



RESEARCH PAPER

An Evaluation of the Effects of Land–Use Pattern on Land Cover Change in Paikoro Local Government Area

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ABSTRACT

This study applied the integrated remote sensing and geographical information system in analyzing the land use /Land cover dynamism in Paikoro Local Government area, Niger State for a period of twenty years (1986 to 2011). Land sat (TM) images of 1996, 2006, and Nigeria sat x image of 2011 were used. The study employed supervised digital image classification method using Erdas images 2014 and Arc GIS 10.2 software which classified the land use into bare surface, Built-up, Farmland, Vegetation and water body. The imageries were made to pass through processes of geo-referencing, image enhancement, resampling and classification. The result obtains shows that the built-up area increased rapidly for the period between 1996- 2011 by 5.4%. This is the evidence that land consumption rate (LCR) is at the increase between 1996 and 2006 respectively, while also Bare surface is the second lowest with the rate of 4.9% in 2006 and increased in 2011 with the rate of 7.9%. Also farmland seems to be practiced moderately occupying 9.0% in 2006 and increased at the rate of 10.9% in 2011 all these Landuse activities affect land cover. It is recommended that land use should be based on effective master plan of the community.

Keywords: Bare surface, Built-up, Farmland, Vegetation and Water body

INTRODUCTION

Due to anthropogenic activities, the Earth surface is being significantly altered in some manner and the presence of man on Earth and his use of land has a profound effect upon the natural environment thereby resulting into an observable pattern in the land cover over time. The land use/land cover pattern of a region is an outcome of natural and socio-economic factors and their utilization by man in time and space. Land is becoming a scarce resource due to immense agricultural and demographic pressure. Space is now crucial to understand viewing the influence of man's activities on the natural resource base over time. In situations of rapid and often unrecorded land use change, observations of the earth from space provide objective information of human utilization of the landscape. Over the past years, data from Earth sensing satellites has become vital in mapping the Earth's features and infrastructures, managing natural resources and studying environmental change. This study tried to observe the influence of man's activities on the pattern of land use and land cover in Paikoro Local Government Area of Niger State, Nigeria. Hence, information on land use / land cover and

possibilities for their optimal use is essential for the selection, planning and implementation of land use schemes to meet the increasing demands for basic human needs and welfare. Paikoro local government has witnessed remarkable expansion, growth and developmental activities such as building, road construction, deforestation and many other anthropogenic activities since its inception in 1967, just like many other local governments in Nigeria.

Land use and land cover change has become a central component in current strategies for managing natural resources and monitoring environmental changes. The advancement in the concept of vegetation mapping has greatly increased research on land use/ land cover change by providing an accurate evaluation of the spread over time and space. In view of the crucial understanding of the influence of man's

Received 18 November, 2016

Accepted 16 December, 2016

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activities on natural resources the study had witness a lot of trespassing and violation of Town planning master planning order. Paikoro local government has witness remarkable expansion, growth and development over the past decades. The explosive influx of migrants in search of farmlands, grazing fields, construction and prospecting for mineral resources in Paikoro triggered rapid grow in population in the area. This study evaluated the effect of Land use and land cover over the twenty year in order to ascertain the anthropological influences in the area.

METHODOLOGY

Paikoro local government area of Niger State is located on latitude 9° 26' N, 9°30'N and longitude 6° 38' E, 7° 20' covering an area of 2,259.24 square kilometer and falls within the southern Guinea savannah region, with an average annual rainfall ranging between 1,100mm - 1,300mm and the mean temperature of the area is 37°C during the dry season. The geology of the area is igneous settlement and the soil is predominantly loamy soil (Obaje, 2010).

Land sat Satellite imageries are acquired from three Epoch, population figure and coordinate point of Paikoro local government area, Niger

state. This was identified through various changes that taken place in the study area. In remote sensing, adequate field knowledge is necessary in the interpretation process, it aids the researcher especially in visual image interpretation (VIP). It is used in gathering data correctly. During the exercise which was carried out in July 2016, a global positioning system and an 8.0-megapixel camera was used. The GPS aided in the collection of the right coordinates (longitude and latitude) for points identified on the study area image during pre-field check. Pictures of specific land marks were taken alongside.

This aspect involved the selection of training fields (sites) from which generalizations were made. First of all, on a Google Earth image of the location under study, important land marks representing various land uses were identified to represent different classes of land cover observed in the study area. Such locations were verified and marked on ground with a GPS during field check. This is shown in table 3.2. Ground trothing becomes a necessary part of site selection because some of the points taken on the image from Google Earth differed by a few degrees in actual location.

