaic for each of the years (1975 and 1991) wete traced inform of maps into an acetate transparent sheet and unto a tracing paper using a light table, pencils and rotting pens.

The scale of the 1975 aerials photogtaph (i.e. 1:10 000) is smaller than those of the 1991 sets of aerial photographs (i.e. 1:8 000). For this reason, the researcher had to enlarge the scale of the 1975 aerial photographs Mosaic to correspond to that of the 1991 set before interpretation was done. Square grid enlargement method was used to transfer information from the former 1:10 000 scale mosaic to the new 1:8 000 scale outline. Penn anent features such as rock out crops and even roads were first registered before the rest information.

Using the elements of interpretation, features such as the University, Federal School of forestry racecourse, senior staff quarters, streams, rocks outcrops, vegetation, footpath, toads etc were delineated and mapped from the 1975 mosaic. Similar procedure

was' applied in the case of the 1991 mosaic. Conventional pictures of scenes in the study area was used to aid the interpretation

3.4 DATA ANALYSIS

The landuse maps produced form the mosaic of the aerial photograph of 1975and 1991 were overlayed on the light table. From these overlay of 1975 and 199t maps an urban change map was then produced to detect and signify the changes that occurred in the study area between 1975 and 1991 (sixteen year period) Before the mapping Was done, the changes detected were field checked ground truth.

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

3,5 ClAsSIFtcATION SCl-ltME

Landuse interpretation accuracy depends on the classification scheme, which had to be designed with regard to the cultural character of the study area. However, the USGS scheme designed by Auderson et al (1976) has provided a valuable guide for the classification scheme used in this research. The concept of different levels 0r details of urban landuse are interpretable according to the di fferent scales of the imagery and hence, the spatial resolution quality is normally adopted by the researcher.

However, each of the urban landusc categories was identified by a two digit symbol rtdicating the level II category interpreted from the aerial photographs of 1975 and t991 espectively. The classification scheme used for this visual manual interpretation is given in table elow,

J'abte.3 urban landuse classification scheme

SIN	t~VEtI	LEVEL II
1.	Built up Areas	1.1 University of Jos
		1.2 Federal School forestry
		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 Bares course
		2.2 Rock outcrops

Soutce:- Compiled by the author (2003)

3.6 GROUND TRUTH

During the course of the study, field checks were conducted first to familiarize the tesearcher with the study area. During the course of interpretation of the aerial photographs, field check was also carried out several time to identity and verify the features seen on the aerial photographs so as to minimise interpretation ettots. All the areas involved in the study visited were photographed. The areas visited included packs, the Federal school of Forestry, Jos, the University of Jos, Racecourse and other areas of interest to the study area. All these areas were considered as samples and represent the rate and type of change in the recent years.

CHAPTER FOUR

4.0 ltESULTS AND iNTRODUCTION

In this chapter, the results of the interpretation of the aerial photograph of 1975 and 1991 of Naraguta area of Jos Plateau are shown in tables and figures. Table 4.1 shows the urban categories of the study area and their percentage aerial coverage as interpreted from t975 and 1991 ait photo mosaic. Figure 4.1 shows the urban map of Naraguta as interpreted from 1975 air photo mosaic while figure 4.2 shows graphically its percentage distributiort. Figure 4.3 shows urban map of the area as interpreted from the 1991 air photo mosaic while figure 4.4 shows graphically the percentage distribution of each of the urban categories of the area. Table 4.2 shows the distribution of urban categories in hectares (ha) for 1975 and I9~ iand the magnitude of change for each of the categories over the period. Table 4.4 shows in proportion the changes for each of the urban category class to the overall change. Figure 4.5 shows the urban change map of the study area as interpreted from the overlays of the 1975 and 1999 air photo mosaic while figute 4.6 graphically compared the relative distribution of each category fot the two period of study.

4.1 tNTEiU>RtTATION OF 1975 AERIAL l>HOTOGJUPH

The interpreted map of the study are which was obtained directly from the ait photo mosaic by the author is shown in figure 4.1 a. The results of the interpretation showed that the under developed areas made up the largest category in the classification covering a total area of 14000 hectares representing about 60.34% (Table 4.1). The interpreted map showed that there was ho Motor Park and so it is represented by 0% (Table 4.1). The only major toad (Bauchi toad) was quite narrow. It was also noted that the Senior staff Quarters was quite small

occupying and area of about 1500 hectares representing about 6.46% (Table 4.1) of the study area. The racecourse can be clearly identified at the northern tip of the map (figure 4.1) occupying an area of about 9.05% (Table 4. J). This can be associated with the presence of expatriates who used it for recreational purpose.

The University of Jos is found at the North Central part of the map (figute 4.1) to the left hand side of the Bauchi road. It covered an area of about 900 hectares representing about 3.87%. the federal School of Forestry Jos is found directly opposite the University (fig. 4.1) Covered an area of about 700 hectares representing about 3.0% (Table 4.1)

Table 4.1 Urban Categories Aerial Coverage and percentage 1975 and 1991.

