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Land Use Land Cover Change in Barkin-Ladi, Jos, Plateau State, Nigeria

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ABSTRACT

This study was a research carried out to detect the change in land use/land cover of Barkin-Ladi area of Plateau State, North Central Nigeria. Three Land sat images of 1975, 1985, and 2005 were subjected to various image processing techniques and a supervised classification was carried out on the various images. The classification schemes used are rock outcrop, built-up, farmland and vegetation. Ground truthing was carried out to confirm the results of the classification. The results were subjected to various statistical analyses and it shows natural vegetated area coverage reduced from 173.77sqkm in 1975 to 121.005sqkm in 1985 and still reduced to 26.119sqkm in 2005. The rate of change of natural vegetation between 1975 and 1985 was 5.277sqkm per annum, and 2005. Loss of naturally vegetated area in Barkin-Ladi is mainly as a result of urban growth and expansion, farming and gully erosion. Land cover of the study area during the period between 1975 and 2005 changed from a forested area to other land uses as a result of increase in population, demand for land for agricultural purposes and increase in the demand for fuel wood.

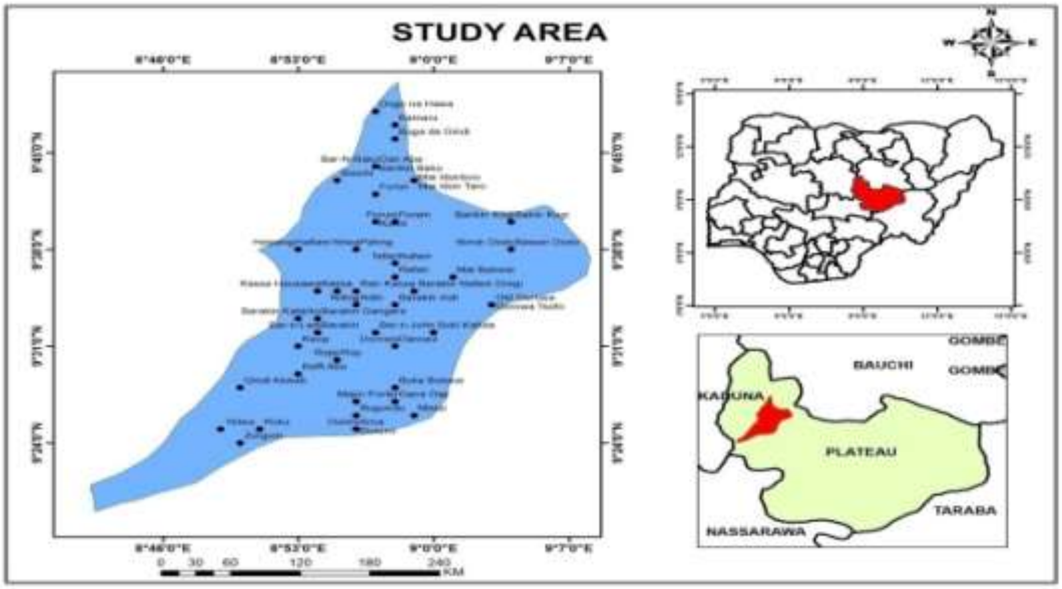
Keyword: Land use, Land use, Classification, Remote sensing, Barikin-Ladi

INTRODUCTION

Land Use Land Cover (LULC) changes play a major role in the study of global change. Land use land cover and human/natural modifications have largely resulted in deforestation, biodiversity loss, global warming and increase of natural disaster-flooding (Mas, Velazquez, Gallegos, Saucedo, Bocco, & Castro, 2004). These environmental problems are often related to LULC changes. Therefore, available data on LULC changes can provide critical input to decision-making of environmental management and planning the future (Prenzel, 2004). The growing population and increasing socio-economic necessities creates a pressure on land use/land cover. This pressure results in unplanned and uncontrolled changes in LULC. The LULC alterations are generally caused by increase in human populations and rapid urbanization, leading to various land uses such as agricultural, urban, range and forest lands. Also environmental degradation caused by natural or anthropogenic processes causing severe environmental problems such as landslides, floods and erosion, all these affect the land use and land cover of an area.

In particular, land use/land cover (LULC) changes in tropical regions are of major concern due to the wide spread and rapid changes in the distribution and characteristics of tropical forests (James Anderson 1976). However, changes in land cover and in the way people use the land have become recognized over the last 15 years as important global environmental changes in their own right (Geremew, A. A. 2013). Consequently, land use and land cover changes could lead to a decrease in availability of different products and services for humans, livestock, agricultural production and damage to the environment as well.