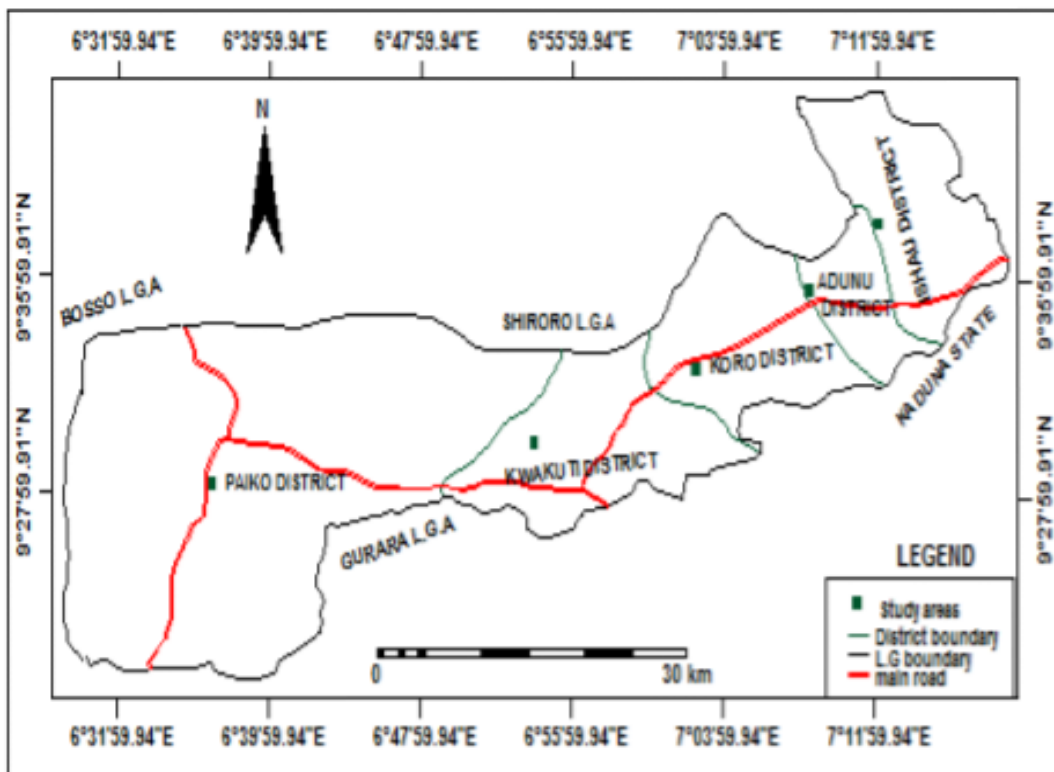


Fig. I. Paikoro Local Government Niger State Nigeria
 Source: Niger State Land and Survey.

Table 1: Coordinate of the Study Area

Land mark	Latitude	Longitude
Paiko	9 ^o 26' 00"	6 ^o 38' 00"
Kwakuti	09 ^o 23' 50"	006 ^o 54' 700'
Kaffin-koro	09 ^o 31' 00"	07 ^o 04' 100'
Adunu	09 ^o 34' 55"	007 ^o 34' 150'
Ishu	9 ^o 36' 800"	007 ^o 19' 250"

Land sat satellite images of Niger State were acquired for 1996, 2006 and 2016. Imageries were obtained from United State Geological Survey (USGS) site. All data were downloaded with projection from UTM-32. On all images, a notable feature which can be observed is the variation in vegetation cover. The Land sat type of remote sensing data has been used in Land use/land cover, change detection applications for decades (Monday and Alfold, 1979; Bukata *et al.*, 1988; Ritchie *et al.*, 1990). The multispectral capabilities of the data allow observation and measurement of biophysical characteristics of land features and the multi temporal capabilities allow tracking of changes in these characteristics over time (Colwell, 1983; Wang and Moskovits, 2001).

Table 2. Satellite sensors used.

Sensor	Year	Res.	Band used	Source
Landsat TM	5 1986	30M	2,3,4	USGS
Landsat TM	7 1996	30M	2,3,4	USGS
Landsat 8	2006	30M	2,3,4	USGS

Res. = Resolution

ERDAS Imagine 2014, an acronym for Earth Resource Data Analysis Software is a raster based software used for spatial, spectral and radiometric enhancement.

Spatial enhancement was carried out using a resolution merge model. The Resolution Merge function has two different options for re-sampling low spatial resolution data to a higher spatial resolution while retaining spectral information:

ARCGIS 10.2 based software designed by ESRI. ArcGIS provides a scalable framework for implementing GIS (Geographic Information System) for its users. ArcGIS is an integrated family of GIS software products for building a

complete GIS. More specifically, Arc Map and Arc Catalogue were used for this project. Arc Map was used for the vectorization of the images and performing overlay functions. Arc Catalogue was used in creating a personal geodatabase and shape files used in performing the overlay.

Band combination: This is also called image compositing, an enhancement technique aimed at improving both visual and digital interpretability of an image by increasing the apparent distinction between the features in the scene. Bands 2 (blue), 3 (green) and 4 (red) of 1986 image are combined. The processes are;

Image processing >Enhancement> Composite> Histogram equalization> Output image.

The same is done for all the remaining years so that at the end, 1986, 2006 and 2011 are formed as output images. Histogram equalization is chosen as compared with simple linear or linear with saturation points because of clarity and precision.

Image Subset: Satellite data image usually covers more areas than users are actually interested in, so a subset gives the section or portion of interest. This was equally carried out on ERDAS by using the shape file of the study area.

An appropriate output file name is entered (AOI "Area of Interest" in this case), then the display window shows the carved area.