SIN	Urban Category	1975		1991	
		Area (it ectares)	Percentage (%)	Atea (Hectares)	Percentage (%)
1.	University of Jos	900	3.87	1792	7.0
2.	Federal School of Forestry	700	3.0	1536	6.0
3.	Race Course	2100	9.05	t088	4.26
4.	Senior Staff Quarters	1500	6.46	3264	12.78
5.	Parks	*	*	384	1.5
6.	Built up Areas (Developed)	4000	17.24	10880	42.60
7.	Under Developed Areas	14000	60.34	6592	25.8
Total		23200	100	25536	100

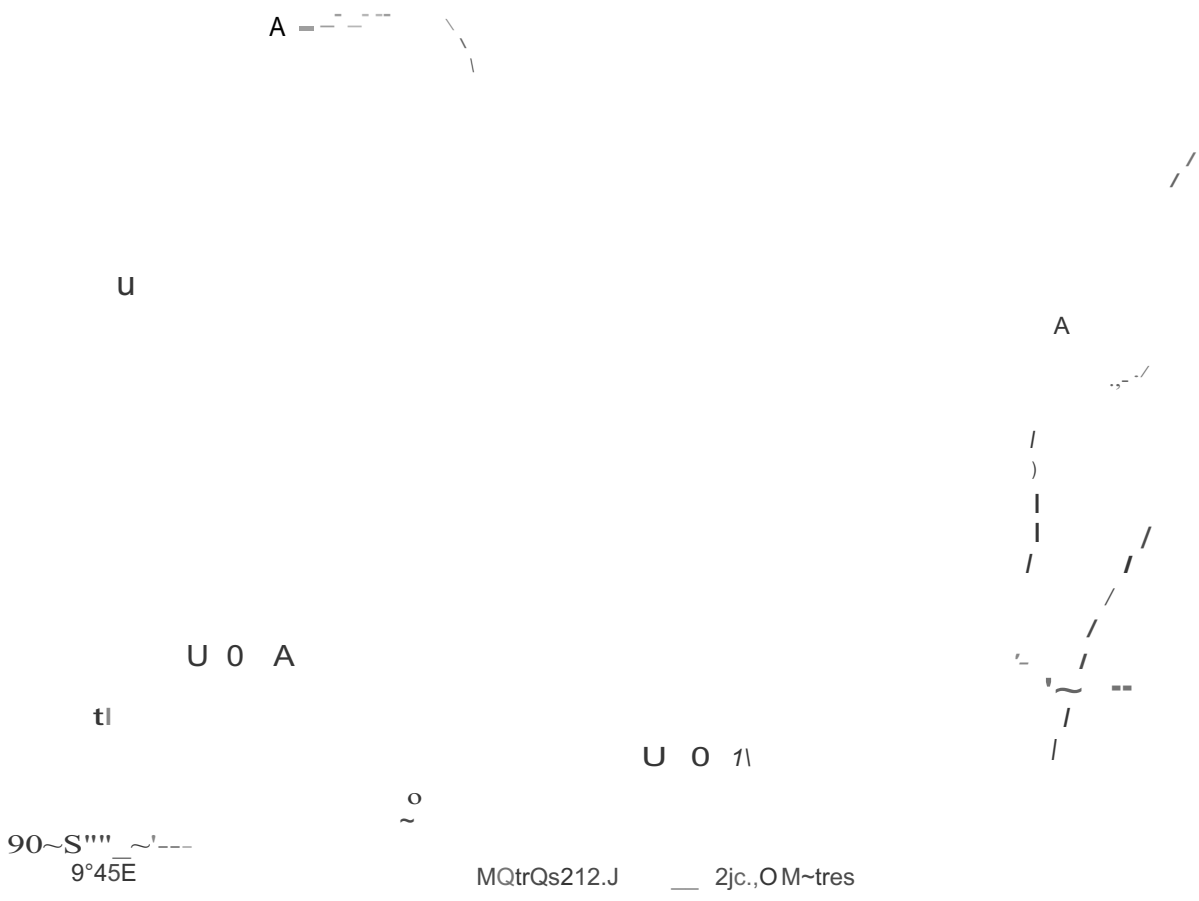
Sources- Author Analysis of Aerial Photographs of t975 and 1991 of Naraguta area of Jos

In general, the built up areas accounted for about 4000 hectares of land of the study area and representing about 17.24% (Table 4.1). A stream which cut across the Bl1UcWtoad fidWit1g frofffDogon-Dutse area down to Anguwan-rogo to the North west of tlie trla~ (fig. 4.1) had lots 01 vegetation covet along its banks. There were neither farms nor humatt settlement at the

western side of the university. The houses seen on the aerial photographs especially those found in the Seniot Staff Quarters and Dogon-Dutse area were well spaced out and arranged in rows dues to tow demand for land.

the toad network is not well developed and mostly narrow and untarred, The occurrence of footpath in the map (fig. 4.1) as seen on the aerial photograph indicated the stage or level of development in the study area. People mostly moved on foot and on animal backs. Most of the trees shown on the photographs were well arranged and demarcates buildings. this suggested that there is Government Reservation Area (GRA) in the area. The drainage pattern of the area can he clearly Identified with its dendrite pattern taken their sources from the hilts around the northeastern part of the map (fig 4.1).

