# ANALYSIS OF LANDUSE AND LAND COVER CHANGE CASE STUDY OF BAUCHI METROPOLIS

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## ABSTRACT

*Land use and land cover change is driven by human actions and changes that limit availability of products and services for human and livestock, can undermine environmental health as well. Therefore, the aim of this research was to produce land use land cover map of Bauchi metropolis. The following data were used; Landsat (7) Thematic Mapper (TM) with 30m spatial resolution of Landsat (7) Enhanced Thematic Mapper Plus (ETM +), with 30m spatial resolution and Landsat (7) Enhanced Thematic Mapper Plus (ETM +), Landsat (7) Thematic mapper (TM) with, Lansat (7) Enhance Thematic Mapper Plus (ETM+), which covered the period between 1999 to 2019. ArcGIS version 10.3 were used for the analysis. The LANDUSE and land cover distribution was determined by classifying the land Use and land cover maps into built-up land, rock outcrop, settlement, vegetation land, bare surfaces and water body using cluster unsupervised classification technique. The results obtained of the landscape change in land use and land cover of the vegetation Land Use and Land Cover status of the area. In view of the above study recommends among other things, the periodic monitoring, control and evaluation of the Land Use and Land Cover (LULCC) of the area in order to checkmate harp-hazard developments or modifications that may be detrimental to the inhabitants.*

*Keywords: Land Use, Land Cover, Imageries, Map and ARCGIS*

## BACKGROUND TO THE STUDY

Land is a specific area of the earth surface with physical entity in terms of its topography and spatial nature (Ashaye, 1987), and one of the characteristic of space that is widely recognized as significant for planning and management purposes (Anderson 1976). Land is therefore, a key element for any developmental processes that takes place on the earth surface Land in urban areas suffers unique ecological and economic pressures (Dewidar, 2004), leading to a lost in its land based. Land is the most important natural resources on which all activities are based. Land use unlike geology, is seasonally dynamic and indeed is more changing.

Information on the rate and kind of changes in the use of land resources is essential for proper planning, management and to regularize the use of such resources. Knowledge about existing land use and land cover and its trend of change is essential for various reasons. Land use data are needed in the analysis of environmental processes and problems that must be understood if living conditions and standard are to be improved or maintained at current levels. Changes in land use can be due to urban expansion, loss of agricultural land, changes in river regimes, the effect of shifting cultivation, the spread of erosion and desertification etc. Therefore, this requires not only the identification of features but also the comparison of subsequent data in order to recognize when valid changes has taken place in Bauchi metropolis.

Land cover (LC) Campbell (1996), refers to as the physical cover of the earth including natural vegetation, crops, artificial constructions that cover the land surface which, land use (LU) refers to as the actual use of the land purpose for which man exploits the land cover Omojola, (1997); land use describes the use of the land by the people usually with emphasis on the functional role of land on economic activities, man's activities which are directly related to the land Anderson, (1976).

Therefore, Land use and land cover (LULC) are treated jointly. They represent both the physical cover and the human imprints on land. Therefore, Land use land cover (LULC) is among the most important phenomenon of the earth's land surface (Lambin and Geist, 2001).

According to the United Nations Press Release (2013), the current world population of 7.2 billion is projected to increase by almost 1billion people within the next twelve years to 8.1 billion in 2025 and 9.6 billion in 2050.

As population increases, there is a corresponding increase in human alteration or modification due to increase in the diversity of functional activities (Angi 2008). Man continued to temper with the original land cover and convert it into other land

Uses in order to meet his immediate needs. Where the supply of serviced land cannot meet his demand, the tendency is often the indiscriminate conversion of other land

Uses such as those meant for agriculture land, vegetation land, crop land, forest land, bare lands, and environmental protection etc.

## STATEMENT OF THE PROBLEM

Land use and land cover changes is evident in Nigerian cities as with other developing nations of the world. Being one of the most urbanized Countries on the African continent with estimated urbanization rate of 3.5% annually, Nigeria has witnessed a tremendous urban expansion over the years World Bank, (2009). Ode (2012), asserted that the share of urban population out of the total population of Nigeria was less than 7% in 1931 but has continued to escalate over the years without mechanism to checked the trend. From 7% in 1931 to 50% in 2012.

This research therefore seeks to analyze the land use land cover change that has taken place in Bauchi metropolis between 1999 and 2019.

## AIM

To analyze land use land cover map of Bauchi metropolis.

## OBJECTIVES

Objectives of the research are:
  i.     To identify the land cover pattern of Bauchi metropolis.
  ii.    To identify the amount and the rate of change between 1999-2019
  iii.   To determine the current land cover map

## SIGNIFICANCE OF THE STUDY

The earth surface is changing as a result of natural phenomenon in human activities. For example, wildfires lighting, strike storms, pest, agro-forestry, agriculture expansion, social, economic, technological, historical factors and urban growth.

The area is perceived to be a place where one could have a better life due to its unique nature of geographical location. It also attract both private and public sector participation for the rapid and economic transformation and finally people migrate to such area to seek for better living condition.

## THE SCOPE OF THE STUDY

The study area covers the whole of Bauchi metropolis.

Area coverage is about 49,933.87m2, approximately (50,000m2) in terms of contact.