Remote sensing and Geographical Information Systems (GIS) are powerful tools to derive accurate and timely information on the spatial distribution of land use/land cover changes over large areas (Carlson & Azofeifa, 1999).A past and present study conducted by organizations and institutions around the world, mostly, has concentrated on the application of LULC changes. GIS provides a flexible environment for collecting, storing, displaying and analysing digital data necessary for change detection (Demers, 2005). Remote sensing imagery is the most important data resources of GIS. Satellite imagery is used for recognition of synoptic data of earth's surface (Ulbricht & Heckendorf, 1998). Landsat Multispectral Scanner (MSS), Thematic Mapper (TM) and Enhanced Thematic Mapper Plus (ETM+) data have been broadly employed instudies towards the determination of land cover since 1972, the starting year of Landsat program, mainly in forest and agricultural areas. The rich archive and spectral resolution of satellite images are the most important reasons for their use (Campbell, B. 1996).



Source: Field work 2017

LAND USE AND LAND COVER CHANGE

Definitions and Concepts

According to the International Geosphere-Biosphere Program and The International Human Dimension Program (IGBP-IHDP, 1999), ***land cover*** refers to the physical and biophysical cover over the surface of earth, including distribution of vegetation, water, bare soil and artificial structures. ***Land use*** refers to the intended use or management of the land cover type by human beings such as agriculture, forestry and building construction.

Land use and land cover change (LULC) is commonly grouped in to two broad categories: conversion and modification. Conversion refers to a change from one cover or use category to another (e.g. from forest to grassland). Modification, on the other hand, represents a change within one land use or land cover category (e.g. from rain-fed cultivated area to irrigated cultivated area) due to changes in its physical or functional attributes. These changes in land use and land cover systems have important environmental consequences through their impacts on soil and

water, biodiversity, and microclimate (Igbokwe, I. E. 2013).
Land cover changes have been influenced by both the increase and decrease of a given population. In most developing countries like Nigeria, population growth has been a dominant cause of land use and land cover change than other forces. There is a significant statistical correlation between population growth and land cover conversion in most of African, Asian, and Latin American countries. Due to the increasing demands of food production, agricultural lands are expanding at the expense of natural vegetation and grasslands (Ulbricht & Heckendorf, 1998).

It is estimated that undisturbed (or wilderness) areas represent 46% of the earth's land surface. Forests covered about 50% of the earth's land area 8000 years ago, as opposed to 30% today. Agriculture has expanded into forests, savannah, and steppes in all parts of the world to meet the demand for food and fibre. Based on data from diverse sources, the Global Forest Resources Assessment 2000 estimated that the world's natural forests decreased by 16.1 million hectares per year on average during the 1990s, which is a loss of 4.2% of the natural forest that existed in 1990 (Lillesand, T. A. 2004).

Generally, knowing of the impacts of land use and land cover change on the natural resources like water resources depends on an understanding of the past land use practices, current land use and land cover patterns, and projection of future land use and land cover, as affected by population size and distribution, economic development, technology, and other factors. The land use and land cover change assessment is an important step in planning sustainable land management that can help to minimize agro-biodiversity losses and land degradation, especially in developing countries like Nigeria (Igbokwe, I. E. 2013).

Remote Sensing and GIS as a Major Tool for Land use Land cover Monitoring

The inventory of land resources calls for current situation of mapping while the control and management of these resources and monitoring of environmental change demand repetitive coverage with proper planning to meet the growing population challenges (Igbokwe, I. E. 2013). Both aerial

Photographs and Land Sat have been used in various studies to assess soil condition and type as inputs into the degradation of soils. Fagbemi, 1986 in Makurdi area, Nigeria, used landsat and aerial Photographs to map and assess the condition of soils including their Physical limitations such as erosion as well as flood hazard problems. Some of the application of remote sensing technology in mapping and studying of the land use and land cover changes are; mapping and classification of the land use and land cover of an area, environmental monitoring, assessing the spatial arrangement of land use and land cover patterns applicable in environmental impact assessment useful in analysis of time-series satellite images used to analyse landscape history, statistical report and analyse results of inventories including inputs to Geographic Information System (GIS), which provide a base for storing, displaying, visualizing and model building of spatial data. The basis of using remote sensing data for change detection is that changes in land cover result in changes in radiance values which can be remotely sensed. Techniques to perform change detection with satellite imagery have become numerous as a result of increasing versatility in manipulating digital data and increasing computer power. In some instances, land use and land cover change may result in environmental, social and economic impacts of greater damage than benefit to the area (Igbokwe, I. E. 2013). Therefore, data on land use change are of great importance to planners in monitoring the consequences of land use change in an area. Such data are of value to resources management and agencies that plan and assess land use pattern and in modelling and predicting future changes. This normally involves the use of sequential satellite imageries over a specific region and the land cover map for each data developed and compared. Direct observations in the field have traditionally provided most land use/land cover information. However, the introduction of satellite remote sensing techniques, gives opportunities of processing and comparing very large quantities of data. In recent years, satellite remote sensing techniques have been developed, which have proved to be of immense value for preparing accurate land use land cover maps and monitoring changes at regular intervals of time. In case of inaccessible region, this technique is perhaps the only method of obtaining the required data on a cost and time –effective basis. The multispectral data provided by the on-board sensors led to an improved understanding of crops, forests, soils, urban growth, land degradation and many other earth features and processes(Igbokwe, I. E. 2013).