1. Calculation of the area in hectares of the resulting land use/land cover types of each study years and subsequently comparing the results.
2. Overlay operations. The two methods involve the calculation of the area in hectare. And the comparison of the land cover statistics assisted in identifying change detection. And a table was developed to show the areas in hectares and the percentages change for each year (1986, 1996, 2006 and 2016) measured against each land use/ land cover type.
3. Population Analysis: To determine the population of the selected years under study, the exponential method of Population projection has been used which was recommended by National Population Commission due to its high variance

$pt = po \cdot e^{rn}$ Where po = Previous/ base year population, in this case 1991 were used.

pt = population of the present year, in this case 2006 were used.

e =exponential n = number of the year interval.

r = growth rate of the state, in this case 3.4% was used.

RESULTS

The period between 1996 and 2006 witnessed a drop in LCR at which the physical expansion of the local government area was going at against the 1996.

Although the vegetation still remains the highest, but other just increase with little percentage as shown on the table and chart.

Table: 3 Population of Paikoro

Year	Population figure	Projected
1996	20,344	33,593
2006	158,178	213,713
2016		

Source: Fieldwork, 2016

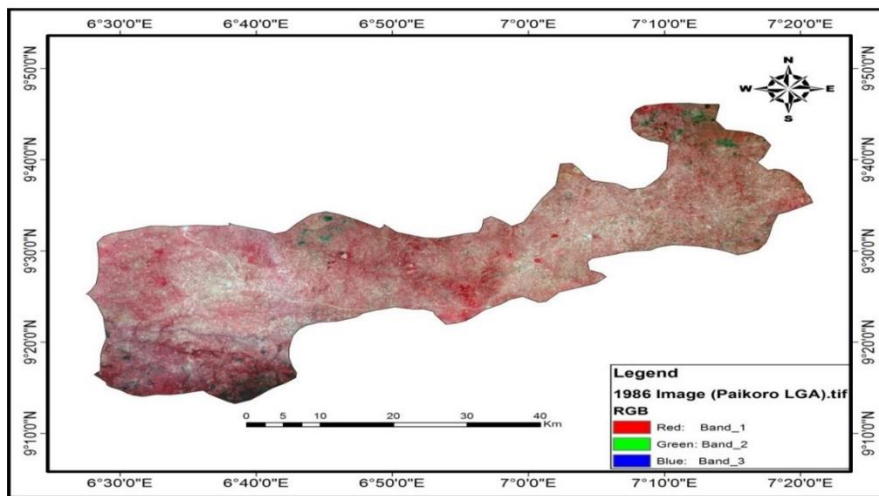


Fig 2: 1996 Landsat TM Image of Paikoro Local government

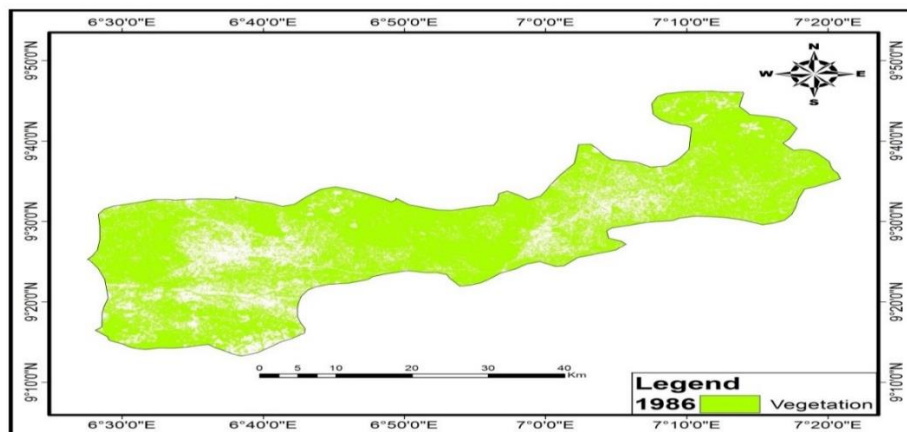


Fig 3: 1986 LULC Map of Paikoro Local government area

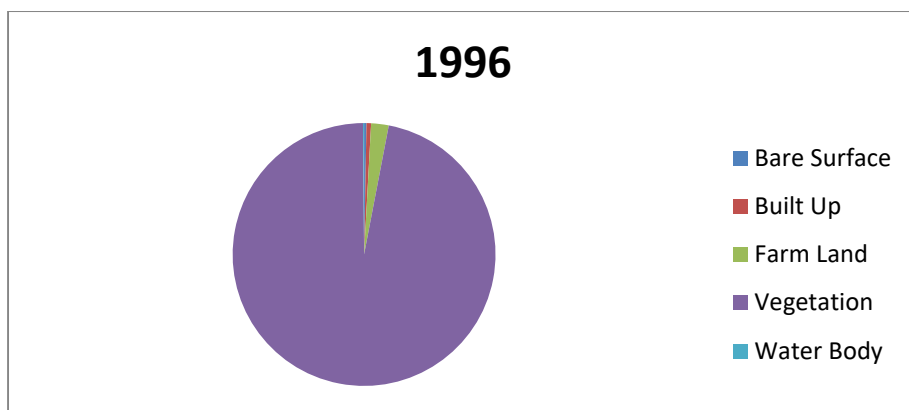


Fig 4: Pie Chart showing 1986 LULC statistics

This chart is showing the study area of 1996 in order to allow us to compare, the vegetation which has the highest value the rate of 21.22% while the lowest values are bare surface 6.45% and water body with 2.91% and again farmland is the second highest with the rate of 47.26% and followed by built-up with 12.37%.

