Land Cover Dynamics in Calabar River Catchment, Cross River State, Nigeria

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Abstract

This paper was necessitated by the need to provide the platform for various geo-spatial analyses in the study area. The study investigated land use changes of a 30 year trend (1980 - 2010) using the Geographic Information System (GIS) analysis. Within the period, urban and farm land use types encroached on grassland, forest, bareland and waterbody by 17.54% and 13.59% respectively; reductions in grassland 12.01%, forest 11.01%, bareland 4.62% and waterbody 3.5%. The resultant is the generation of maps/charts of land use changes of the study area which reveals rapidly deforested region for urbanization and agricultural activities. This result will provide planners and decision makers a quick assessment of the potential impact of human activities and initiation of appropriate steps to minimize the action in the study area. Furthermore, it will yield valuable information for the analysis of the environmental impacts of population pressure, agriculture, urban expansion, resettlement programme, climate change, resources managers, development agents, fund providers, socio-economic development planners, public administrators and environmentalists because it has provided accurate information related to land use changes overtime.

Keywords: Land cover, dynamics, river catchment, urbanization, geo- spatial, deforestation, Geographic Information System (GIS).

1. INTRODUCTION

The coastal environment has been a subject of interest to both researchers and policy administrators due to its dynamic land use/cover pattern. There is enormous pressure on land as a result of constantly growing human population and demand for agriculture around the world (Cunningham, Cunningham and Siago, 2005). The coastal belt offers the potential for residential, industrial, agricultural, recreational and commercial land use development, hence characterized by rapid population growth (Oyegun, 1993). Concerns about land use change emerged in the research agenda on global environmental change several decades ago with the realization that land use changes trigger-off climate and soil degradation (Otterman, 1974; Charney and Stone, 1975; Sagan, Toon and Pollack, 1979).

> ‘‘There is increased awareness on this area of research since the International Geosphere and Biosphere Programme (IGBP) and the International Human Dimension Programme (IHDP) on global environmental change which initiated their core project on the realm of study in the mid-1990s’’(Turner, Skole, Sanderson, Fischer, Fresco, Leemans, 1995; Lambin and Geist, 1999).

Nigeria in general and Calabar in particular had witnessed unprecedented land use changes. Ayoade (1988) noted that most of the changes in vegetation and rural land use take place within the tropics. In Calabar region, Efiong (2011) observed of a massive shift of land development from the eastern and southern parts of the city to the northern part of the State because of the restrictions imposed by the Calabar River, Great Kwa river estuary and the wetlands of Cross River estuary, accordingly. For instance, the National Integrated Power Project (NIPP) is making use of large expanses of land at Ikot – Nyong in Odukpani; Pamol Rubber Plantation and Tinapa Leisure Resort in Odukpani and Municipality respectively and is situated along the Calabar–Itu highway of the study area.

There are continuous economic activities carried out on these lands by man which have affected the land use pattern of the area. Despite these activities, there is no evidence of ecological attention by the government to improve the environment in the region. Okude (2006) noted of the existence of dearth of literature and also, low level of recognition on the ecological dimensions of land use studies in Nigeria. The link between Calabar river basin directly or indirectly determines what happens in Calabar the State Capital of Cross River State which is the host to major African Leisure Resorts. The rapid rate of deforestation is further accompanied by

urban expansion due to diverse human activities in the region. The trend explains the significant land use changes experienced in the study area overtime. Jackson, Hart, Adekunle and Nkwunonwo (2012) noted that in every coastal environment, expansion of an urban/residential area over a period of time encroaches on other land uses such as farmland, water body, swamp/mangrove, grassland, bareland, forest etc.

There are various forms of change detection applications that have been tested, and executed in different study areas; the result indicated no significant answer. This study employed the visual analysis based on map-to-map comparison method which is commonly used for land change detection. This method has been adopted and supported by Sadar and Winne (1992); Sunar (1998); Ulbricht and Heckendorff (1998); Stone and Letebvre (1998) among others. Several other studies had been conducted in the area of land use change/cover in Nigeria (Omojola, 1997; Bisong, 2007; Ekpeyong, 2008; Idoko, Bisong, Bisong and Okon 2008; Igbokwe, Akinyede, Dang, Alaga, Ono, Nnodu and Anike, 2008; Nduji, Nnam and Ekpete, 2012 etc). In all such studies, the conclusion was that urban/residential land use overrides the land use change pattern.