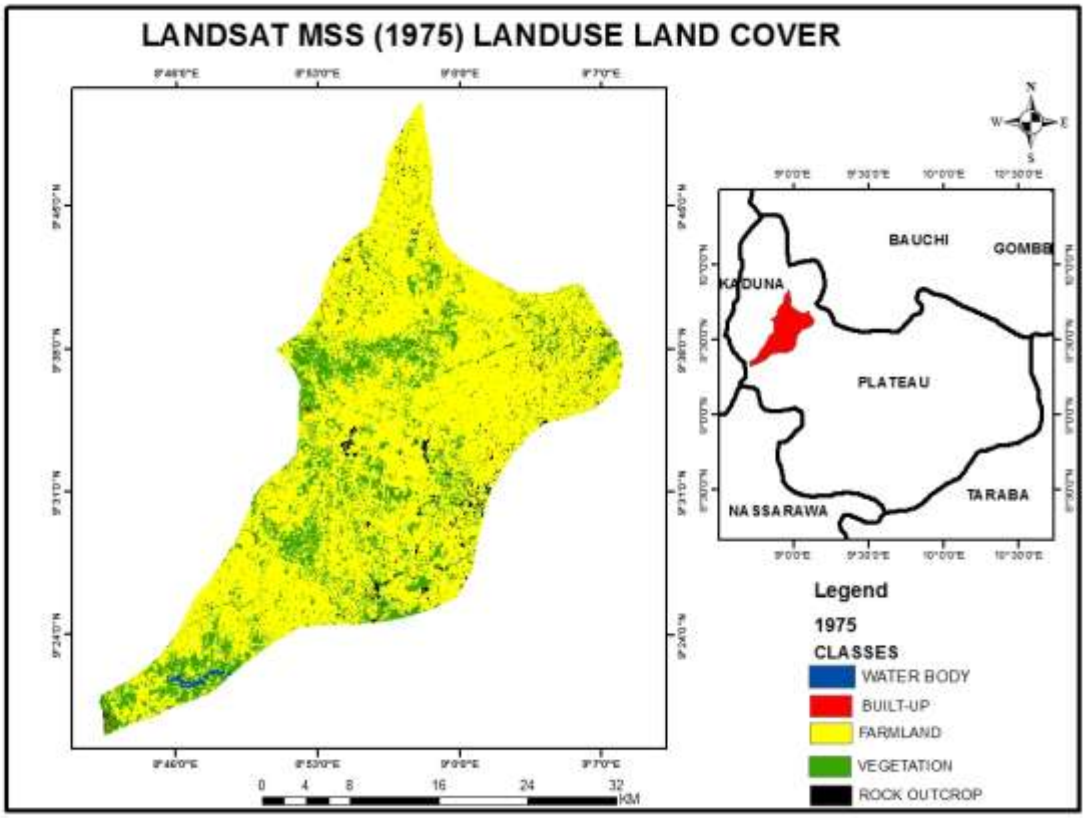
Role of Remote sensing in Spatial Data Acquisition

Remote sensing plays an important role for spatial data acquisition from economical perspective (Muzein, B. A. 2006). Changes in natural vegetation particularly around urban areas are always due to human influences. The intensity of such changes increases with population size and in most recent time, human manipulation of the earth's surface has become very strong. Humans make use of the land they inhabit to a degree unmatched by other species (Igbokwe, I. E. 2013). The human imprint is most marked in the temperate and tropical zones, but even the remote deserts, high mountains and Polar Regions bear evidence of the works of man, in large urban and industrial centres and major transport networks, the alteration of the landscape is most evident. Rapid environmental growth has resulted in many environmental problems which has escalated deforestation and loss of vegetation in urban fringes. As population increases, more land is cleared for farming, building of houses and road construction; less is left to forest or fallow. Rapid population growth has forced people to build and farm on marginal lands which have increased erosion processes. This has also resulted in the loss of forestlands and land resources (Ogunmola G. E. 2014). Developing countries in particular are often faced with a dilemma. Their need for money and resources to satisfy the growing populace leads to loss of their forest and modifies their savannah to obtain timber, rubber and other cash crops for export (Igbokwe, I. E. 2013). Advances in transport and food preservation have allowed cities to expand further. Cities in recent times have gone on growing faster than the population as a whole. Cities and suburbs sprawl in all directions.