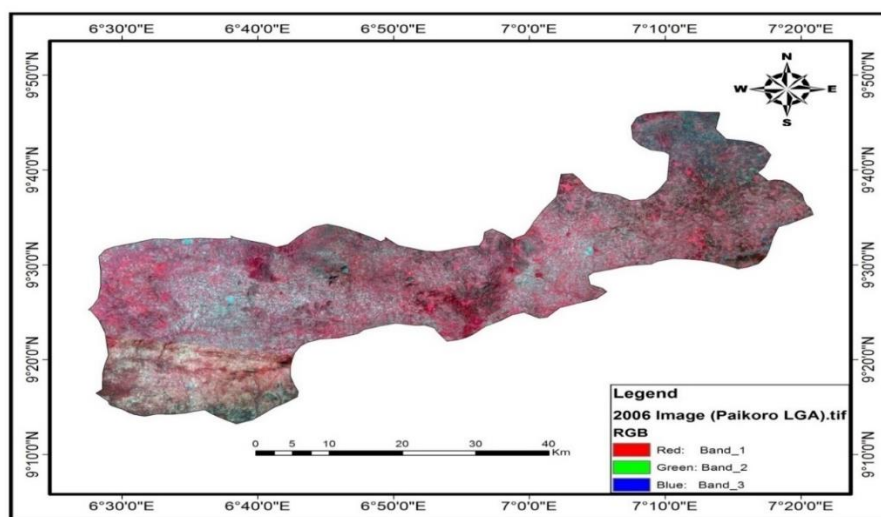


Fig 5: 2006 Landsat ETM+ Image of Paikoro Local government area.

This study area was extracted from Niger state satellite imagery of 2006 used to identify the five classes through the process of classification and changed over time.