## Study area

Bauchi is geographically located between latitudes10° 19′ 55″ to 10° 20′ 58″N and longitudes 9° 50′ 50″ to 9° 51′ 29″E.
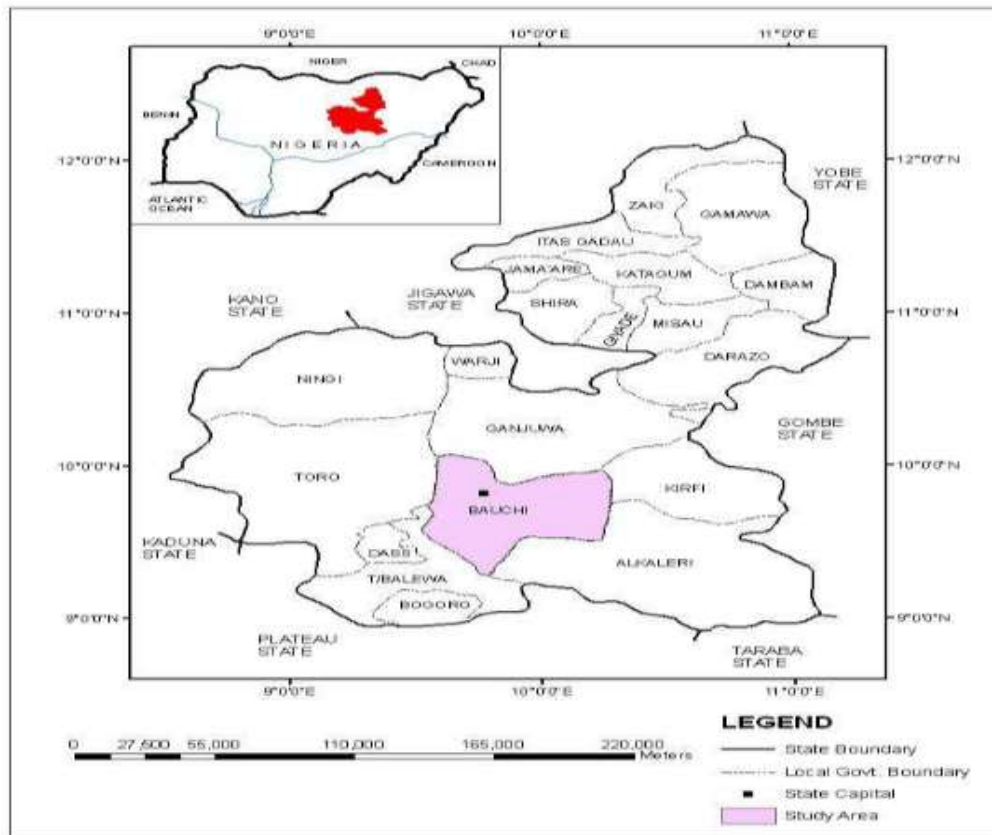


Figure1. Map of Bauchi State showing the study area,

Source: (Bauchi State Ministry of Lands, 2013).

## Methodology
### Reconnaissance
It is the first step taken before the survey commences. It consists of two parts:
   a.  Office reconnaissance
   b.  Filed reconnaissance

Office reconnaissance, this is stage whereby, the choice of instruments, hardware, software, the imagines, the cost of the research, and controller need for the research which be consider.
### Field reconnaissance
At this stage, the surveyors move out to the site, and see things by himself or herself, this involved consultation in which the elders or people around the area, to have the first hand information about the area.

### Equipment
   a.  Hardware
      -   Hp 650 Laptop
      -   Handheld GPS
      -   Microsoft word  2.07

### Data source
The source of land use land cover images were freely downloaded Landsat imagery from USGS website. The detail of satellite data are presented in the table below. The imageries were processed using ArcGIS10.3. The land use land cover change detection of the study area was analyzed for the time interval of twenty years of four years interval.

### Hardware
-HP 650 laptop
-Handheld GPS
-External disk drive (500GB)

### Software
-ArcGIS 10.3
-Microsoft Word 2007

## DATA SOURCE

To have access, and to download requested data. A set of seven files was downloaded and clipped in a folder.

Launch on-to the ArcGIS application, click on add data to add your clipped data folder. Enable the Spatial Analyst Extension, the toolbar for Spatial Analyst and Image classification and set your workspace, add the sub-set Landsat image.

## Evaluating, Normality and Partitioning

You can look to one training sample at a time or highlight many at once; for instance all of water. Once you have highlighted the training sample row, click on the histogram button; give ArcGIS a moment to build up the histogram. ArcGIS opens the histogram window to the left of the table of content. Still highlight one of the classes (said water) and click on scatter-plots, again allow ArcGIS to open a new window on the left side of the table of content, this time for scatter-plots. There are many plots because it is comparing each band to another band. Now left click on the

merge training sample button, merge the water classes into one , the scatter-plots display will change automatically and change the colour of water to blue and then it was saved, do for all other four classes and save.

Click on the statistic button to show measures that characterized your training sample data (such as mean, mode etc.) and covariance, which evaluate the correlation of values in different bands.

Close your scatter-plots window, leave all rows in the training sample manager highlighted and click on the statistic button. Allow ArcGIS to open a new window on the left side of the table of content with a statistic matrix for each of your training data rows. If satisfied with your results, save your training data one last time.

## Image classification

Left click on the down arrow next to classification and click on the option maximum likelihood classification.