The build-up areas have also expanded greatly. The building structures have been modernized; an indication of rises in 'living standard and taste of the people. The build up areas though scattered about the map (fig 4.1) accounted for 10880 hectares representing about 42.6% (Table 4.1), while the underdeveloped areas had drastically reduced in size due to encroachment by buildings and farmlands. This category (under developed Areas) accounted for about 6592 hectares presenting about 25.8% (Table 4.1) of the land categories in the study area (fig. 4.1a). The expressway to Bauchi State (Bauchi ring road) had also been constructed (plate 3c) Large number of motor vehicles where noted on the aerial photograph plying the ring road. this suggested rapid development in transportation in the area. The drainage network can hardly be noticed due to blockage by building structures in the area.



'g.4.1:URBAN MAP OF NARAGUTA, JOS (1975),

Sour ce Author's Analysis of Air Photogro,hs (1975)

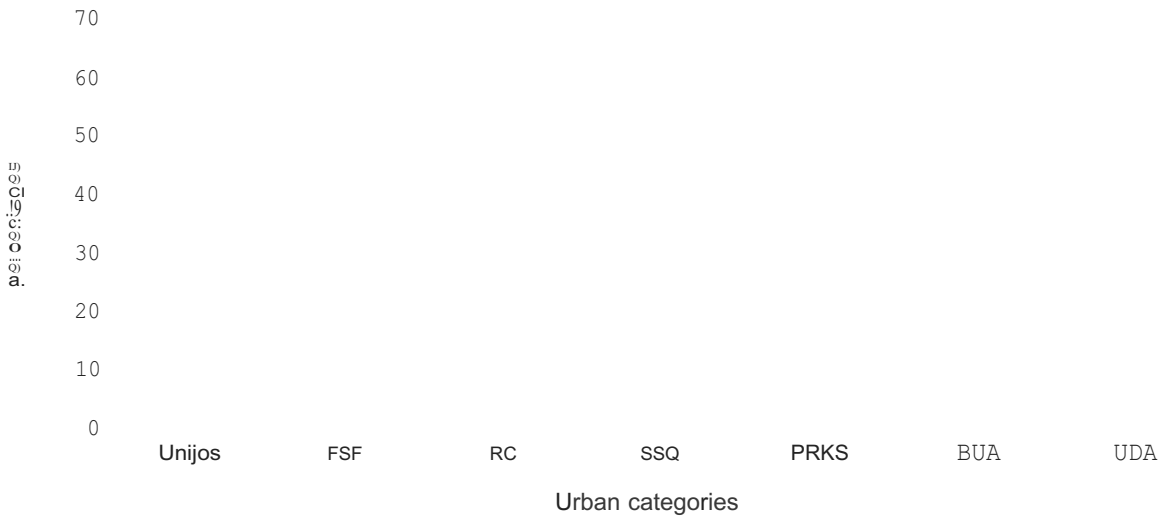


Fig 4.1b Percentage distribution of urban categories 1975

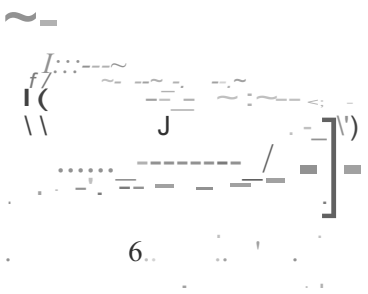
Source:- Author Analysis of Aerial Photography of Naraguta Jos (2003)

The Racecourse had also shrunk in srze and lacks maintenance. Building structures and some farming activities had encroached on the racecourse (plate 1b). It now only account for 1088 hectares representing about 4.26% (Table 4.1) of the land categories in the map (fig 4.1) of the study area. The graphical representation is seen in Figure 4.2

4.2 tNtERPRETATION OF 1991 AERIAL PHOTOGRAPH

The 1991 Aerial photo mosaic (fig 4.3) shows a great contrast of what was the study area in 1975. A lot of developments have taken place over the sixteen-year period. Petrol Stations now lined tip the boundary of Bauchi road, which also witness expansion with even streetlights. Other roads that led into the major pad of the town have also been expanded and tarred. The stream that cut across the Bauchi toad had shrunk to less than half its original size and there was an absence of vegetation on either side of its bank. This was because refuse have been continuously dumped in most parts of the river banks while at other areas of the river banks structure had been etected there.

A new tnotor park have been constructed (Bauchi Park) covering an area of about 384 hectares representing about 1.5% (Table 4.1) of the land categories in the map (fig 4.3). The Jos University had also witnessed expansion and it now accounted fot about 1792 hectares representing about 7% (Table 4.1) of the land categories in the map (fig. 4.3). The Senior Staff Quarters of the University located at the southeastern part of the map (fig. 4.3) also expanded and it now covered an area of about 3264 hectates representing about 12.78% (Table 4.1) of the land categories in the study area. The graphical representation is seen in fig. 4.4.



