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Mapping of Land Use and Land Cover Change and Its Trends in Makurdi, Benue State, Nigeria

IBRAHIM, ABAKPA DAVID[1], ANTHONY I. G. EKEDEGWA[2]
[1]*Geography and Environmental Management University of Abuja*
[2]*Nigeria Atomic Energy Commission*

Abstract -This study employed geospatial techniques to capture the process of land conversion taking place. The objectives include mapping the land use types. The methodology involved geospatial techniques which used remote sensing and GIS techniques to identify the past and current condition of land use change occasioned development activities in the Makurdi Metropolis for 1999, 2009 and 2019. The result shows that overall, there was progressive and increasing change in a built-up area and water body categories, at (17.00%) and (1.73%) respectively during the period of study. However, vegetation cover, farmland, bare land and wetland decreased by (2.51%), (3.51%), (4.61%) and (8.08%) respectively. Residential buildings are fast encroaching on the flood plain of River Benue in Makurdi. There is a need to sensitize the residents on the danger of flooding and provisions should be made to relocate those already occupying the location.

Key Word: Land Use change, Mapping, Trend, Benue State

I. INTRODUCTION

Land use change is universal; it majorly claims open land around the urban hinterland. However, there is little scientific understanding of land use change patterns as they affect cultivated areas in some developing countries like Nigeria. However, land use change is the introduction of land for different uses caused by natural and human activities. It often claims arable land in areas where it is mostly observed. As elucidated by Enoch, John and Jonathan (2020), "the world's population is becoming increasingly urbanised; cities keep increasing". However, the socioeconomic footprint of the cities is much larger than that of rural areas due to land use change. Countries in East Asia, North America and Europe have all lost cultivated land during their periods of economic development, which are mostly caused by socioeconomic factors which include population growth, urbanization, exploitation of natural resources and many others which may eventually last for a short or long term.

While urban centres are growing in population and areal extent, the surrounding open/agricultural lands are undergoing rapid transformation, coming under increasingly intense pressure through construction to provide space for an array of urban land uses (Mohammed, 2015). Thus, with rapid population increase and a finite urban land area therefore, available land per individual shrinks pitilessly with tremendous effects such as low or reduced food production, low agricultural produce, ecological degradation, and environmental and socioeconomic challenges (Heimlich and Anderson, in Mohammed, 2015). It is also evident that the rapid rate of urbanization in Africa and the consequential explosion of the urban population have not been matched by a corresponding change in social, economic and technological development, resulting in a nearly stagnant economy and negligible growth of industrialization (Oyeleye, 2013).

In Nigeria, like most other developing nations, a high rate of urbanization causes land use change and it is a consequence of the "push" of the rural areas and "pull" of the urban centres (Aluko, 2013). The push and pull in this regard concerning the population can be traced to the effects of regional imbalances as most rural areas in Nigeria lack social infrastructures like roads, electricity, tap-borne water, good housing facilities and other administrative activities that would have served as a pull factor in the environment. As a result, the rural dwellers abandon their agrarian community, where farming is the primary duty, to the urban centres where most of the activities are non-agricultural which changes land use as fast as possible in Makurdi and its nearby villages.

As the population increases, besides other urban activities in Makurdi, it becomes pertinent to map the environmental resources to monitor the level of changes over the years. In recent times Geographic Information system (GIS) technique and remote sensing data have become spectacularly useful tools for mapping natural resources, including vegetation

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and land use/cover changes over geographical areas thereby overcoming many limitations of traditional surveying techniques to obtain a continuous and extensive inventory of ecosystems (Abu, Tukur and Zemba 2019). It is in light of this that geospatial technology were employed to study the land use change for the period of twenty years as urban development in Makurdi requires more scholarly attention.

II. METHODOLOGY

Location and Size

Makurdi is located between latitudes $7^0$35' N and $7^0$50'N and longitudes $8^0$22'E and $8^0$40'E. As shown in Fig 2.1, Makurdi Town as currently defined politically covers an area of 820km^2.