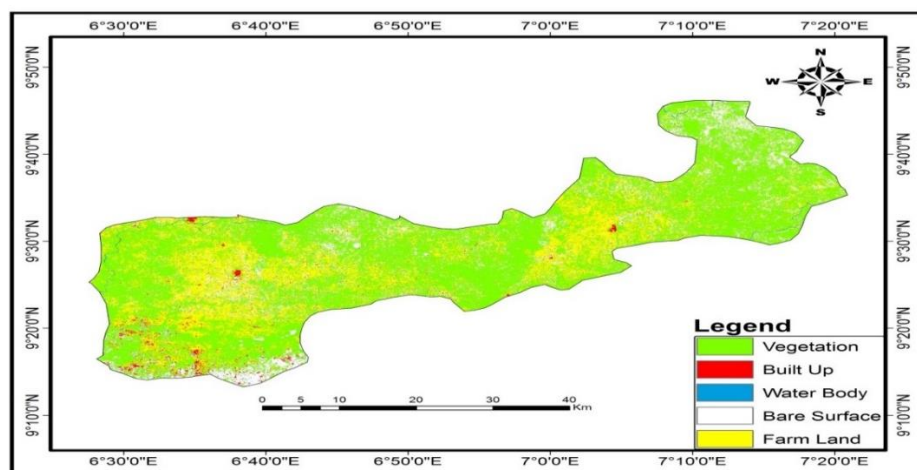


Fig 6: 2006 LULC Map of Paikoro Local government area

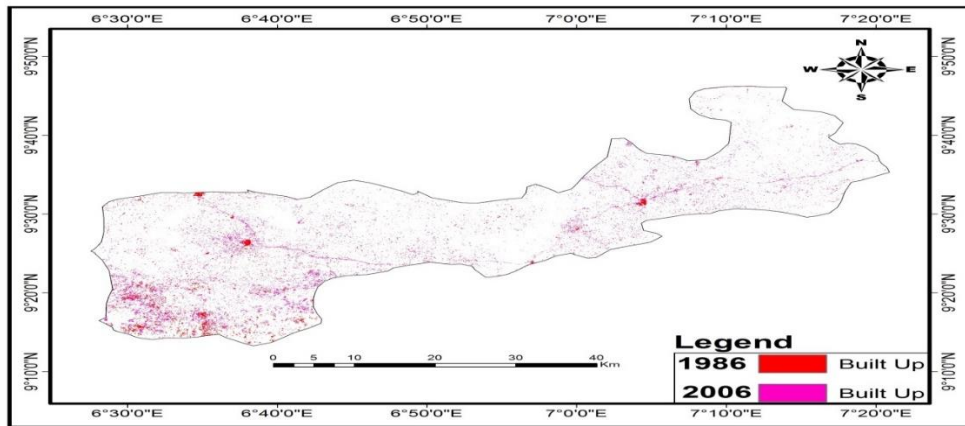


Fig 7 :1996-2006 Built up

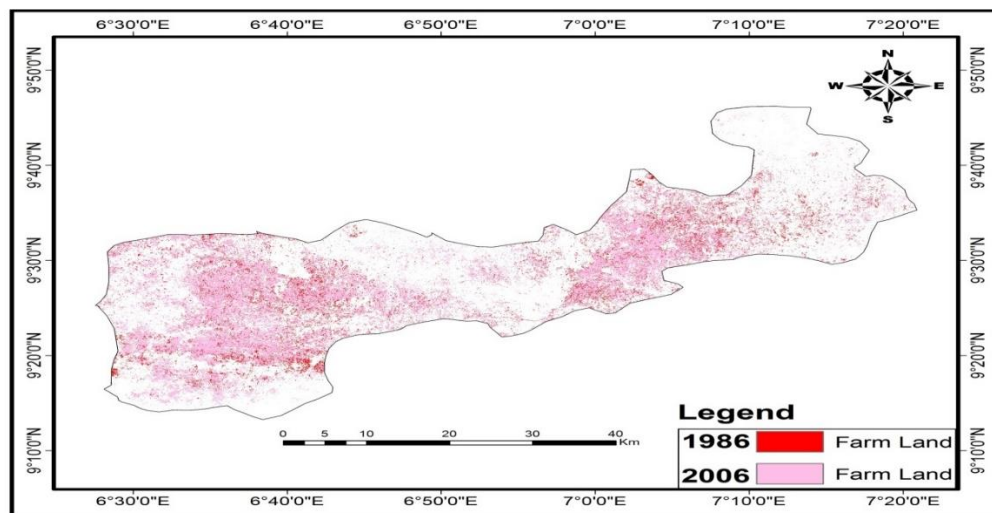


Fig. 8:1996-2006 Farm Land

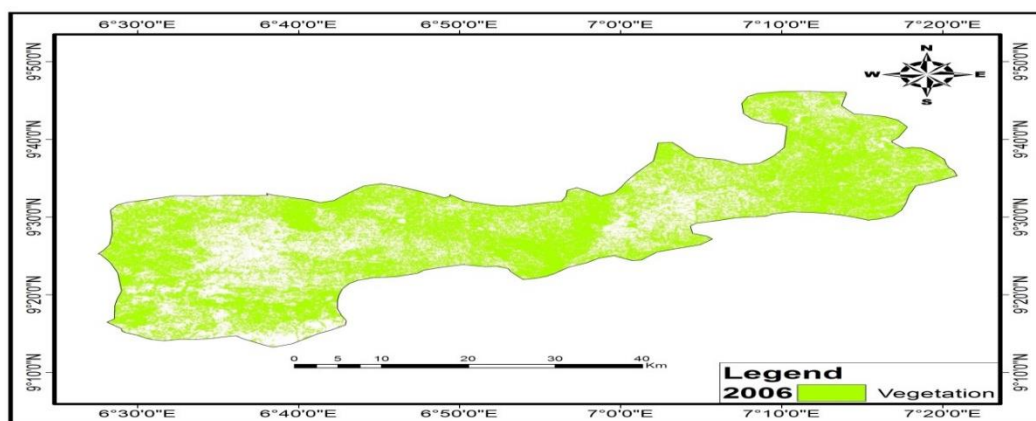


Fig 9: 2006 Vegetation

Vegetation in 2006 is gradually reducing due to anthropogenic activities such as new buildings, farming and mining that place at the rate of 36.91%

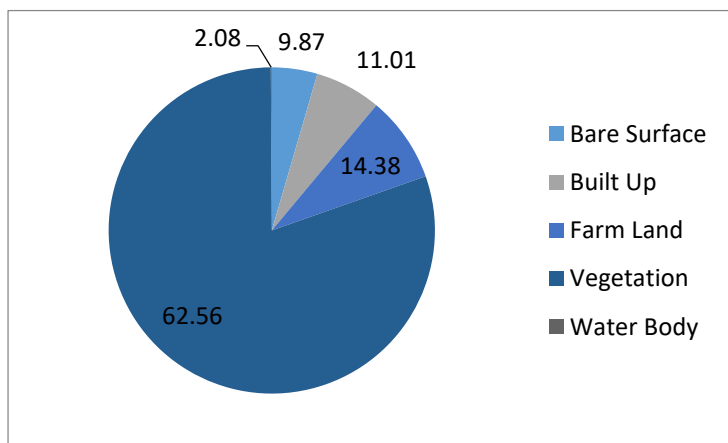


Fig 10: Pie Chart showing 2006 LULC statistics

Fig 11 – 2 depicts change in the normal course of land cover. The yearly records revealed that some of the classes identified some reduced vegetation at the rate of 62.56% while built-up increased with the rate of 11.01% and bare space decreased at 9.87%, while water body at 2.08% and farmland increase at the rate of 14.38%.