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(1) Jos University (2) fedQrol School of Forestr v (3) Race (ourse(f.) Senior $taft QUarters

5) Pork s (6) Built- Up ArQos (7) Undc?r-DQVQlOPQd Ar ecs O Rock Out-Crops/Hills

V'\: Streams ~ Major Roods ═ .Minor Roods - - - Foot Path

Fig.4·3 URBAN MAP OF NARAGUTA,JOS(1991)

SourcQ~-Author's Analysis of Air Photo<}'ro,'hs 01 (1991)

NARAGUTA JOS'__ ~991

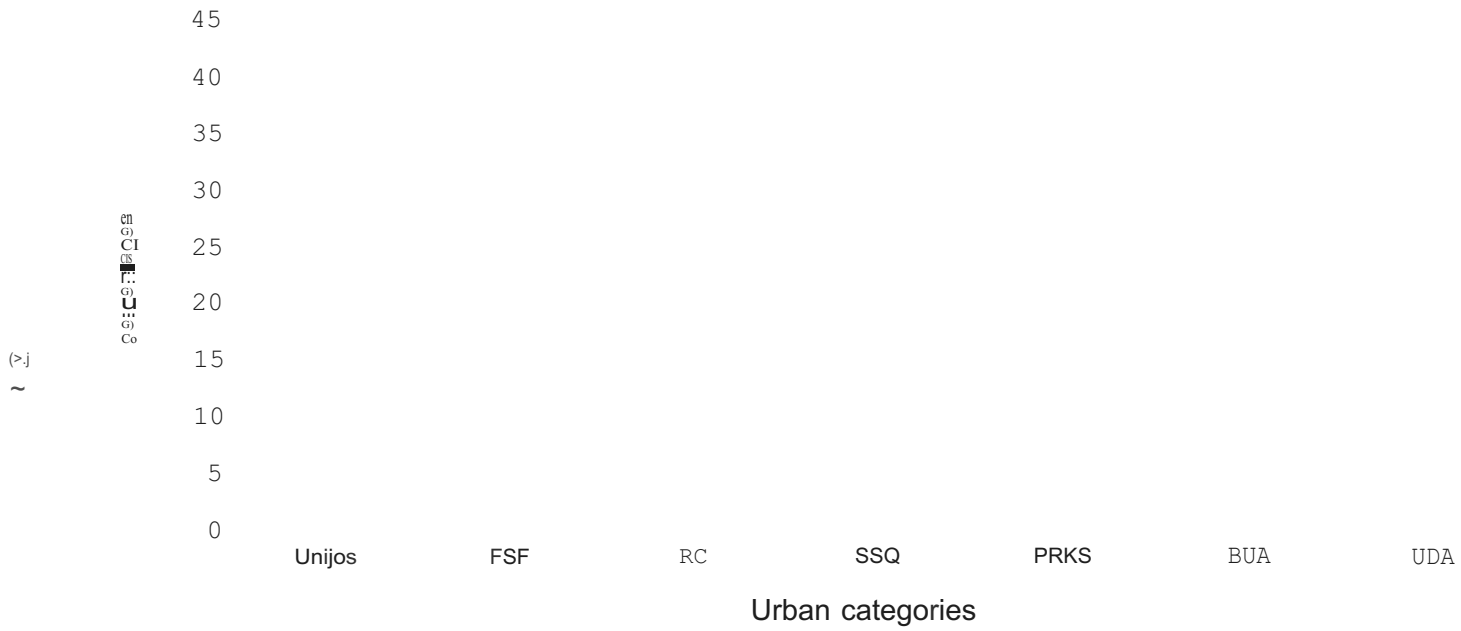


Fig 4.4 Percentagedistribution of urban categories 1991

Source:- Author Analysisof Aerial Photographyof Naraguta,Jos

4.j URbAN tANDtJSE CHANGE BETWEEN t975 - 1991

In this study, urban change refers to the reduction or increase of the various urban categories used in the classification scheme (table 3).

Table 4.1 shows the aerial coverage and percentages of the categories of the urban landuse of the study area. Table 4.2 shows the distribution of urban changes based on each category and the magnitude of changes between the two period, 1975 and 1991. this makes urban change analysis much easier. Fig 4.6 shows the graphical representation of the relative distribution of urban change categories over the two periods.

Table 4.3 shows the percentage changes in the distribution of the urban categories in the study area over the two period (1975 -1991). As can be seen in Table 4.3, the underdeveloped areas recorded the highest amount of change from 60.34% to 25.8% and a decrease of -34.54%. the Built up areas increased from 17.24% in 1975 to 42.6% in 1991. This therefore shows an indication of an upward rise in terms of development in the study area. More lands have been used up, building expanded and structures had been erected including the expansion in road networks. These changes are shown in the urban change map (fig 4.5) of the study atea.

The Jos University also recorded a positive change from 3.87% in 1975 to 7.0% in 1991 and a percentage increase of 3.13% (table 4.3). The racecourse on the other hand recorded a negative change from 9.05% in 1975 to 4.26% In 1991 and decrease of -4.79% (table 4.3). this can be attributed to the increase demand for building and other forms of urban activities. the Senior Staff Quarters have on the Other hand recorded as positive change from 6.46% in t975 to 12.78% in 1991;an increase of6.32% (Table 4.3). The rise in the figures is the result of increase in student's population and hence, the P pulation f the Staff of the University due to the expansion witnessed in the institution 'over the sixteen yeat period. the park (Motor) on the

other hand did hot appear in the 1975 urban map because it was non-existent theh in the study area (fig 4.1) but it appeared in the 1991 urban map (fig. 4.3). This shows the development that was witnessed over the sixteen-year period afler 1975. Therefore the percentage tose from nil or 0% in 1975 to 1.5% in 1991 (Table 4.2). The Federal School of Forestry also recotded an increase changes from 3.0% in 1975 to 6.0% in 1991 and increase of 3.0% (table 4.2).