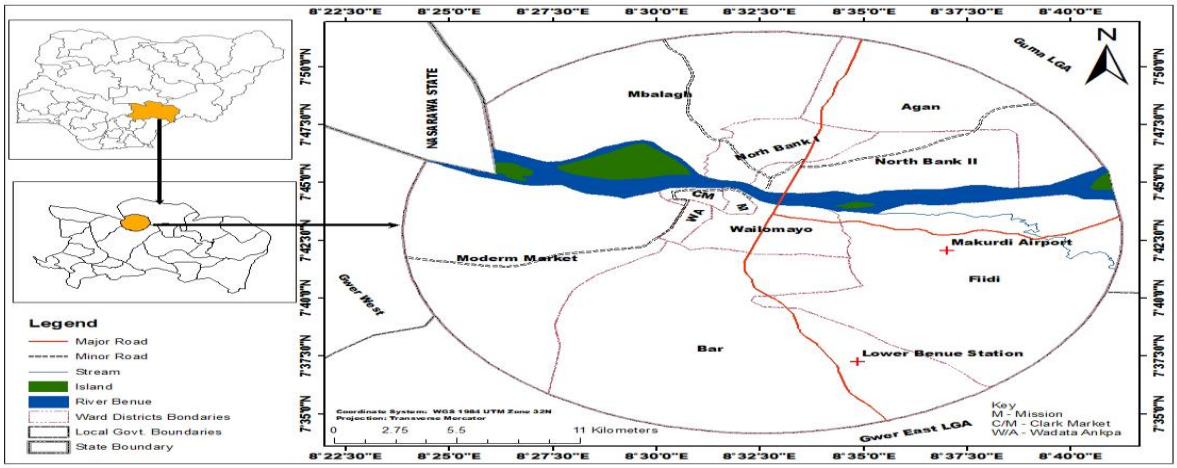

Figure 2.1: Location of the Study Area

Source: Adapted and modified from the administrative Map of Makurdi

Types and sources of data

The data for the study was collected from both primary and secondary sources. The primary sources consist of field observation and GPS locations collected during the fieldwork. The secondary sources consist of literary materials like journals, newspapers, textbooks, World Bank publications etc. Others include a base map of Makurdi LGA and satellite imagery covering the study are shown in Tables 1 and 2

Table 1: Types of Map

Map	Types	Date of Production	Source	Scale
Landuse/landcover map	Secondary	1999	Military Air Force Base Makurd	1:1000000
A base map of Makurdi LGA	Secondary	2019	Benue State Ministry of Land and Survey	1:50000

Source: Author 2019

Table 2: Land Sat Images Used

Landsat Sensor	Path/Row	Date of Imagery	Source	Resolution
TM (Band 1-7)	188/55	July 5, 1999	National Space Research and Development Agency, Abuja	30m
ETM$^+$(Band 1-7)	188/55	August 4, 2009	National Space Research and Development Agency, Abuja	30m
OLI$^+$	188/55	July11, 2019	Download from Global Land Cover Facility (GLCF) database.	30m

Source: Author 2019

Materials for Geospatial Analysis

The following materials and software were used:

I. A base map of Makurdi LGA obtained from the Ministry of Land and Survey.
II. ARC GIS 10.1 software was used for carving out boundaries from the Benue state imagery. It was also used for display, subsequent processing and enhancement of image like manipulation, feature identification, recognition and classification
A Garmin Etrex 32 handheld (GPS) was used to record coordinates for training sites.

Use of Geospatial Technology to Detecting Land Use

Many types of change detection methods for multi-spectral image data are available. They can be classified into three categories: characteristic analysis of spectral type, vector analysis of spectral changes and time series analysis. The most popular and the one adapted for this study is the time series analysis, whose aim is to analyse the process and trend of changes by monitoring ground objects based on remote sensing continuous observation data (Adzandeh, et al., 2014).In this study, a time series of LULC data sets was produced from multi-spectral Landsat TM/ETM^{+}/OLI^{+} imagery, which was acquired for three separate dates.

Classification Scheme

The first step of land use and land cover change detection was to identify the land use and land cover class of interest as shown in Table 4.3. As adapted from Andersen *et, al.,* (1976) classification scheme, six classes were adopted for this study with modifications considering the following.

- The objective of the study
- Geography of the study area
- Mutual exclusivity of categories (i.e. defining each category clearly).
- Spatial resolution of the multi-temporal satellite imagery.