A dialogue box at the top of the next page was displayed, since our image is the only one in the map document, it defaults into the dialogue box. Navigate to where we save our signature file and add to the dialogue box, name the out

file and leave the rest of the information as default settings. Click on OK, the new file is automatically added to the Table of content and map document window. There is a need to set the colours and do a Reclassify.

Set the colours to correspond with the bands of the classified data and then use the Spatial Analyst tools/ Reclassify to classify into 5 informational classes i.e. Settlement, Vegetation, Rock outcrop, bare surface and Water.

Below are the classification scheme.

### Table 1

**Classification Scheme**

| CODE | LAND USE/LAND COVER CATEGORIES | DESCRIPTION |
|---|---|---|
| 1 | Settlements | Land used for residential and building of urban infrastructures such as roads, schools, railways etc. |
| 2 | Rock outcrop | Land used as cropland, agricultural plantation such as farmlands and orchards etc. |
| 3 | Vegetation | Lands covered natural vegetation that is predominantly grasses, shrubs and grass-like plants and natural forest |
| 4 | Water body | Streams, Rivers, dams and ponds |
| 5 | Bare land | Exposed soils, land devoid of vegetal cover |

**Source:** The Researcher (2020)

## RESULTS AND DISCUSSIONS
### Land use land cover map
Red, green and blue band combination was used to display stacked images in the standard colour composite. Spectral class combination to display images frequently varies.

The land use-land cover maps produced by integration of remotely sensed image classification and corresponding GIS editing have provided important Land Use and Land Cover (LULC) information for this research.

Analysis of 1999 imagery has been summarized in Figure2, Figure 3 and Table 1.

It is shown that the major share of the land area was covered by different types of Land among which vegetation comprised the maximum of 48.2% covering 137140290Sqm, followed by Bare-surface 33.5% covering 43082552.25Sqm. Other Land Use Land Cover features, namely settlement, Water and Rock outcrop comprised 3.70% covering 8070516Sqm, 2.3% covering 4921422.75Sqm and 12.3
% covering 16777023.75Sqm respectively of the study area's total extent of 209,991,804.75Sqm.
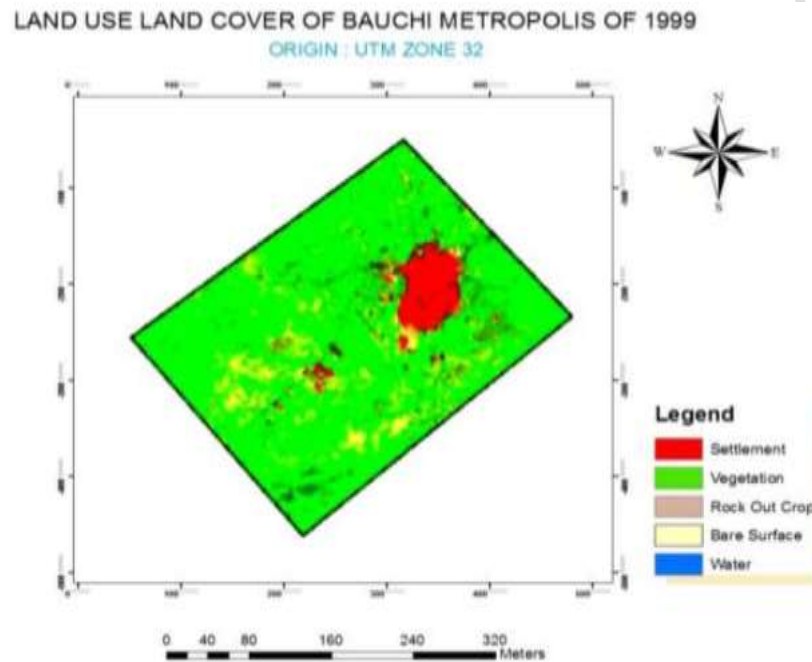


LAND USE LAND COVER OF BAUCHI METROPOLIS OF 1999
ORIGIN : UTM ZONE 32

Figure 2: classified land use land cover map of Bauchi metropolis.

Table 2    Land use and cover change of Bauchi metropolis.

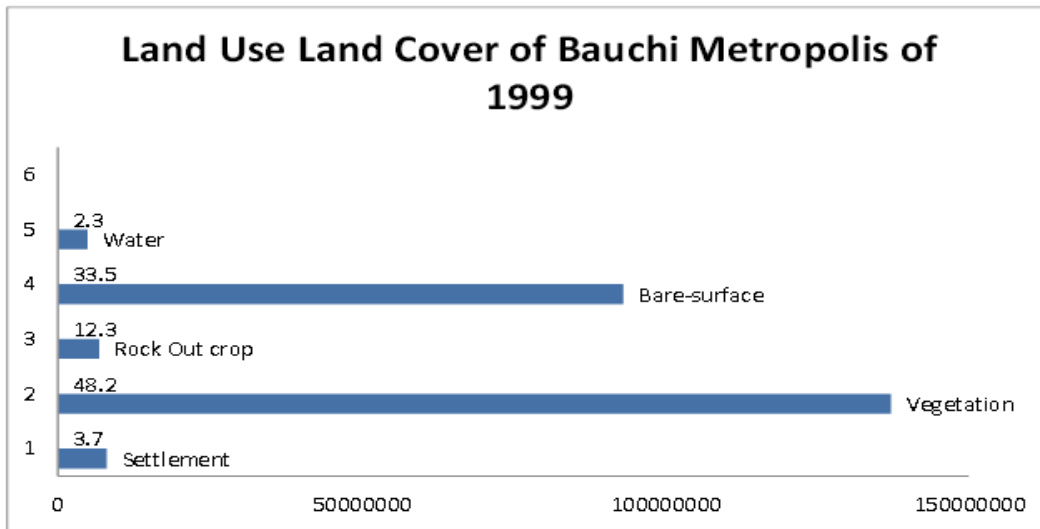| FID | Land cover Sqm | Percentage Cover % | Land Uses |
|---|---|---|---|
| 1 | 8070516 | 3.70 | Settlement |
| 2 | 137140290 | 48.2 | Vegetation |
| 3 | 16777023.75 | 12.3 | Rock Outcrop |
| 4 | 43082552.25 | 33.5 | Bare Surface |
| 5 | 4921422.75 | 2.3 | Water |