In view of the above facts, Calabar river catchment follows the trend of land use change pattern because the region is rapidly urbanizing. Therefore, the findings of this study are compared to other studies in Nigeria and elsewhere cited above.

Arising from the above, this study seeks to answer the following research questions:

1. What are the major land use types of the study area?
2. What is the trend of land use changes in the study area overtime?

AIM AND OBJECTIVES

The aim of this study was to examine the land cover dynamics in Calabar river catchment, Cross River State.

To achieve the aim above, the specific objectives were to:

1. Identify the major land use types of the study area.
2. Determine changes in the land use pattern of the study area overtime.

RESEARCH HYPOTHESIS

For the purpose of this research and in support of the research objectives above, the hypothesis of this study stated that:

1. Land cover of the study area has changed considerably over the past decades.

THE STUDY AREA

The study area, located in south - eastern Nigeria lies between Latitudes $4^{0}45^{1}$N and $5^{0}10^{1}$ N and Longitudes $8^{0}05^{1}$ and $8^{0}45^{1}$ E. It is within the Hydrological Boundary of the Calabar River system. This Lower Calabar river is a fourth–order river catchment. It has an estimated area of 2,340km^{2} **(Fig.1)**. The catchment area covers the present Calabar South, Calabar Municipality and parts of Akpabuyo and Odukpani Areas of Cross River State. **Figs. 2-5** below show the satellite imageries/land use covers of the study area between 1980 and 2010.