Table 4.3: Land Use/Land Cover Classification Scheme Adopted

Land Use	Description
Built-up Area	The built-up Area comprises all developed surfaces including residential, commercial, and industrial complexes, public and private institutions, recreational areas, airports, Factories, Interstate highways, and road networks that link most of the areas together. Other places like cemeteries constructed surfaces comprising of concretes, metal, asphalt, roofing and other building materials.
Vegetation,	Areas covered with plants of various species. This category includes grassland and non-agricultural trees and shrubs they are mostly wild plants. Grassland here refers to land where the vegetation is predominantly grasses or grass like plants. It also includes lawn parts, golf courses and other herbaceous-converted landscape areas. The woody land includes forest land, shrubs deciduous green areas.
Farm Land,	Is land used primarily for the cultivation of food and fibre, it includes cropped areas, fallow land and plantations (Orchards, nurseries, vineyards etc.), harvested areas and herbaceous croplands.
Bare Surface,	Includes open surfaces, rocky outcrops, sandy areas, strip mines, quarries, gravel pits, silt etc. Exposed soil devoid of vegetal cover, that is open spaces.
Water body,	includes areas covered with water bodies such as rivers, streams, lakes, floodplains, and Reservoirs it also includes artificial impoundment of water like dams used for irrigation, flood control, municipal water supplies, recreation, etc. It also involves an area of water which is covered with less than 30% of vegetation
Wetland.	an area where water covers the soil either at or near the surface of the soil all year or for varying periods during the year, including during the growing season.

Source: Adapted and modified from Anderson et al., (1976)

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Land Use and Land Cover Change Detection Analysis

Change detection techniques were used to analyse land use change, Statistical tables show information about the total area for the different land use classes for the different study periods. The previous image with the succeeding year was crossed to observe the change in land use and land cover. Cross table showing the change from land use and land cover, using percentage (%) and square kilometres (Km^2) to observe the change in areal coverage of land use and land cover. This was the comparison of area under land use and land cover change during the study periods. This shows the total area of land converted from one land use to the other as stated in the objectives.

III. RESULT

Land Use and Land Cover Mapping

The objective of this study was to map out land use types aided by GIS applications. Images of the study area were classified using the Geographic Information System techniques to observe spatial and temporal changes of Makurdi Town. This is in line with Mary (2021) who stated that a Geographic Information System (GIS) is an organized collection of computer applications and personnel designed to handle all phases of geographic data capture, storage, analysis, query, display and output for mapping environmental resources.

Table 5.1: Land Use and Land Cover Distribution of Makurdi (1999/2009/2019)

		1999		2009		2019	
S/No	Land classification	Area (km^2)	Area (%)	Area (km^2)	Area (%)	Area (km^2)	Area (%)
1.	Built-up Area	98.079	11.97	170.968	20.86	237.46	28.97
2.	Vegetation Cover	138.20	16.86	125.695	15.33	117.653	14.35
3.	Farm Land	203.56	24.83	184.608	22.52	174.735	21.32
4.	Bare Land	142.487	17.38	122.249	14.91	104.561	12.77
5.	Water Body	22.459	02.74	29.164	03.56	36.658	04.47
6.	Wetland	214.89	26.22	186.99	22.78	148.696	18.14
	Total	819.670	100	819.670	100	819.670	100

Source: Author, 2020.Derive from a classified satellite image of Makurdi

Tables 5.1, 5.2 and 5.3 reveal that there is a progressive and significant increase in built-up area which is necessitated by the increase in commercial activities, residential growth, and economic and social activities. This is in line with the findings of Etim and Dukiya (2013) who opine that urban encroachment on agricultural land has reduced the productivity of most farmers in Makurdi. The water body recorded little increase which is due to the increase in water works like the construction of Kaptai Lake which is the largest artificial lake in the country, increase in irrigation activities along River Mu in Makurdi as the population increases. While the farmland, vegetation cover, bare land and wetland decreases throughout the twenty (20) years period of study. The classified images (false colour composite) for the different periods 1999, 2009 and 2019 of the study area are shown in Figures 5.1, 5.2 and 5.3 respectively. This colour composite shows the visual distribution pattern of the distribution and change taking place in the images of the areas throughout study.