**Source: Researcher (2020)**

Figure 3. Land Use Land Cover Bar chart.
Source: Researcher (2020)

Figure 4 Figure 5 and Table 4 display the output generated from the analysis of 2004 Landsat imagery. As in the 1999 analysis, Vegetation comprised the dominant portion 44.4% covering 87271200Sqm of the land area among which Bare Surface covered 30.7% covering 73841400Sqm, followed by Rock outcrop 10.7% covering 24647400Sqm, Settlement 12.5% covering 20641500Sqm, and Water 1.7% covering 3555000Sqm respectively of the study area's total extent of 209,776,500Sqm.
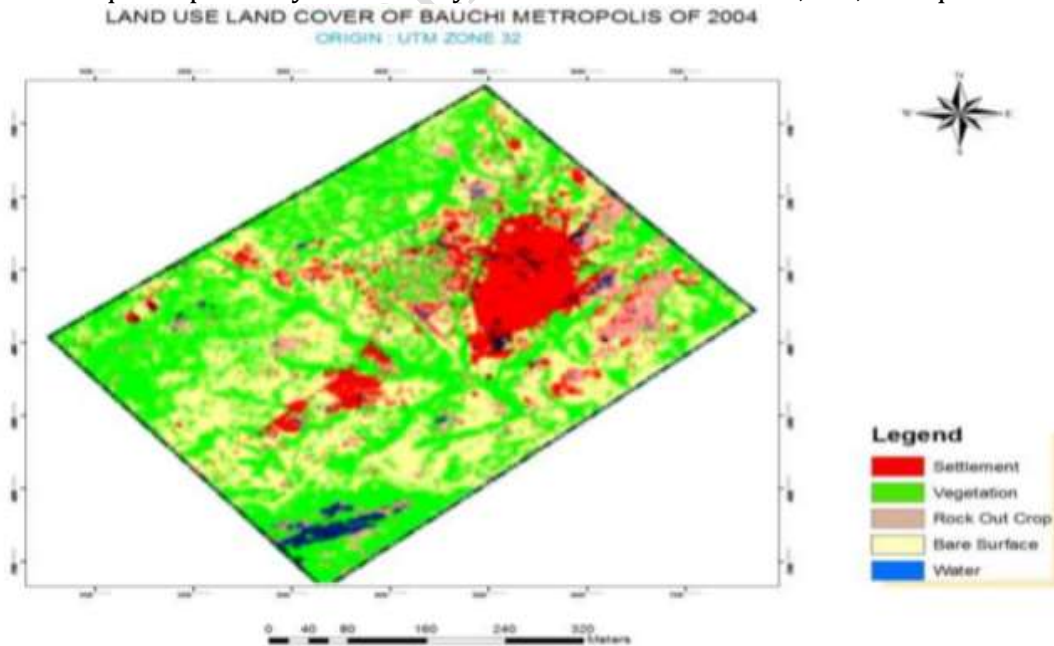


Figure 4 Classified Land Use Land Cover of Bauchi metropolis.

Table 5: Land use land cover change of Bauchi metropolis.

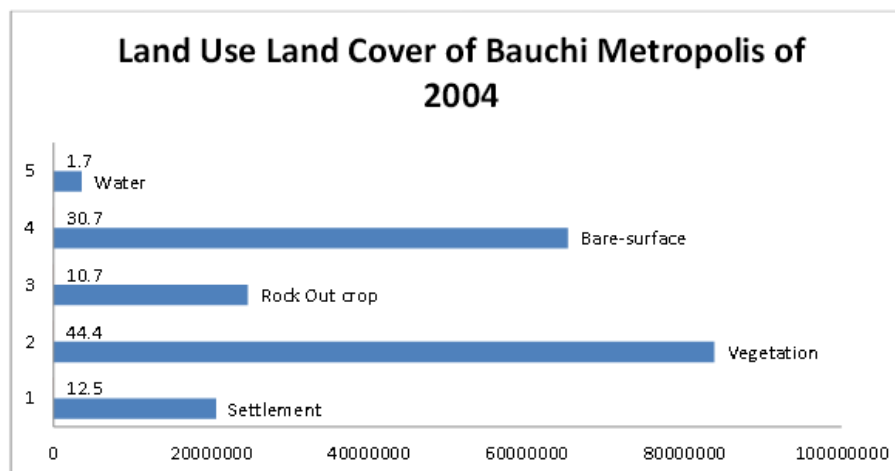| FID | Land cover Sqm | Percentage Cover % | Land use |
|-----|----------------|--------------------|----------|
| 1 | 20641500 | 12.5 | Settlement |
| 2 | 24647400 | 44.4 | Vegetation |
| 3 | 73841400 | 10.7 | Rock Outcrop |
| 4 | 87271200 | 30.7 | Bare Surface |
| 5 | 3555000 | 1.7 | Water |