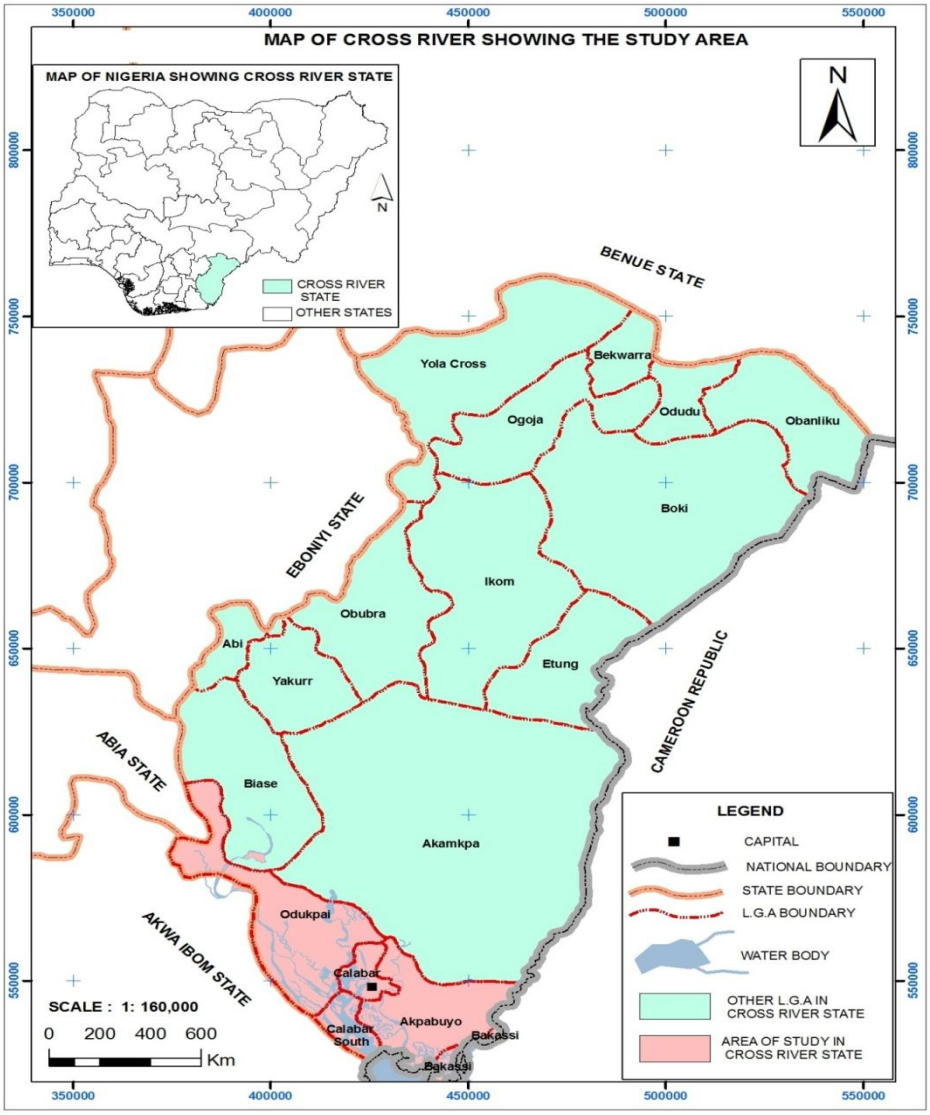

Fig. 1: Cross River State Showing Study Area

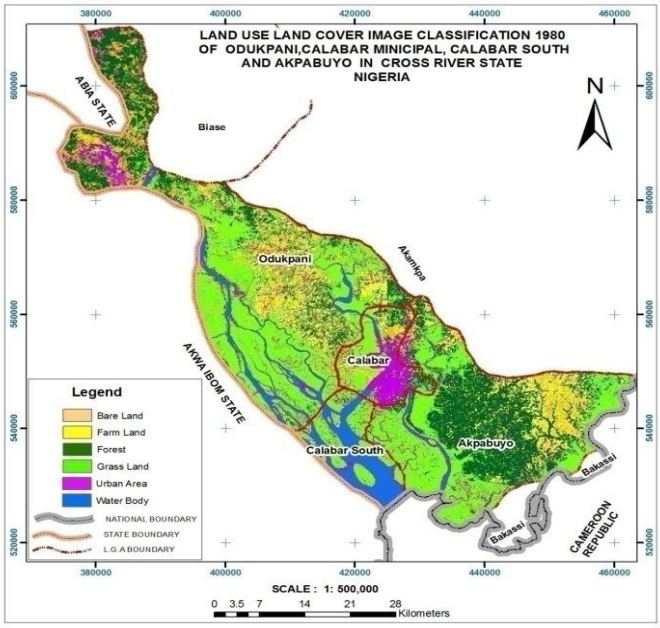

Fig. 2: Land use Change Image Classification of the Study Area in 1980

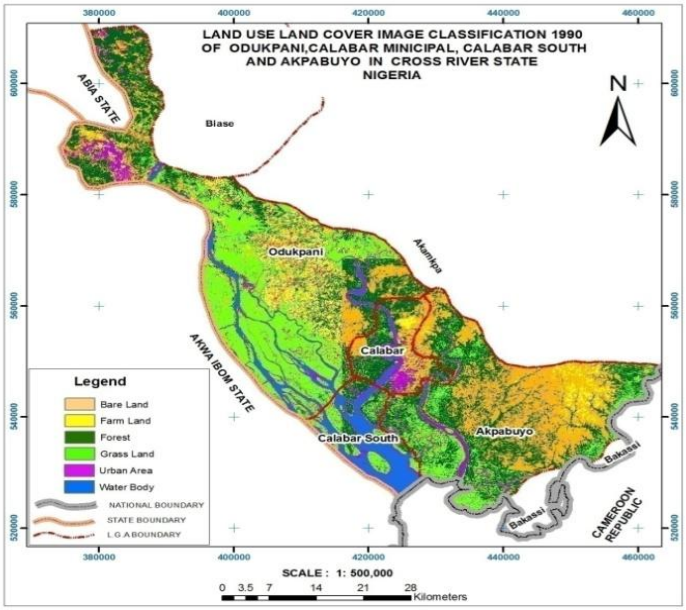

Fig. 3: Land use Change Image Classification of the Study Area in 1990

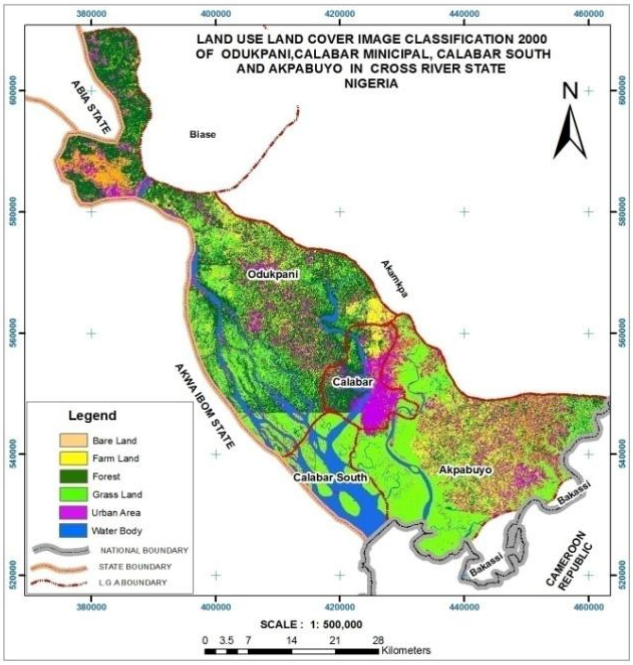

Fig. 4: Land use Change Cover of Image Classification of the Study Area in 2000

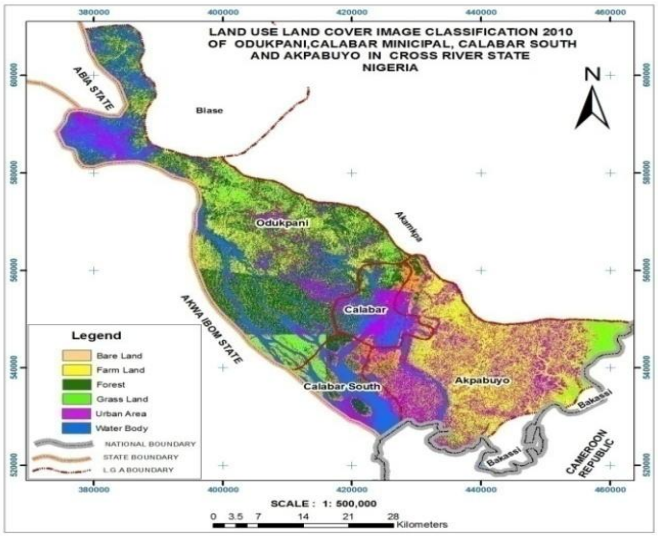

Fig. 5: Land use Change Cover of Image Classification of the Study Area in 2010

2. RESEARCH METHODS

The land use activity of the basin of the study area integrated data collected through available topographical map and aerial photographs. This served as a basis for interpretation and comparison of the change of the different land use types in the study area. The satellite imageries' interpretation of the study area covered four epochs: 1980, 1990, 2000 and 2010 on a scale of 1:500,000. The study also integrated the available topographical map of the study area on a scale of 1:160,000. The study adopted data from different sources and used different methods and approaches to analyze the long term land use/cover changes and trends in the four decades of the study area. The approaches included imageries from different satellites (Landsat), multi-temporal dates (MSS 1980, TM 1990, ETM 2000 and ETM+2010), fieldwork surveys and forest inventory application. Pixel-based classification was applied as a new approach of imagery classification. The Earth Resources Data Analysis System (ERDAS) Imagery version 9.1, Integrated Land and Water Information System (ILWIS) software version 3.7 was used for image processing, masking and classification. Meanwhile ArcGIS was employed for database development, spatial data analysis, producing thematic maps and Statistical Package for the Social Sciences (SPSS) were used for statistical analysis. Coordinates of different locations in the study area were obtained by the use of a Global Positioning System (GPS) using the WGS84 32N Minna Datum.