✓ LandUse/Land Cover in 1999

The dominating land use and land cover category in 1999 as shown in Table 5.1 and Figure 5.1 is the Makurdi wetland which covers an area of 214.89km^2 (26.22%); this is understandable as Hemba, *et al.,*(2017) describe the relief of Makurdi town as lying entirely in the low- laying flood Plain with River Benue forming the major drainage channel. The wetland is mostly used for farming rice and other crops that support the Benue Mill and other food industries in the state due to the low development of socioeconomic infrastructures. The Makurdi population then comprises Indigenous farmers and migrants who are mostly engaged in farm activities as noted by Oju *et al.,*(2011).

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The farmland category covers 203.56km^2 representing 24.83%of Makurdi and it is the second major land use after the wetland. Most residents engage in farming, either crop production or livestock farming as the soil is fertile and the weather is conducive for agricultural practices. This assertion supports the views of Hula, (2010) who noted that most farmers in Makurdi cultivate land for crop production, rearing of animals for consumption and selling part of the produce to generate money to meet other needs.

Due to farming and hunting and other activities like sand mining carried out in Makurdi, the size of bare land is observed to occupy a large space of 142.487 km2 represented by 17.38% in 1999 as indicated in Table 5.1, and Plate 1. This is because farmers have enough space to cultivate. Farmers relocate to other lands whenever a particular land becomes unproductive and this has been the major cause of bare land in the study area. This contradicts Tee, (2019) who argued that hunting, grazing and other factors which lead to the clearing of land through manual, mechanical and chemical means have greatly changed the original vegetation cover to bare land and other classes of land use in Makurdi.

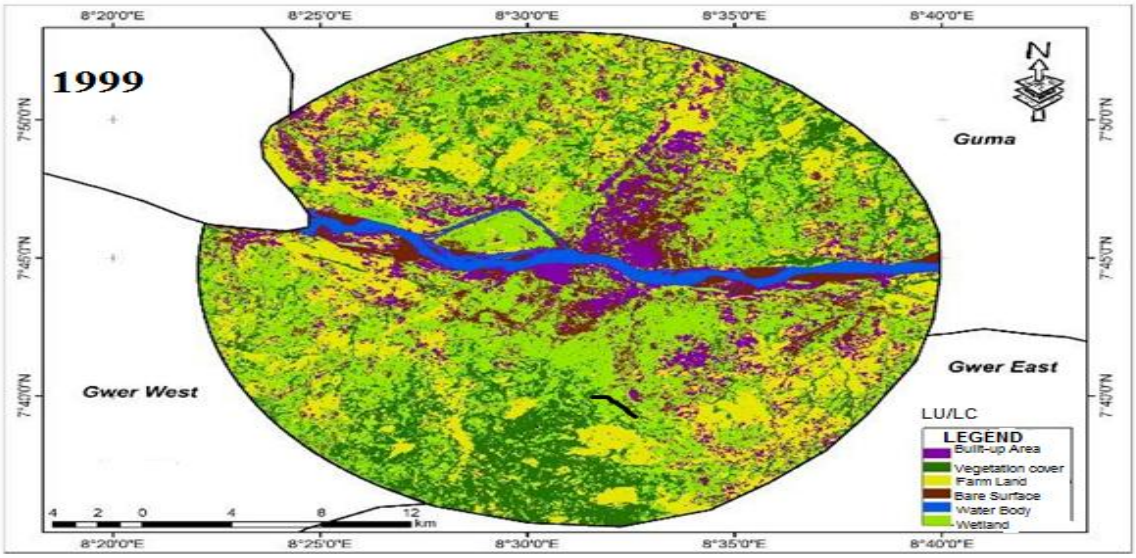

Figure 5.1: Land Use and Land Cover of Makurdi in 1999

Source: Derived from classified Land sat TM, 1999.