Source: Researcher (2020)



Figure 5. Land Use Land Cover Bar chart

Source: Researcher (2020)

Analysis of 2009 Landsat imagery is displayed in Figure 6, Figure 7 and Table 6.

The dominant land use was the Vegetation comprising 40.7% covering 87696000Sqm of the study area, followed by Bare-surface 28.9% covering 73115100Sqm, Settlement 20.6% covering 26550900Sqm, Rock outcrop 9.3%covering 21228300Sqmand Water 0.65% covering 1366200Sqm respectively of the study area's total extent of 209,956,500Sqm.
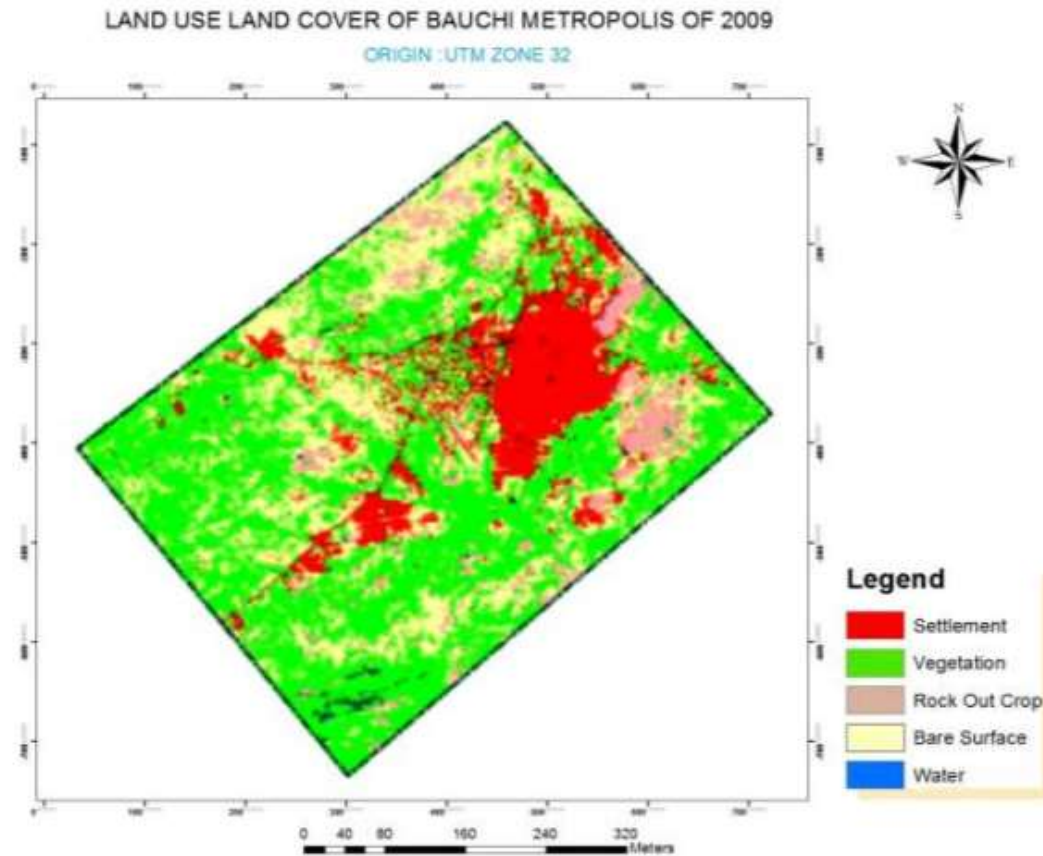
Figure 6.Classified Land Use Land Cover map of Bauchi metropolis.
**Source: Researcher (2020)**

Table 6. Land use land cover change of Bauchi Metropolis.

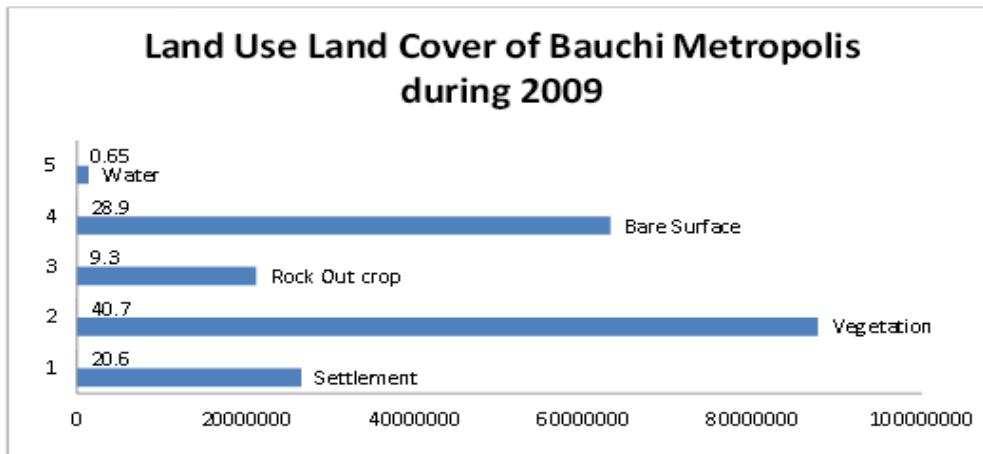| FID | Land cover Sqm | Percentage Cover % | Land use |
|---|---|---|---|
| 1 | 26550900 | 20.6 | Settlement |
| 2 | 87696000 | 40.7 | Vegetation |
| 3 | 21228300 | 9.3 | Rock Outcrop |
| 4 | 73115100 | 28.9 | Bare Surface |
| 5 | 1366200 | 0.65 | Water |