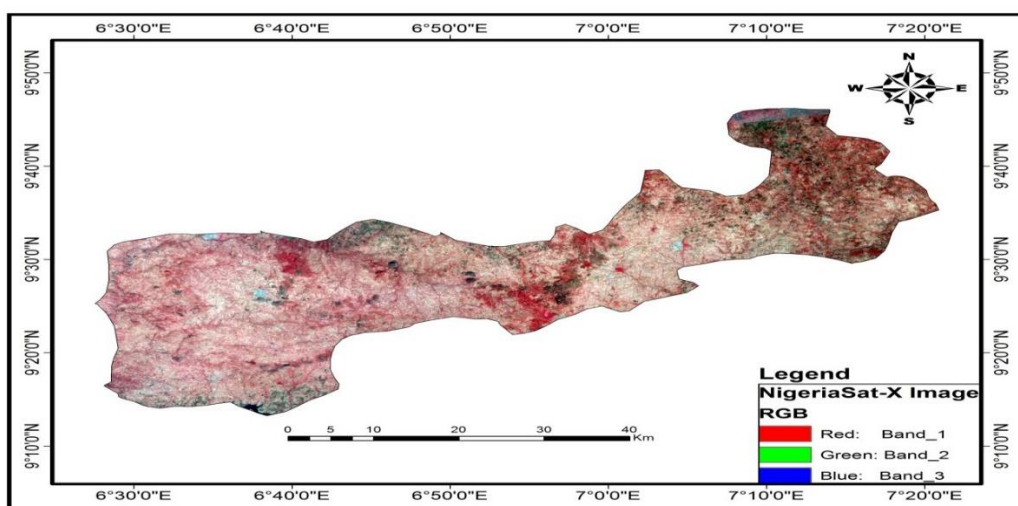


Fig 11 :2011 NigeriaSat-X Image of Paikoro Local government area

This is the map of the study area, downloaded from USGS was extracted from Niger state satellite imagery of 2011. which will be used to identify the five classes through the process of classification, in other to know the differences or change of what has change over time.

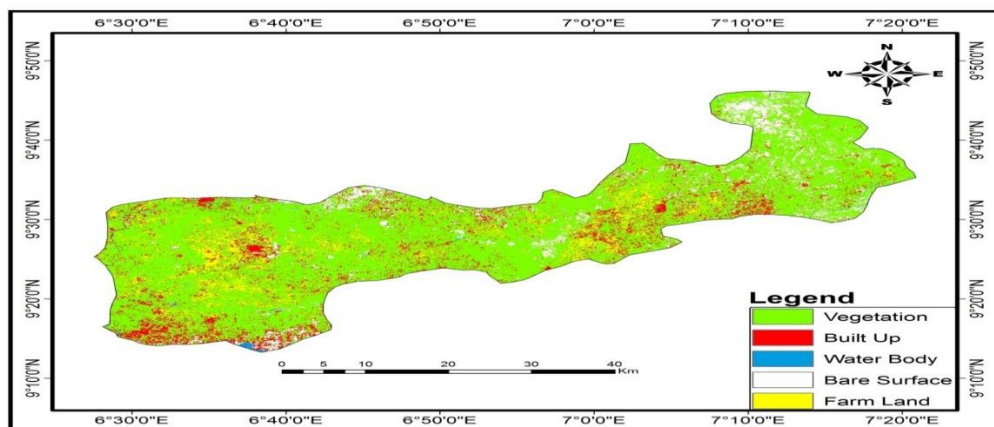


Fig 12 :2011 LULC Map of Paikoro Local government area

The landuse/ landcover map of 2011 and it shown the result of LULC classification of the study area for 2011. Five classes are here identified with the legend, which is the LULC map for 2011 for comparison between fig 4.1.1, 4.2.2 and 4.3.2 are presented for further comprehension.

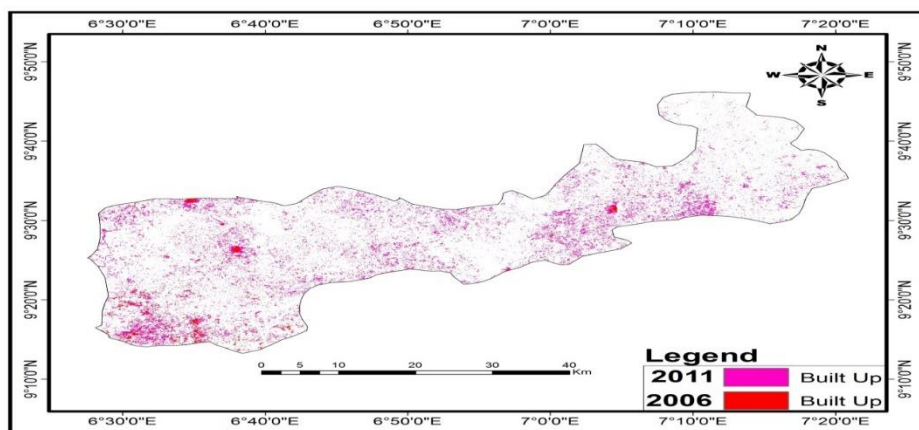


Fig 13 :2006-2011 Built Up

The change detected as of 2006-2011 in term of built-up shown that there is increase in buildings at the rate of 11.06%, due to urbanization.