Observing the classified image in Fig 5.1, the vegetation covered a reasonable size of land and it is represented in Table 5.1 to be 138.20km^2(16.86%). This is attributed to the few number of settlers in Maukurdi and the low level of human activities taking place within the urban centre at the time. Few houses were observed to have sprawled to farmland and places that were natural ecosystems during the 1999 period. It was observed that the water body was 22.459 km^2(2.74%) with River Benue forming the major drainage system in the area and is the main source of water for human use. this is in line with the views of Nnule and Ujoh, (2017) who pointed out that the Benue River is the main source of water in Makurdi. This doesn't mean that other forms of water sources like boreholes, ponds and dams are not important but the river system forms the major source of water for irrigation and other domestic and industrial use.

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Plate 1: sand Mining Point at the Bank of River Benue North Bank Makurdi

✓ Land Use/Land Cover in 2009

After the interval of about ten years (1999- 2009) and as seen in Fig 5.2 and Table 5.1, the wetland still had the largest area coverage of about 186.99 km2 (22.78%) as the entire land fall within the Benue Valley and Trough. The geology of the study area influences the wetland, this infection is also confirmed by Iorliam, (2014). This is closely followed by farmland which occupies 184.608km^2(22.52%), as most residents are farmers. The number is significant as those who are government workers also own farms for food and to augment their income sources. However, the built-up of 170.968km^2 (20.86%) recorded a high increase due to the increase in population which has claimed other land for residential buildings, commercial, industrial and other institutional buildings to support the increasing number of people. This corroborates the findings of Jiang, *et al.,* (2013) who stated that the urban expansion of agricultural land is associated with both shrinking agricultural land area and a higher level of urban development. Also, it agrees with the findings of Araya and Cabral, (2010) which says in the last few decades, substantial growth of urban areas has occurred worldwide with population increase being one of the most obvious agents responsible for this growth.

Plate 1: Residential Houses at the Flood Plain of River Benue Sited Between the Old and the New Bridge

The vegetation cover depreciated to 125.695km^2 (15.33%). It is understandable as more forest was cleared to provide more space for increasing human development as also observed by Mugish and Nyandwi, (2015) who opine that housing development on arable farmland in most cities has become an issue on the global agenda in recent times. Bare land 122.52km^2 (14.91%) decreased as the spaces were covered with more structures but the water body 29.164km^2 (3.56%) slightly increased, this is an indication that most of the human activities use water and other sources of water are being developed to meet the need of the increasing populace.

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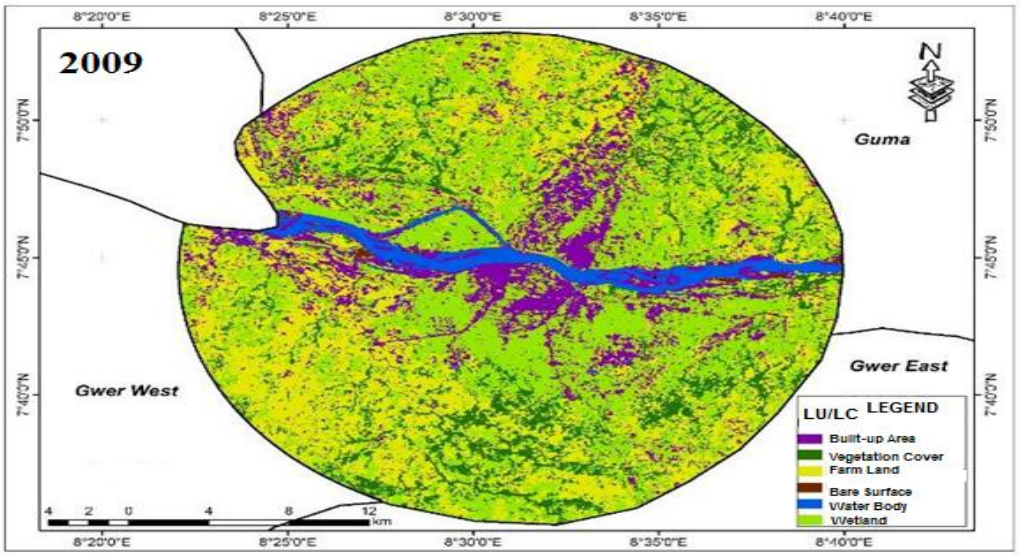

Figure 5.2: Land Use and Land Cover of Makurdi in 2009

Source: Derived from classified Land sat ETM, 2009.