**Source: Researcher (2020)**

Figure 7. Land Use Land Cover Bar Chart.

**Source: Researcher (2020)**

Analysis of 2014 Landsat imagery is displayed in Figure 8, Figure 9 and Table7. The land use Vegetation comprising 35.1% covering 101825100Sqm of the study area, followed by Settlement 37.4% covering 42786900Sqm, which is the dominant, Bare-surface 20.1% covering 33377400Sqm, Rock outcrop 7.4% covering 32192100Sqm and Water 0% covering 0Sqm respectively of the study area's total extent of 210,181,500Sqm.
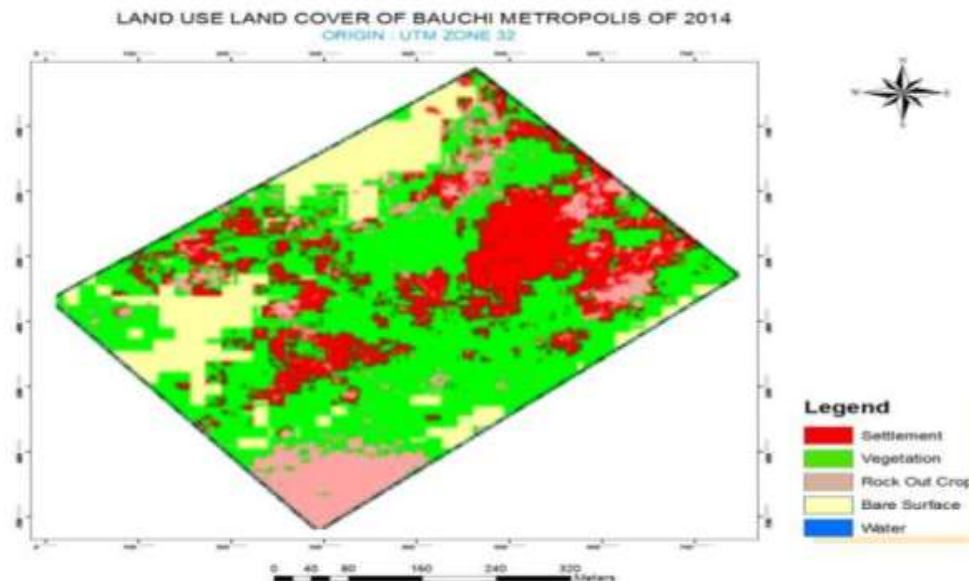


Figure 8. Classified map of Bauchi metropolis.

**Source: Researcher (2020)**

Table 7. Area and percentage share of Bauchi metropolis.

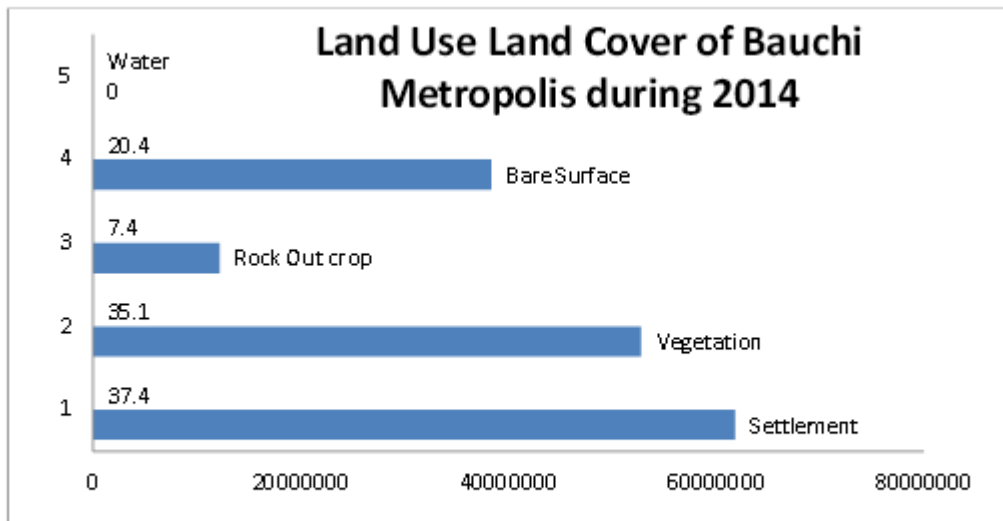| FID | Land cover Sqm | Percentage Cover % | Land use |
|-----|----------------|--------------------|-----------| 
| 1 | 42786900 | 37.4 | Settlement |
| 2 | 101825100 | 35.1 | Vegetation |
| 3 | 32192100 | 7.4 | Rock Outcrop |
| 4 | 33377400 | 20.1 | Bare Surface |
| 5 | 0 | 0 | Water |