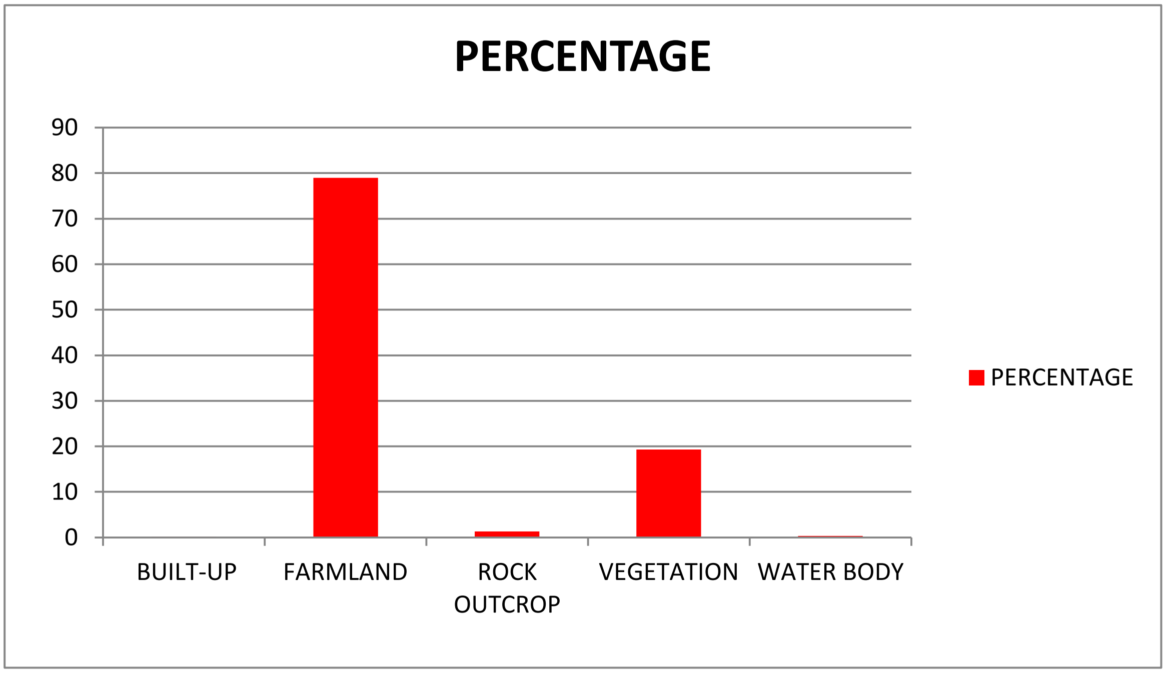
In Nigeria, urban areas represent less than 10% of the total land area of the country, yet accommodate 28% of the total population. The urban growth rate is 3-5 times greater than the rural growth rate (Ogunmola G. E. 2014), population growth has out-paced adequate housing, livelihood, roads, transport, water, sanitation, waste disposal and health services. These have forced people to settle on urban fringes thereby clearing forests for building and construction works. In most developing countries, especially Nigeria, availability of relevant and current information about our environment and how it changes over time has been lacking, (Igbokwe, I. E. 2013). This problem therefore, has consequently been affecting the achievement of change detection and sustainable development, and as such, requires research for accurate and timely information, which is needed for environmental monitoring, planning and forecasting.