✓ Land Use/Land Cover in 2019

The level of human activities in the year 2019 was very high, although Makurdi has no functional Master Plan to check the developmental activities, however, as shown in the image Fig5.3 and Table5.1, the built-up land of 237.46km^2(28.97%) almost triple the size of what was recorded in1999.This supports the assertion by the United Nations Department of Economy and Social Affairs (UNDESA, 2010) that urban cities have changed from small isolated population centres to large interconnected economic, physical, and environmental features. In recent times, issues of the Herdsmen/Farmers crisis are among the factors contributing to the migration of people from neighbouring villages to Makurdi Town for safety, these numbers of people mostly settled along the urban hinterland which is mostly used for agricultural purposes have converted the land for building of houses and other socioeconomic infrastructures. The farmland occupies 174.735 km2 (21.32%). It decreases as more population settles in the study area. Farmers move outside of Makurdi to get land for their activities which makes the cost of cultivation expensive than expected. Agencies with the mandate of protecting the natural ecosystem are weak in areas of law enforcement in Makurdi as infrastructural development is indiscriminately carried out. This observation contradicts the views of (Wade quoted in Nico, *et al.*, 2000) that Various NGOs, governments and international Agencies have been supporting urban agriculture (UA) since the 1970s, in major world regions. There was a reduction in wetland to 148.696km^2 (18.14%) and vegetation cover to 117.653km^2 (14.35%) compared to the previous ten years while the water body to 36.658km^2(4.47%) increases during the same periods.

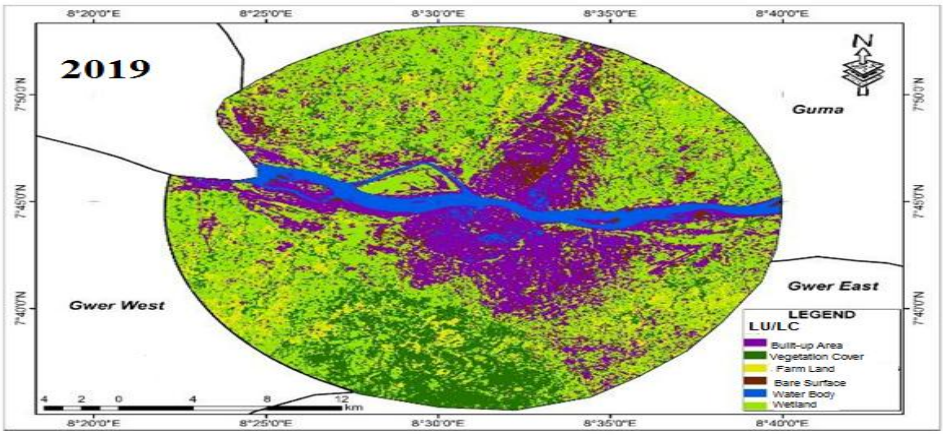

Figure 5.3: Land Use and Land Cover of Makurdi in 2019

Source: Derived from classified Land sat ETM$^+$, 2019.

IV. MAJOR FINDINGS

The research findings reveal that built-up areas increased throughout the study while arable land decreased due to infrastructural development. This is in tandem with the findings of Zubair (2018) who revealed that the built-up area is rapidly growing as the surrounding agricultural land is fast decreasing. Bare land, vegetation and wetlands decreased throughout the study as human settlement increased over the years. This corroborates the findings of Hula and Ukpong (2013) who observed that the land use of Makurdi is changing fast as the population increases. It was observed that the effect of the development was concentrated more in the North-eastern part of Makurdi as residential buildings with a high rate of economic activity is observed in the region.

V. CONCLUSION

In conclusion, this study has been able to show that the conversion of open/agricultural land for infrastructural development was mostly due to an increase in people through migration and natural means of population growth. The land use and land cover change detection for 20 years revealed the extent and type of conversion. The study recommends, Green areas within and around the city should be properly preserved as this allows for ventilation. All efforts should be put in place to prevent unofficial development and measures should be in place to curb population growth which has encouraged urban sprawl on prime agricultural land as this is feasible around Makurdi hinterland.

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