Thus, the Positive and Negative changes noted in the study area between 1975 and 1991 might be the result of population increase, increase in economic and othet activities and hence, the rise in living standard of the people of the study area and consequently the demand for land,

Table 4.2 Distribution of Urban categories and magnitude of change betweet11975 - 1991.

SIN	Urban Category	1975 Area (Hectares) (Al	199t Area (Hectares) (M	Magnitude ot t1l1lhge In hectares (b-si}=t	Remarks
1.	University of Jos	900	1792	892	Increase
2.	Federal School of Forestry	700	1536	836	Increase
3.	Race Cource	2100	1088	- 1012	Reduction
4.	Senior Staff Quarters	1500	3264	1764	Inctease
5.	Parks	'"	384	384	Increase
6.	Built up Areas (Developed)	4000	10880	6880	increase
7.	Under Developed Areas	14000	6592	- 7408	Reduction
total		23200	25536	tg.76	Increase

Nbt~* Urban Change Categories did not appear on the t975 Aerial Photo.

Stmt-ce:- Author Analysis of Aerial photographs of 1975 and 1991 of Naraguta atea of Jos

(i003)

Table 4.3 Percentage Distribution of the Urban Categories.

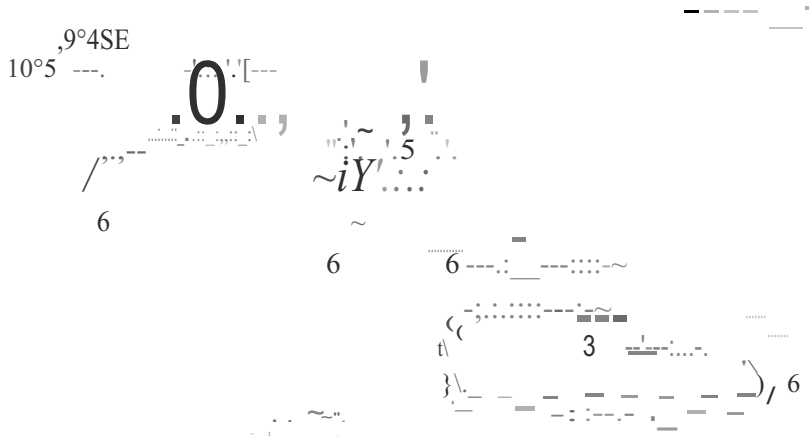
SIN	(A) Urban Categorlcs	(B) ⅄975 Percentage blstrlbutfon	(C) 1991 Percentage Dlstrtbutlon (%)	(D) Percentage Change (C-tl) %
1.	University of Jos	3.87	7.0	3.13
2.	Federal School of Forestry	3.0	6.0	3
3.	Race Course	9.05	4.26	-4.79
4.	Senior Staff Quarters	6.46	12.78	6.32
5.	Parks	-	1.5	1.5
6.	Built up Areas (Developed)	17.24	42.60	25.36
7.	Under Developed Areas	60.34	25.8	-34.54
	Total	100	100	-

Source:- Authors Analysis of Aerial photographs of, Naragula area of Jos (2003).

table 4.4 Proportion of change of Eaeh Urban Category Class to the Overall Change

SIN	Utban Category	Magnitude of Change (C) (Ita)	Change % ot tach Class (Crrotal C :lt 100)
1.	University of Jos	892	4.65
1.	Federal School of Forestry	836	4.35
3.	Race Course	- 1012	5.27
4.	Senior Staff Quarters	1764	9.19
S.	Parks	384	2.00
6.	Built up Areas (Developed)	6880	35.87
7.	Under Developed Areas	- 7408	38.63
	Total	19176	100

SotittM:- Authors Analysis of Aerial photographs of Naraguta area of los (20t)3)



StA lE

KE:Y Uni ity (2) Fo der School of y (3) Rac«p Course

(t.) Se.ni or Staff QlJartQrs (5) Parks (6) Bcr e -Ground £1.J'Chan9Qd Aroas

0 ~ock OUt Crop5 / Hi Jl s F Str Qam sEx pro ssW a y

.:: ~ajor Roads .:=:::::;Minor Roads --- Foot Path

Fig.4,.5" URBAN CHANGE MAP OF NARAGUTA, J05(1975-1991).

Sour ce Author-s Analysi 5 of 1975and '9~1 Air Photot;JforhS.

NARAGUTA, JOS (1975 - 1991)