MATERIALS AND METHOD

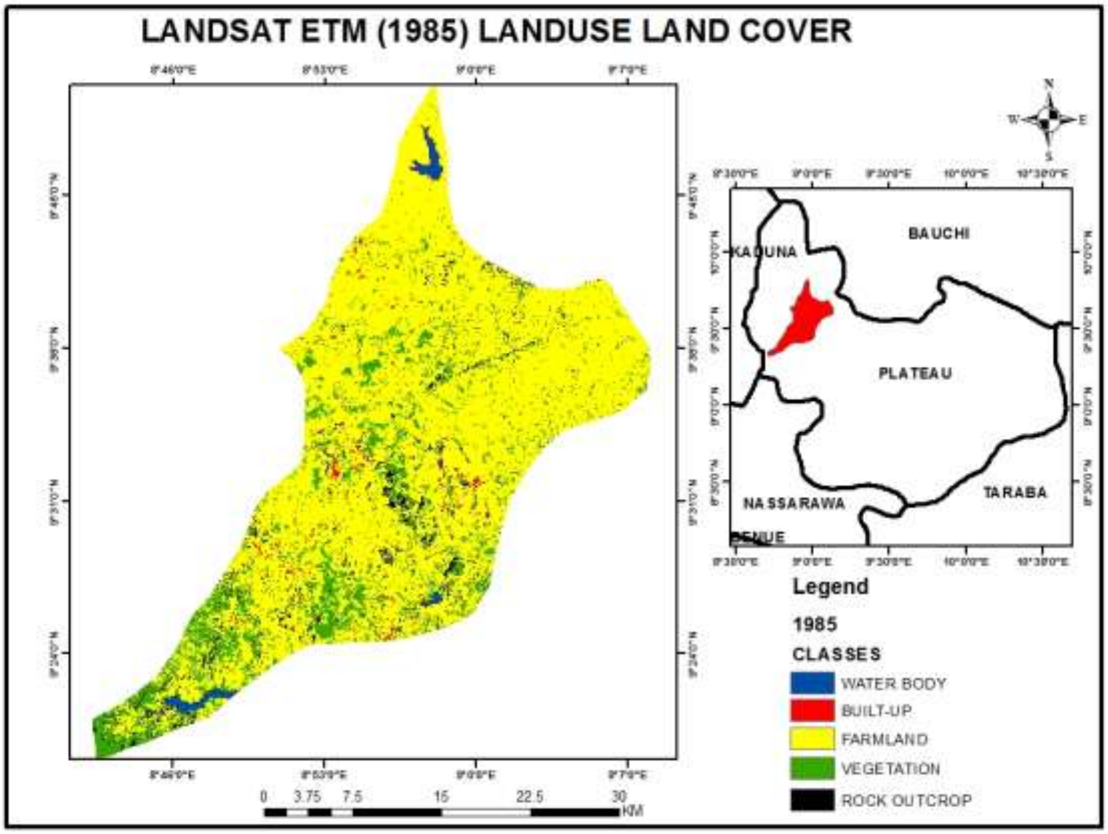
For the purpose of this study, landsat images of Barkin-Ladi were acquired for three epochs; 1975, 1985 and 2005. The acquisition of the data includes; Three (3) Satellite images from NASRDA/NCRS, LANDSAT image from glovis, usgs and Global Land Cover Facility (GLCF) were used. Ground truthing to gain historical information of the study area such as cultivated land, grassland, rock outcrops and bare-lands was also conducted. The three period of Landsat imageries were classified using the supervised classification technique. The bar chart of all imageries at each band showed acceptable normal distribution pattern. Therefore, employing the Maximum Likelihood classifier was found out to be appropriate. The results are presented inform of maps, charts and statistical tables. They include the static, change and land use land cover of each class.


LANDSAT MSS (1975) LANDUSE LAND COVER
BAUCHI
GOMBE
KADUNA
PLATEAU
TARABA
NASSARAWA
Legend
1975
CLASSES
WATER BODY
BUILT-UP
FARMLAND
VEGETATION
ROCK OUTCROP
0 4 8 16 24 32 KM

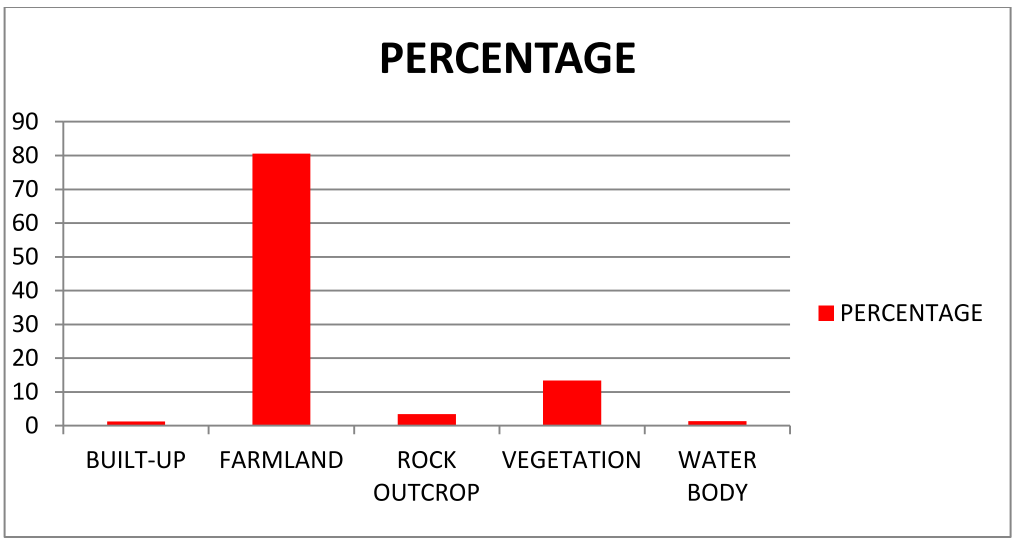
CLASSES	AREA EXTENT sq km	PERCENTAGE
BUILT-UP	0.745241	0.110926
FARMLAND	711.761561	78.952631
ROCK OUTCROP	12.032491	1.334712
VEGETATION	173.778371	19.276483
WATER BODY	3.186887	0.353508