Landsat satellite imagery of the study area was acquired for four epochs: 1980, 1990, 2000 and 2010 from Global Land Cover Facilities (GLCF) and United State Geological Survey (USGS). The approach included imageries from different satellites (Landsat), multi-temporal data such as Landsat 1-5, the Landsat Multi-Spectral Scanner) 60m resolution in multispectral (MSS 1980), Landsat TM 1990 (Landsat 4 and 5 Thematic Mapper) 30m resolution in multispectral (TM 1990), Landsat 7 Enhanced Thematic Mapper 30m resolution in multi-spectral (ETM 2000) and Landsat ETM + 2010 (Landsat Level1 Enhanced Thematic Mapper Plus) 30m resolution (ETM+ 2010).

3. RESULTS AND DISCUSSION

Data on land use changes / covers of the study area between 1980 and 2010 were acquired through a renaissance survey and Landsat Thematic Mappers (LTM) of the Geographic Information System (GIS) analysis **(Land use covers in Figs. 2 - 6 above)**. Consequently, six land use types with varying degrees of changes were identified. They include forest ground, bare surface, urban surface, farmland, water body and grassland **(Plates 1 and 2)**. Below is the summary table of the result **(Table 2)** and statistical information **(Figs. 6 – 9)**.

Plate 1: Urban Surface (Front View of the University of Calabar)

Plate 2: Concretized surface, Bare surface, Grassland, Farmland and Pamol Forested Rubber Plantation side by side along Calabar – Itu Highway

Table 2: Summary of Land use Change Category at Different Epochs (1980 - 2010) in the Study Area

Land use Change Category	***1980***		***1990***		***2000***		***2010***		
	Area (m^2)	***Percentage (%)***	Area (m^2)	***Percentage (%)***	Area (m^2)	***Percentage (%)***	Area (m^2)	***Percentage (%)***	***% Diff.***
Water	2050983	8.77	1365903	5.84	1281195	5.48	1234026	5.27	-3.5

body	00		00		00		00		
Urban Area	74699100	3.19	173699100	7.42	271471500	11.60	485040600	20.73	17.54
Grassland	577357200	24.68	574892100	24.57	583918200	24.96	296449200	12.67	-12.01
Farmland	238747500	10.20	283138200	12.10	282449700	12.07	556709400	23.79	13.59
Forest	838700100	35.85	705433500	30.15	606020400	25.90	581134500	24.84	-11.01
Bare surface	405070200	17.31	465919200	19.91	467693100	19.99	296936100	12.69	-4.62
Total	**233967200**	**100.00**	**233967200**	**100.00**	**233967200**	**100.00**	**233967200**	**100.00**	

Source: Landsat Thematic Mappers (LTM) of the Geographic Information System (GIS)

The initial records of land use changes/covers obtained in 1980 above revealed that water body occupied 8.77%, urban area (3.19%), grassland (24.68%), farmland (10.20%), forest (35.85%) and bare land (17.31%). The summary result shows that forest was the dominant land use type. Urban land use was the least recorded within the period **(Fig. 6)**

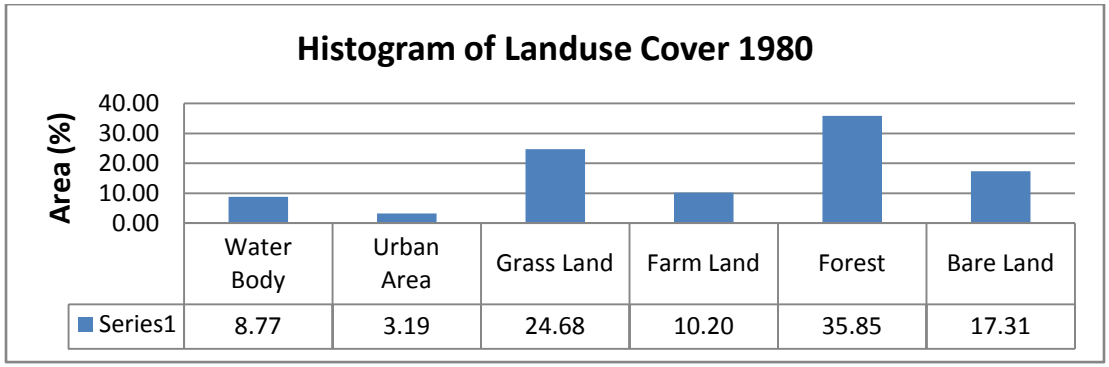

Fig.6: Histogram of Land use Cover (1980) of the Study Area

By 1990, urban and farmland land use types had increased by 4.23% and 1.9% respectively and then expanded/encroached on bare land, grassland, water body and the forest. Within the period; water body, forest, bare land and grassland had reduced significantly **(Fig. 7)**.