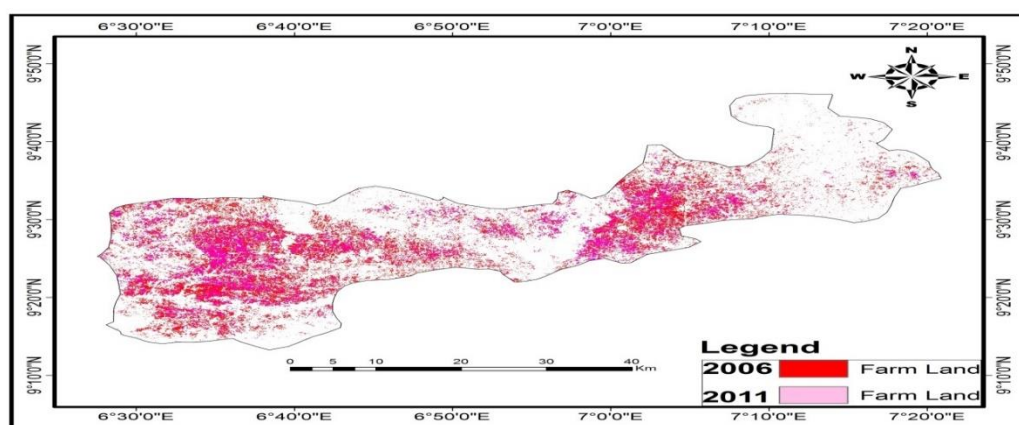


Figure 2.13 :2006-2011 Farm Land

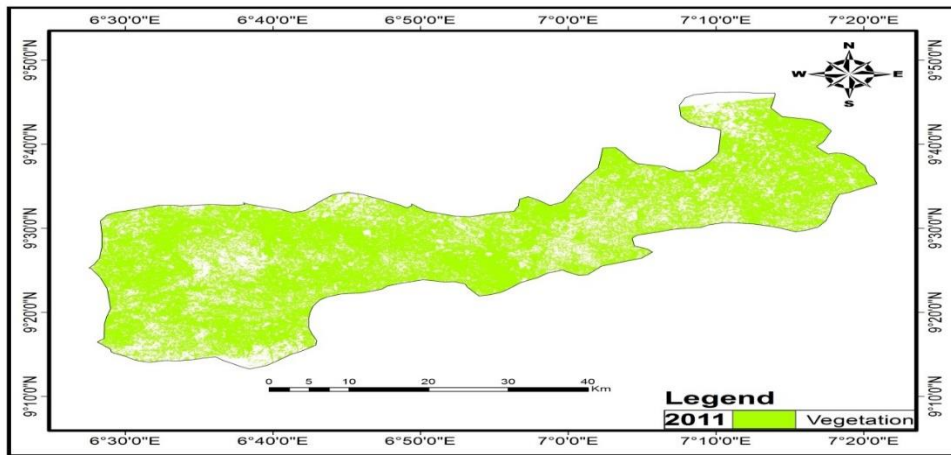


Figure 14: 2011 Vegetation

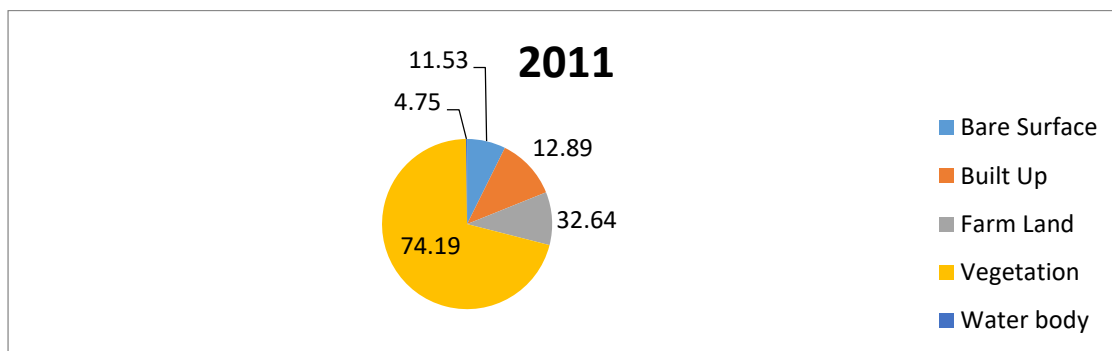


Figure 4.3.7: Pie Chart showing 2011 LULC statistics

Fig:4.2.6 and 4.3.7 depict an analysis revealing the changed that has occur between 2006 and 2011.