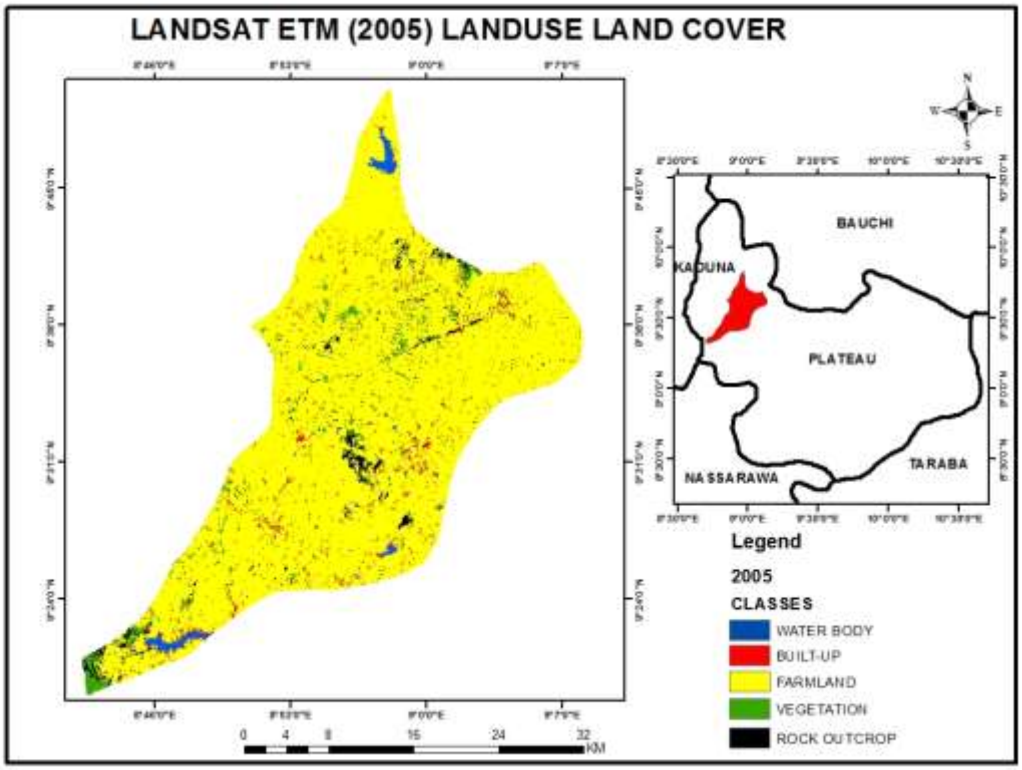
From table, it can be seen that for the year 1975, most parts of the study area were farmland and bare surfaces. It shows that while naturally vegetated area accounted for 19.3% of the total land area (a 173.7sqkm land area), non vegetated accounted for the remaining 88.6% with built up area took 0.1%. LULC units under rock outcrop and water body covered 1.3% and 0.3% of the total area respectively. Built-up occupies the least class with just 2% of the total classes. Also, farming seems to be most practiced, occupying 70% of the total classes. This may be due to the fact that the area is developing and farming seems to form the basis for living.