Figure 9. Land Use Land Cover Bar Chart

**Source: Researcher (2020)**

Analysis of 2019 Landsat imagery is di splayed in Figure 10, Figure 11 and Table 7. The dominant land use was the Settlement comprising 50.3% covering 79875000Sqm of the study area, followed by Bare-surface 15.9% covering 66963600Sqm, Vegetation 27.7% covering 43103700Sqm, Rock outcrop 5.9% and Water 0.2% covering 469800Sqm respectively of the study area's total extent of 210,181,500Sqm.
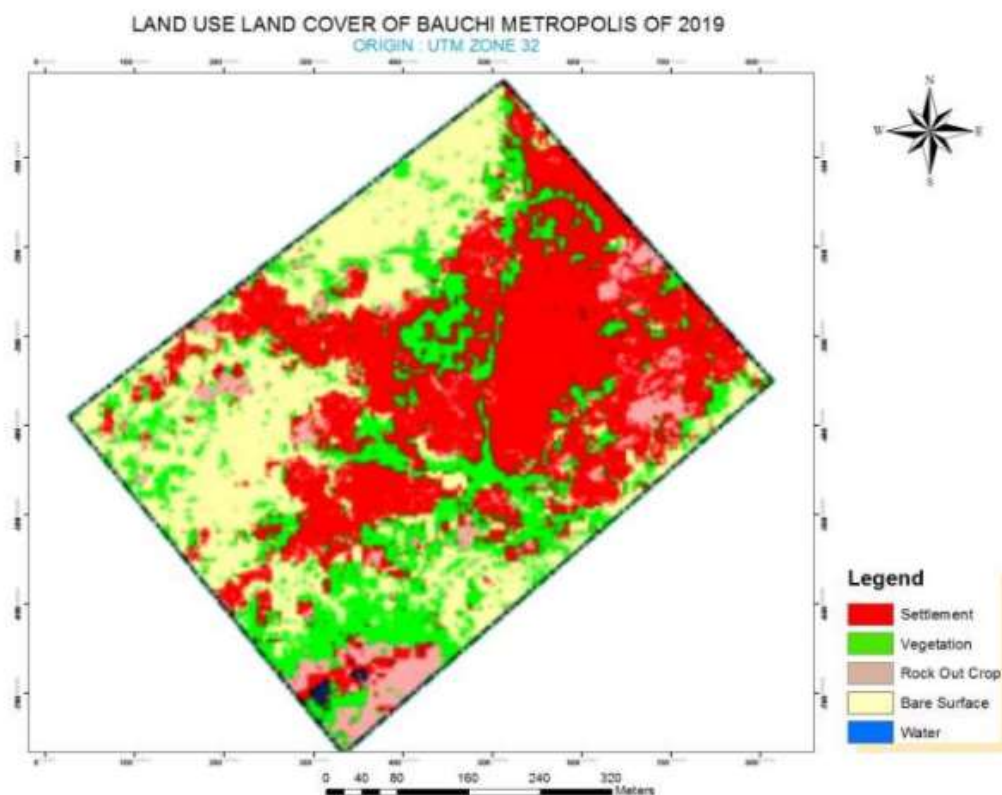
Figure 10. Classified Map of Bauchi Metropolis

**Source: Researcher (2020)**

Table 8. Area and percentage share of Bauchi Metropolis.

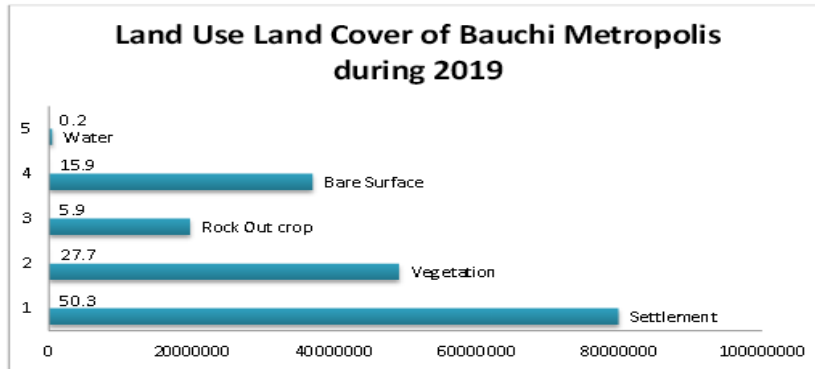| FID | Land cover Sqm | Percentage Cover % | Land use |
|-----|----------------|--------------------|----------| 
| 1 | 79875000 | 50.3 | Settlement |
| 2 | 43103700 | 27.7 | Vegetation |
| 3 | 19769400 | 5.9 | Rock Outcrop |
| 4 | 66963600 | 15.9 | Bare Surface |
| 5 | 469800 | 0.2 | Water |

Figure 11. Land Use Land Cover Bar Chart

**Source: Researcher (2020)**

The change of settlement, vegetation, bare-surface, water and rock outcrop areas covered for the present study was presented in Table; there was several of change in different land cover types.