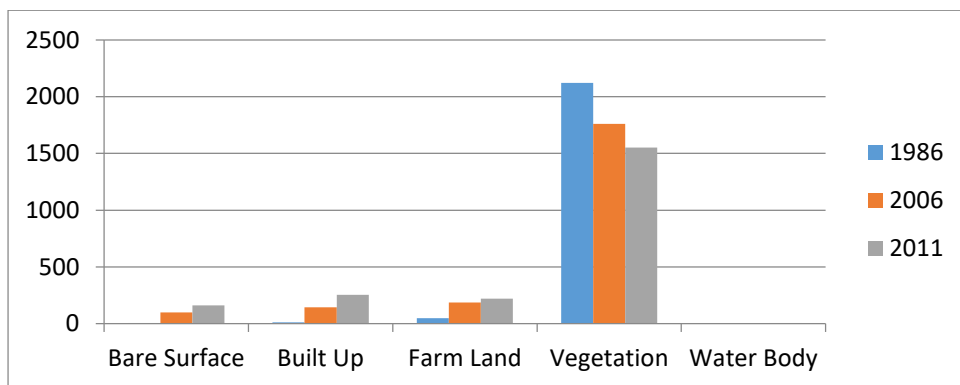


Figure 4.3.8: Histogram showing the detected changes over the LULC

Landuse/Landcover Distribution

This static land use/land cover distribution for each study year is derived from 1986, 2006, 2011 images. The figures presented represent the static area of each land use/ land cover category for each study year.

Percentages of each classes using $\frac{\text{observed changed}}{\text{Based year}} \times 100$

Table 2: Chance in Vegetation Cover

Classes	2006	2011
Bare surface	4.90	7.98
Built-up	7.2	12.6
Vegetation	87.7	77.14
Farmland	9.32	10.97
Bodies water	0.10	0.24

Source: Fieldwork 2016

DISCUSSIONS

The combination of several spatial datasets (points, lines, or polygons) creates a new output vector dataset, visually similar to stacking several maps of the same region. These overlays are similar to mathematical Venn diagram overlays. A union overlay combines the geographic features and attribute tables of both inputs into a single new output. An intersect overlay defines the area where both inputs overlap and retains a set of attribute fields for each. A symmetric difference overlay defines an output area that includes the total area of both inputs except for the overlapping area. Data extraction is a GIS process similar to vector overlay, though it can be used in either vector or raster data analysis. Rather than combining the properties and features of both datasets, data extraction involves using a "clip" or "mask" to extract the features of one data set that fall within the spatial extent of another dataset.

In raster data analysis, the overlay of datasets is accomplished through a process known as "local operation on multiple rasters" or "map algebra," through a function that combines the values of each raster's matrix. This function may weigh some inputs more than others through use of an "index model" that reflects the influence of various factors upon a geographic phenomenon.

The landuse/ landcover map of 1986 shows the result of LULC classification of the study area for 1986, five classes are here identified with the background given at 0.00 value which make it

negligible in the course of the work the main LULC identified are displayed and can be identified using the map showing bare surface 6.45%, Built-up 12.37%, farmland 47.26%, vegetation 21.22%, and water body 2.91%.

The changed detection of built-up area from 1996- 2006 shows that there is increase with about 13.46% decrease in vegetation due to process of urbanization with the rate of 36.91%

The change detected from 1996-2006 shown that the farmland reduces due to some anthropogenic activities such as building, mining and farming activities at the rate of 14.86%. Farmland increased from 2006 to 2011, with the rate of 33.42%. because, as population increase there is need for agricultural produce such as yam, maize, rice, in other to satisfy and therefore this led to increase in farming. On the other hand vegetation occupies the highest portion in 1986 and decreased in 2006 and 2011 respectively, due to farming activities and socio-economic activities that take place in the study area vegetation reduces with about 27.91%.

The change detected as of 2006 and 2011 in term of built-up shown that there is increase in buildings ,e.g ,residential, shops, schools mosques and churches e.t.c with the rate of 110.06%, bare surface increase with 61.66%,and also farmland increased with 33.52% due to increase in agricultural produce, while vegetation reduce with the rate of 74.19% because of anthropogenic activities take place

on vegetation and water body increase with 2.67%.

Change detection has shown the differences that occur within this fifteen years (1996-2011) Bare surface which is the second lowest with the rate of 4.9% in 2006 and increased in 2011 with the rate of 7.98%. The period between 2006 and 2011 Built-up in 1986 occupies the least class of the total land area and now more than farmland at about 5.4%. On the other hand vegetation occupies the highest with 87.69% in 2006 and decrease to 77.14% in 2011. Cultivation landuse occupies about 9.32% in 2006 and increase to 10.97% in 2011. It is also revealed that water body has an area of about 0.10% in 2006 and increased to 0.24% in 2011 which could have been due to climate change. The spatial growth on land use expansion cover type increases in area coverage which is as a result of development in the area. Figure 4.1.1, 4.2.1, and 4.3.1 are the land use/land cover map derived from satellite imageries of 1986, 2006 and 2009 respectively depicting different land use covering of the study area.

Conclusion and Recommendations

This study indicates that, supervised classification provided satisfactory result in term of adhering to the appropriate master planning of any giving community. The main change observed for the time period of twenty five years was the decrease in farmland area due to population influx from 1991 (20344) to 2006 (158178) and increase in Built-up areas due to urbanization. The greatest amount of urbanization is occurring around the edges of existing towns. New settlements have also appeared and grown in more recent times. The urban cover type shows the most dramatic increase in population which show that there is need for adequate planning. The lack of inadequate planning within the area has led to decreasing presence of vegetation cover type in the study area.

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