LANDSAT ETM (1985) LANDUSE LAND COVER
BAUCHI
KADUNA
PLATEAU
NASSARAWA
TARABA
BENUE
Legend
1985
CLASSES
WATER BODY
BUILT-UP
FARMLAND
VEGETATION
ROCK OUTCROP
0 3.75 7.5 15 22.5 30 KM

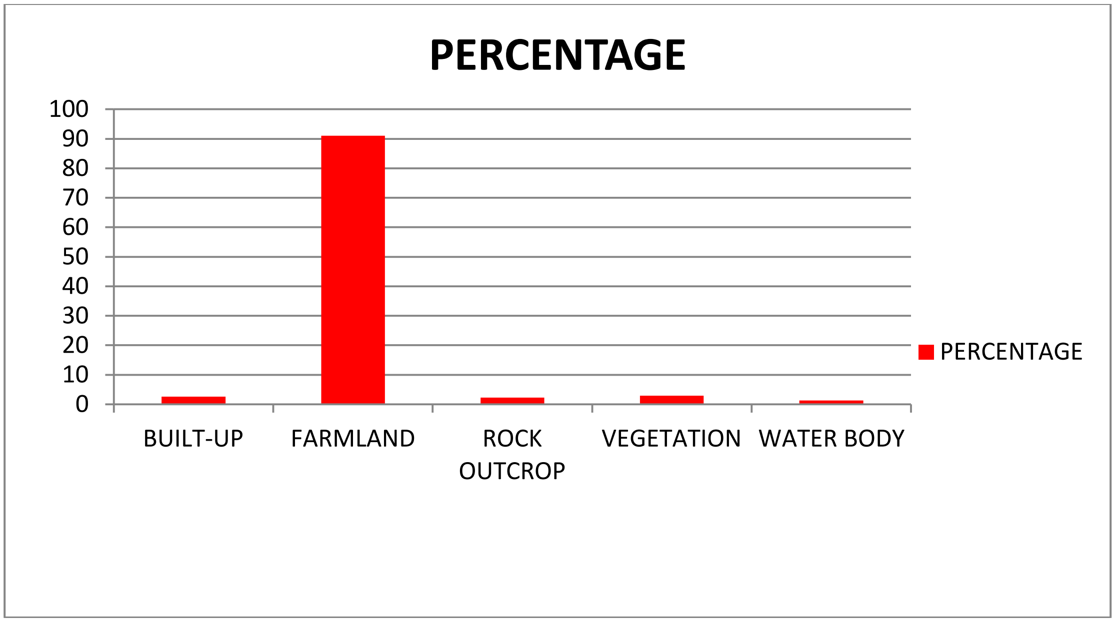
CLASSES	AREA EXTENT sq km	PERCENTAGE
BUILT-UP	11.05956	1.2266
FARMLAND	726.477623	80.5726
ROCK OUTCROP	30.774939	3.4132
VEGETATION	121.005	13.4205
WATER BODY	12.326796	1.3671



In 1985, farmland still occupies the highest class with 80.5% (726.48 sq km) of the total class, taking up more than half of the total classes and vegetation decreased due to hamattan could also be a major contributing factor to the observed classification. Furthermore, the high percentage may be due to the season of the year and water body increased by 1.3% (12.33 sq km) due to the artificial dam which was created at the time used for irrigation for their cultivated land. Loss of naturally vegetated area in Barkin-Ladi is mainly as a result of urban growth and expansion which increased to 1.2% (11.06 sq km), farming and gully erosion. Rock outcrop which covered 3.4% (30.77 sq km) of the area



CLASSES	AREA EXTENT (sq km)	PERCENTAGE
BUILT-UP	23.351321	2.5897
FARMLAND	820.96691	91.0472
ROCK OUTCROP	20.114813	2.2308
VEGETATION	26.119047	2.8967
WATER BODY	11.141851	1.2357



For the period between 1985 and 2005, table 3 shows that vegetated area was 2.89% (26.11sq km) while built-up area accounted for 2.5% (23.35 sq km), farmland was 91.05% (820.97 sq km) and water body took up to 1.24% (11.14 sq km) of the total land area which is 901.69 sq km. Vegetation was taken over by farmland which led to its drastic reduction in land area. There was an increase in built-up area which is a reason why farmland still seems to be very high due to high demand for food, firewood and commercial purposes. The demand for food to feed increasing population also necessitated the clearing of forest lands that has being converted to farmlands. Also weather condition could be a contributing factor. Another important issue is the problem of soil erosion. In the past mining activity had led to accelerated gully erosion which has stripped substantial areas of lands of their vegetations.