The magnitude of the land use and land cover distribution was further obtained by subtracting the area coverage of the Land uses in the generated land-use/land-cover maps of the former from the latter; that is, (Reference year –The base year).

For example, the area in Sqm in 2004 -the area in sqrm$^2$ in 1999. While, the annual rate of change of land use and land cover was determined by dividing the magnitude by the number of years between periods multiply by 100%.

Mathematically;

Reference year –Base year = Growth in hectares.

Where:

Reference year = the latter study year or period e.g. 2014.

Base year = the former study year or period e.g. 1990.

Rate of change = {(Growth in hectares/No of years between periods) X 100%)}

Table 9.land use and land cover change of Bauchi metropolis during 1999-2019

| CLASSES | Area | % | Area | % | Area | % | Area | % |
|---------|------|---|------|---|------|---|------|---|
| LULC | 1999-2004 | | 2004-2009 | | 2009-2014 | | 2014-2019 | |

**Source: Researcher (2020)**

Settlement +12570.9 +155.8 +5909400 +28.6 +16236000 +61.2 +37088100 +86.7

Vegetation -63298.9 -46 +13854600 -18.8 +14129100 -16.1 -58721400 -57.6

Rock +7870376.3 -46.9 -3419100-13.9 +10963800 -51.6 -12422700 -38.6

Bare land +441886.75 +102.6 -14156100 -16.2 -39737700 -54.3 +33586200 +100

Water -1366422.72 -27.8 -2188800 -61.6 0 0 +469800+94.2 Change detection of land use land cover of 1999 -2019

The rate of change of settlement, vegetation, bare surface, rock outcrop and water body cover for the study area have been presented in Table 9. This result indicated that though recourses are fixed, there was various rate of change in different land cover types and variables among them.

The analysis calculated manually indicated that between 1999 –2019, settlement has increased with the rate of 71804484 Sqm caused by the outflow of vegetation, Rock out crop and Bare-surface and water. In the same period vegetation, Rock Outcrop, Bare Surface and water decreased by 94036590 Sqm, 2992376.25 Sqm and 23881047.75Sqm and 4451622.75 Sqm respectively.

Table10. Change detection in land use land cover of Bauchi metropolis 1999-2019.

| Area (sqm2) | | Percentage (%) |
| --- | --- | --- |
| Settlement | +71804484 | 88.9 |
| Vegetation | -94036590 | 68.6 |
| Rock outcrop | -2992376.25 | 17.8 |
| Bare surface | -23881047.75 | 55.4 |
| Water | -4451622.75 | 90.5 |

## SUMMARY, CONCLUSION AND RECOMMENDATIONS
## SUMMARY OF THE RESEARCH FINDINGS

The results revealed that settlement witnessed a tremendous increase in its area coverage over the study periods while vegetation, bare surfaces, water bodies, and rock outcrop witnessed a decrease in their area coverage. For example, settlement occupied 3.20% of the total area in 1999; increased to

12.5 % in 2004, and further increased to 20.6% in 2009, and further increased to 35 .4% in 2014 and lastly increased to 50.3 % in 2019. Therefore, settlement recorded an overall increase of 122.1% with an annual growth rate of 122.1% from 1999 to 2019.

In a similar manner, vegetation land use occupied 49.2% in 1999, decreased to 44.4% in 2004, and further decreased to 40.7% in 2009, decreased to 35.1% in 2014 and lastly decreased to 27.7% in 2019 respectively. On the other hand, are Surfaces which resurfaces in the study area, 39 occupied an observable land area of 33.5% in 1999 and decreases to 15.9% in 2019. While water Body which had the lowest proportion of land coverage occupied 2.3% in 1999 and slightly decrease to 0.2% in 2019. Rock outcrop which has a proportion of land coverage of 12.3% in 1999 and decreases to 5.9% in 2019. And in a similar manner, settlement occupied a total land area of 3.20% in 1999 and increased to 50.3% in 2019. The study also revealed that settlement is the major source of encroaching into other land uses.

## CONCLUSION

This research work demonstrates the ability of GIS and Remote Sensing technique in capturing spatial-temporal data for analyzing land use and land cover changes. Land-use and land-cover change is evident in Bauchi metropolis as revealed by the analysis. All the land uses in the study area have change dramatically in the second period (2004 and 2009) from their original coverage. The main changes observed is increase in urban land use (122.1%) between 1999 and 2019. It was also established that most of the land use and land cover changes are driven by human actions which in-turn affects man.

The analysis of the results revealed that most of the land use and land cover change took place during the 2004 and 2019 period, a period which coincided with a period when Bauchi metropolis experienced frequent and drastic growth in settlements. The analysis also revealed that urban land use is the leading course of encroachment into other land uses.

## RECOMMENDATIONS

Having revealed by the study that land use and land cover is evident in the study area; the following recommendations should be adhere to:

i.      There should be periodic Modelling of land use and land cover changes for formulating effective environmental policies and management strategies.

ii.     Monitoring, control and evaluation of the Land Use and Land Cover (LULCC) of the area should be done regularly so as to checkmate the harp-hazard developments or modifications that may have negative consequences on the inhabitants.

iii.    Encouragement of building of vertical structures should be upheld by the relevant authorities in order to minimize the amount of urban land use encroachment into other land uses.

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