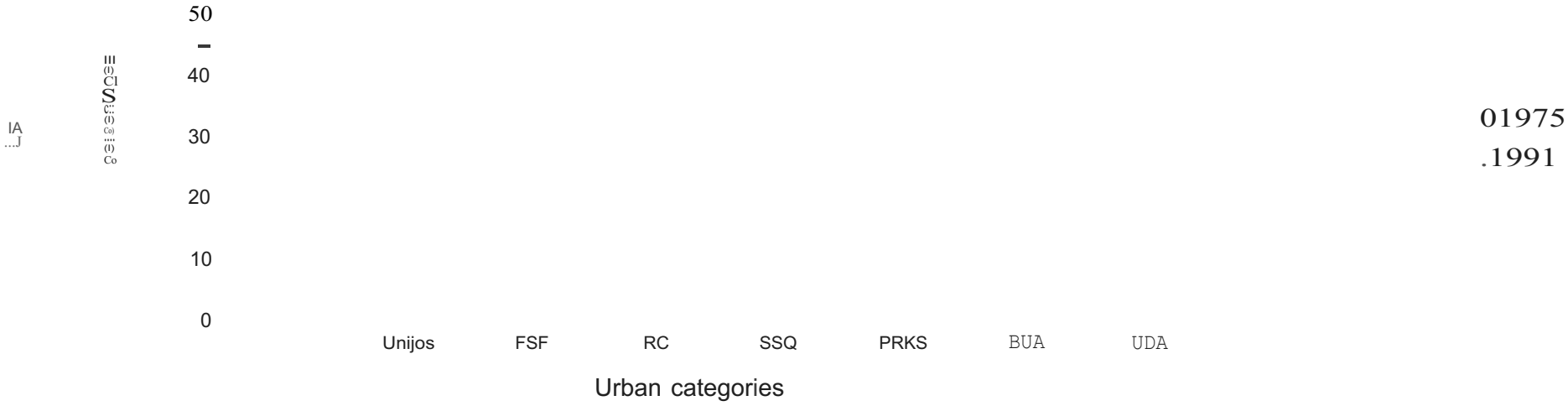


Fig 4.6 Relative distribution of urban categories (1975 -1991)

Source:- Author Analysis of Aerial Photography of Naraguta, Jos (2003)

4.4 DISCtJSSION OF RESULTS

Naraguta which was once quite scenic, sparsely peopled and more or less occupied by expatriate who came as a result of mining and other related activities in the area has now change significantly and it is witnessing urban growth. This growth is mostly attributed to the result of influx of migrants form within and without the Jos Plateau. This have a fat reaching implications on its environment as well as the resources within.

The study have demonstrated the usefulness of remote sensing applications in analyzing the applicability of aerial photographs in detecting urban changes in the area. From the analyses of the air photo mosaics of 1975 and 1991 it was discovered that so rnany developments have taken place as can be seen below.

The 1975 air photo mosaic (fig 4.1) revealed that there was no Motor park in the area and hence, a nil was recorded as its aerial coverage and its percentage distribution (tables 4.1, 4.2 and 4.3) its present location was occupied by farm lands. The influx of population and hence, the heed for accommodation and other activities stimulated the need for additional Motor parks in Jos and hence, its present location along the Bauchi road at the northern *tip* of the map (fig 4.3) arid plate 2a shows some Motor cars parked in the Motor park. The aerial coverage as obtained from the analysis of the 1991 photo mosaic is 384ha. (table 4.2) which is about 1.5% of the total land area (table 4.3) and its percentage change in all the categories is 2.0 (table 4.4). Fig 4.6 graphically compares its relative distribution from the two air photo mosaic (1975 and t~9t). Therefore, there is ah increase or gtowth from hit to 2.0% for the Motor patk in relation other urban categories.

tM raceccur (fia 4,1) that was relatively lata in "r 9, welt t11tUtihllti lid welt ~et\rtoed 1{s fecteiiUtlfi centre fof the expatriate riiine workers as how become Ii shadow of it~~llSt dUe ld

neglect and consequently the demand for land (fig 4.3 and 4.5). lts aerial covetage in t975 mosaic is 2100ha (table 4.3) and its percentage distribution relative to other urban categories is 9.05% (table 4.3) and a percentage change of -4.79%. Plate lb shows its present state in 2003 while figutes 4.3 and 4.5 show its 1991 mosaic. At present, most part of has been encroached by farmlands and residential uses (Plate Ib). Most of creational facilities have beeh vandalized and the structure dilapidated.

The underdeveloped area is 14,000 ha in 1975 mosaic and about 60.34% of the total land area (table 4.1) as can be seen figure 4.1 and its graphical representation itt figure 4.2. tt however, rec6rded the highest negative changes over the period from 14,000ha (60.34%) in t975 to 6,592ha (25.8%) in 1991 mosaics (tables 4.1 and 4.3). Its magnitude of change is about -7408ha and a percentage change from overall total of 38.63% (table 4.4). This can be seen in figure 4.3 and 4.5. Figure 4.6 compared its relative distribution for 1975 lind 1991. The negative change however have impacts on the reduction in farmlands and hence agricultural productivity. It also 'reveals the increase in demand for various urban Ianduse. this however explains the teason why farrning activities are carried out on hillslopes and many highlands iii the area.

Anguwan Rogo located to the northwestern part of the map (fig. 4.1 and 4.3) which hither to was well organise and the planned has now tum to shun or squalo area. its streets wete taken over by commercial and industrial user. Forest found along the stream banks (fig. 4.1) have been cleared (fig. 4.3) and was replaced by residential, commercial and industrial landuser (plate 1a and c). The stream have also shrunk considerably due to dumping of garbage and household refuse to the extent that its flow have been reduced to almost a trickle. it this trend is rtol controlled ita however. Ii ared that in A h ar future nvironment pcllution and its attet1datit effects and f100d might pose a problem t0 the area. The tole of vegetation cover itt teducing impacts of

rain dtops on soil, encouraging the in filtration of water and preventing soil erosion is not In doubt. Its destruction is bound to encourage surface run off rain water and soil erosion. Since household sewage are continuously dumped into stream channel flood might result which may have far reaching consequences on the people and those categories of landuse located along the stream banks.