Land cover in Barkin-Ladi 1975-2005						
Classes	**1975**		**1985**		**2005**	
	Area sq km	%	**Area sq km**	%	**Area sq km**	%
Built-up	0.745	0.111	11.059	1.227	23.351	2.589
Farmland	711.762	78.952	726.478	80.573	820.967	91.047
Rock outcrop	12.032	1.335	30.774	3.413	20.115	2.231
Vegetation	173.778	19.276	121.005	13.420	26.119	2.897
Water body	3.187	0.354	12.327	1.367	11.142	1.236
Total	901.6	100	901.6	100	901.6	100

Source: Field work 2017

Classes	**A 1975**	**B 1985**	**C Magnitude 0f changes A-B**	**Annual frequency of change C/10**	**Percentage of change C/A *100**
Built-up	0.75	11.06	-10.31	-1.031	-1374.667
Farmland	711.76	726.48	-14.72	-1.472	-2.068
Rock outcrop	12.03	30.77	-18.74	-1.874	-155.770
Vegetation	173.78	121.01	52.77	5.277	30.360
Water body	3.19	12.33	-9.14	-0.914	-286.520
Classes	**A 1985**	**B 2005**	**C Magnitude 0f changes A-B**	**Annual frequency of change C/30**	**Percentage of change C/A *100**
Built-up	11.06	23.351321	-11.75	-0.392	-46.564
Farmland	726.48	820.96691	-94.468	-3.149	-15.570
Rock outcrop	30.77	20.114813	10.655	0.355	82.775
Vegetation	121.01	26.119047	94.891	3.163	66.845
Water body	12.33	11.141851	1.188	0.039	18.248

The magnitude of change for 1975-1985 is calculated by subtracting the area of each Land cover type for the year 1975 from 1985 i.e (B-A) absolute. The percentage of change (E) is calculated by dividing the magnitude of change C of each Landover category by the figure of the base year i.e 1975 then multiplying the result by 100. The same is done for the periods 1985 to 2015 where 1985 is the reference year. Annual frequency of change is gotten by dividing the magnitude of change of each Land cover category by the number of years between the period i.e 10 years for 1975-1985 and 30 years for 1985-2005.The results of the analysis unveil a tremendous change in the Land cover of the study area during the 40 years period from 1975-2005. The magnitude of change of naturally vegetated area between 1975 and 1985 was 52.77sq km, representing a change of 30.36%, hence, annual frequency of change stood at 5.27sq km per year. This annual frequency of change means that 5.27sq km of land was forested annually for 10 years (1975-1985). Therefore, this period showed a total increase in naturally vegetated area of 52.77sq km for the period. Furthermore, the period 1985-2005 showed a decrease in naturally vegetated area from 121.01 to 26.119sq km, a 94.891 sq km loss of vegetation. Percentage of change during the period was 66.84% and annual frequency of change was 2.69sq km. This means that 0.108sqkm of forestland was cleared annually for 30 years. Urban expansion into the area resulted in a 80.89sq km loss of forestland during the period from 1985-2005. Farmland increased in 2015 from 2005 by 0.729% which was due to the raining season and the period the image was taken. Also, the period from 2005- 2015 in the class of rock outcrop showed a tremendous decrease in the total area from 20.115 - 5.302sq km which is due to extensive mining activities.

The period between 2005 and 2015 witnessed a drop from 23.35sq km to 16.28sq km at which the physical expansion of the city was going as against 1975 and 2005. This as a result of crisis which occurred within this period, the mining activities which affected their agricultural lands resulted to the migration of people and thus the decrease of the total area covered within this years.

Many projects were embarked on in this study area especially the exploration of mining in the 1980s and this attracted a lot of people to the area thus contributing to the physical expansion of the area as evident in the increased land consumption rate from 0.74 to 23.35 sq km and magnitude of changes by -10.31 between 1975 and 2005. Many of these projects include the airport; dams for irrigation; and mining sites which in all encouraged its migration into the study area.

CONCLUSION

From the findings of this study, the following conclusions were arrived that the loss of naturally vegetated area in Barkin-Ladi is mainly as a result of urban growth and expansion, farming and gully erosion and another important issue in the study area is the problem of soil erosion. In the past, mining activity had led to accelerated gullying which has stripped substantial areas of lands of their vegetation. This has led to the formation of bare surfaces.

This research work demonstrates the ability of GIS and Remote Sensing in capturing spatio-temporal data. Attempt was made to capture as accurate as possible five land use land cover classes as they change through time. The five classes were distinctly produced for each study year but with more emphasis on built-up land as it is a combination of anthropogenic activities that make up this class; and indeed, it is one that mostly affects the other classes. In achieving this, magnitude of change and annual frequency change were introduced into the research work. However, the result of the work shows a rapid growth in built-up land across the study period. The land use changes and the consequent changes in land cover characteristics in the study area have left their traces in the form of extensive farmlands to built-up land and sparse vegetation.

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