The Dogon Duste area (GRA) located to south west (fig.4. 1) has become a shadow of its past and is now considered as a twilight zone (fig. 3). Slums or barchas (Zinc houses) have taken ovet most of the available spaces in the area.These slums are mostly the residences of the retired and serving low cadre mine workers. Also mining and other allied construction firms now compete for space in the area designated for residential uses. This however, is bound to affect the urban plan of the area.

The University of Jos has also recorded a positive change from 900ha or 3.87% in t975 I photo mosaic (fig. 4.1) to 1,792 or 7.0% in the 1991 photo mosaic (fig. 4.3) as is seen in table 4.1 and 4.2. And magnitude of and proportion of change can be seen in table 4.3 and 4.4. The growth tate of 892ha over the period might be attributed to expansion in virtually all the lhstitutions of higher learning in the country to accomtnodate the increase tate of student enrollment as welt as inctease in the coutses offered and department. This also tnight influence the increased of about 1764ha (table 4.2) for the senior staff quarters. this is because as the students population and the number of courses and departments increased so also the number of academic and non academic staff to cope with the demand and hence the need for increase in humber of their accommodation.

the Federal School of Forestry has also witnessed art increase change from 700ha Itt 1975 photo mosaic' (fig. 4.3) as isseeri in table 4.1. The increase change is ~t~6ha (table 4.2).

This can beattributed to the introduction of new courses as well as increase in student enrollment over the period just as is the case with the University of Jos.

The built-up areas witnessed the highest positive change from its 4000ha (fig. 4.1 and table 4.1) in 1975 mosaic to l0880ha (fig. 4.3, 4.6 and table 4.2) an increase of 6880ha (25.36%) as is seen in tables 4.3 and 4.4. The built-up areas can seen scattered in most part of the t991 mosaic (fig. 4.3). This growth rate can be attributed to the influx of population due to increasing tote of Jos from its hitherto mining centre to its present administrative, commercial, industrial, educational and other functions.

The study also reveal an overall increase urban landuse of the area from a total of 23200ha in 1975 mosaic to 2553611a in 1991 mosaic, thereby indicating a magnitude change of +10,756ha and -8,420ha for both developed areas and underdeveloped areas respectively. This is howevet, inline with similar studies conducted elsewhere such as those of Owolabi (1998) in Victoria Island; Lagos, Ojigi (1997) in Federal Capital City; Ahuja, Adeniyi (1980 and 198t) in Agege; Lagos and Roger, et a1 (1985) in St. Lawrence valley, Quebec; Canada.

4.5 CONSEQUENCES OF TilE CHANGES

We live in world of dynamics of nature, economics, population and urbanization. These has far reaching consequences on man and his environment. Principal threats to man come from nature (his environment) and from man himself. There is a growing awareness and evidences that continuous, unrestrained and unplanned intervention on the natural ecosystem can only lead to disaster. There now a growing fear that rate at which the world's population is growing and the corresponding rate at which the resources are being exploited is becoming a source of concern that man existence, will within the foreseeable future be threatened.

Analysis of the t991 photo mosaic of Naraguta (fig. 4.3) as compared with that of t975 photo mosaic indicated that most of changes detected especially in the built-up areas deviated from the initial landuse pattern of the area. As was pointed out in chapter 4.4, there is an encroachment of farmlands and residential uses into the racecourse which hitherto setve as a recreation center. It is also reveal that there is a massive deforestation especially along the stream banks of, Anguwan Rogo. There is also a massive expansion of squalor and shims in both Anguwan Rogo and Dogon Duste areas. The study also revealed the encroachment of commercial and industrial uses in the area meant for residential Use thereby creating a sort of mixed or haphazard landuse pattern. The ground truth conducted in May, 2003 also reveal the indiscriminate and uncontrolled dumping of household refuse and industrial sewage into the stream channels thereby blocking now of water and hence leading to environmental pollution and health hazards.

The overall consequences of the above on man and environment in the area cart be summed up under the following perspectives;

0. Traffic congestion: - Due to high population and number of vehicles particularly along the toad between the University of los, the Federal School of Forest up to the Bauchi road Motor park, traffic congestion is a daily phenomenon. This is mostly severe during the rush-hour periods i.e. in the morning when the student and children ate going to the school and workers to their work places and from the early hour of the afternoon Up to evening. This situation is most acute at the road junctions where most road users ate impatiently eager to reach their destination.

ii). Overcrowding:- population pressure create the desire for more lands as well as the development of and expansion of squalors and slums. This is paticularly pronounced in areas of lower cadre mine and construction workers. This study revealed the concentration of slums known as "Barchas" in Anguwan Rogo and Dogon Dutse areas. The consequences of this development are the overstressing of the utilities and social amenities in the area. The situation is so acute that electricity and pipe borne water is being rationed in some areas. Government or public health facilities arid schools are over populated resulting in massive decline in the services they provide to the citizens.

Hi) Flood and environmental pollution:- Due to the increasing tate of deforestation, pavement of houses and toads with concrete and tarmac which encourages surface run ofT artd the reduce the rate of percolation of tain water into the soil. The dump of refuse and industrial waste into the stream channels block them and thereby cteating an environmental pollution and consequently, flood during the period of heavy rainfall.

the foregoing situations therefore calls for the urgent attention ot the policy makers and ttl particular, the urban and town planning authority to control the trend.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RE OMMENDATIONS

5.1 SUMMARY

To understand and develop the present landscape, we need to discover why town and cities in Nigeria have grown to their present pattern. This study demonstrated the applicability of aerial photographs in detecting landuse changes in Naraguta area of los Plateau from 1975 to 1991. The research focused on analyzing the nature and extent of changes in the urban parameters of the area. To achieve the objective, manual technique was used to interpret the aerial photograph of the area for the two periods (1975 and 1991). This was achieve by mapping the urban extent of the area for each category of landuse types for the two period. The landuse maps generated from the air photo mosaic of the two period were overlayed and then and change map was produced and the changes detected were calculated, The USGS' landuse/landcover classification scheme of Anderson, et at (1976) has provided a valuable guide for designing the lahduse classification scheme for this study. This scheme provides tor urban landuse details (level 11) interpretable according to different scales of the photographs and hence, the spatial resolution quality is adopted.

The results obtained have reveal that the University of Jos has increased by 892ha, Federal School of Forestry by 836ha, the senior staffs by 1,764ha, the Motor park by 384ha and built-up (developed) areas by 6,880ha. The underdeveloped areas and racecourse shows a decline in both aerial coverage and is negative magnitude of change of 7408ha atid - 101211a respectively, Table 4.3 and 4.4 shows the percentage distribution of the Urb:11categories and the proportion of change of each urban category class to the overaI1 change over the 1975 and 1991 petiod (ltiyears).

i CONCLUSION

Landuse maps derived of change detection derived from aerial photography data allows us o compile an objective inventory of an entire area before proceeding to a detailed study phase. 3y comparing photographs acquired on di fferent dates or recent imageries with older maps, we can monitor growth rate and detect every change that occur. It is our job as environmental scientists to examine when growth should be allowed to take place and the land are required. We also need to know what resources are threatened and the likely consequences of the planned growth.

In line with the stated objectives, this study has shown that there is a significant changes in the urban landuse of Naraguta area of Jos Plateau over a sixteen year period. That the build tip areas increase from 7100ha in 1975 to 17856ha in 1991 showing a positive increase or changes while the underdeveloped areas including the race course show a negative change or decrease growth from 16100ha in 1975 to 7680ha in 1991.

From the foregoing therefore, it is concluded that aerial photographs as a tool of remote sensing can help in providing adequate information necessary for detecting urban changes in landuse and can also be used in monitoring and studying the landuse parameters of on area.

5,3 tttCOMMENDATIONS

From the research conducted and the findings made so fat, the following recommendations are made;

i. That there is an urgent need for the policy makers, the town planning authority as well as all the parties concerned to tty as much as possible to adhere to the tnaster plan of the area for the purpose of development contro1.

ii. there is the need for the Stale Sanitary and environmental board to monitor and ensure that house-hold refuse and industrial waste are disposed of at the right places to avoid pollution and flood disaster.

iii. The is also the need for the town planning authority to properly Implement the zoning system of landuse to avoid conflicting uses of the land as the trend shows in some areas.

iv. there is also the need to separate commercial/Industrial uses of the land from the tesidential uses.

v. Ther~ is the need [or the town planning authority to work hand in hand with the National Remote sensing center, in Bukuru, Jos to obtain up-to-date and teal time data on satellite imageries of the los Plateau so that different aspects of the environment can be monitored and studied.

VI. The launching of the Nigeria satellite t in September 2003 is a welcome development , and its image should be acquired at regular interval by the state planning authority so that it can facilitate its activities.

vii. Staff of the state town planning authority should be trained on the current remote sensing techniques of interpretation of imageries and digital image processing techniques to facilitate its activities.

To this end, it can thus be concluded that the use of remote sensing to not only urban applications is inevitable in this epoch of technological advancement. Further research Is recommended on the application of satellite imageries in urban change detection.

PLATES

rtes fa, j c

These two plates are evidence of the negative impacts of urbanization In the study area. ate t a and 1c show what is left of the large stream that cuts across the Bauchi road on the maps efuse and Garbage have blocked its path of flow and buildings have taken over most of banks 'the stream. This stream has been reduced and almost blocked. It is now a refuse dump for both dustrial and domestic waste. The complete disappearance of the stream is inevitable.

late 1b

This plate shows the once large and well-maintained racecourse. Fanning activities have ow taken over it due to lack of available land for farming. At the top right hand cotner of the tate, are the recreational structure which have been dilapidated and neglected .,

'ilites 2a, 2b, 2c

Plate 2c shows more organised pattern of packing space. While plate 2b shows the tnain entrance of the University of Jos which is some of the positive land Use system in the study area. Plate 2a shows the Bauchi park in the study area which is an eletnent of high percentage of development.

Plates 3a,jb, 3c.

these are showing wider and better road networks in the study area. This is a positive developlnent in urban development and evidence of the high percentage of development.

'Iates 4a, 4b,

These plates show commercial areas. It should be noted that theses areas before were not eveloped and only were occupied by dense vegetation. This is also a positive trend in rbanization, and it is due to the high rate of development.

Plates 5a, 51>,5c

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

PLATE 1a

PLATE 2a

PLATE 1b

PLATE 2b

PLATE 1c

PLATE 2c

PLATE 3a

PLATE4a

PLATE 3b

PLATE4b

PLATE 3c

PLATE Sa

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PLATE 5b

PLATE 5c

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