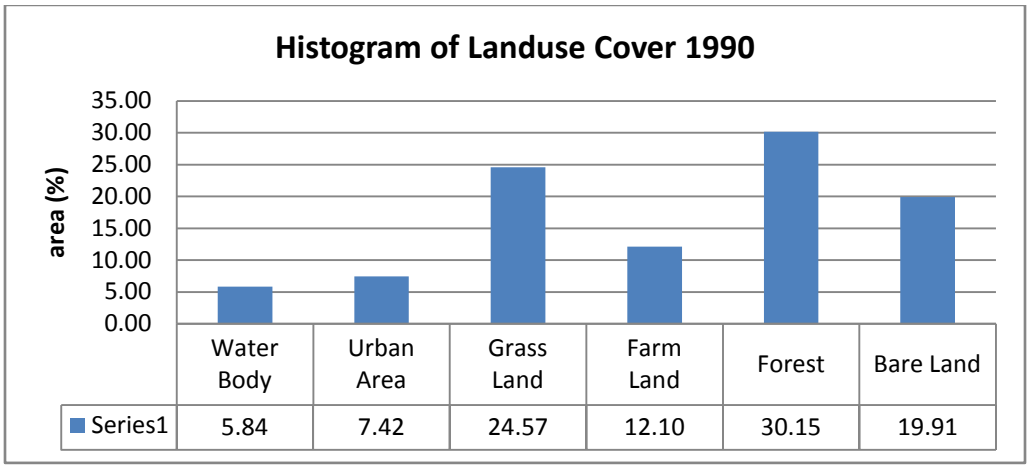

Fig.7: *Histogram of Land use Cover (1990) of the Study Area*

By 2000, urban land use type had increased by 8.41% and then expanded/encroached on bare land, water body and the forest. Farmland declined by 0.03%. Within the period; farmland, water body, bare land and forest had reduced **(Fig 8)**.

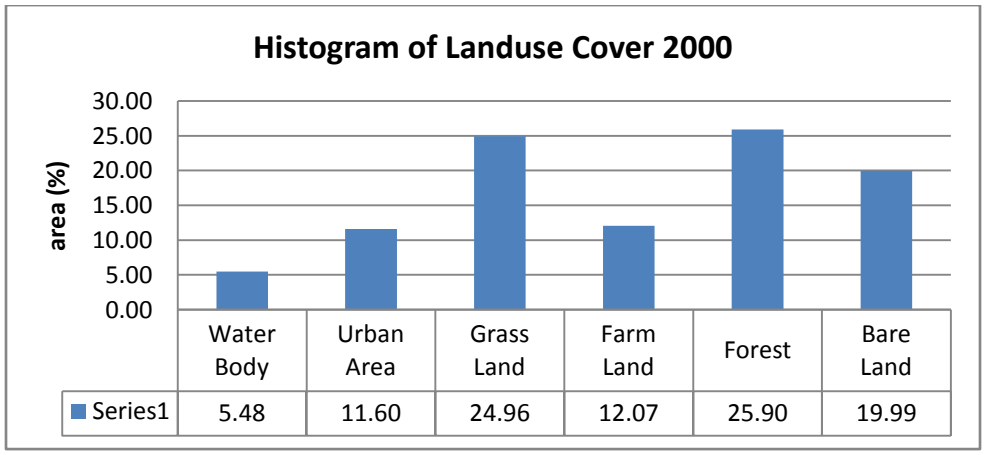

Fig.8: *Histogram of Land use Cover (2000) of the Study Area*

By 2010, urban and farmland land use types had increased by 17.54% and 11.72% respectively and then expanded/encroached on bare lands, water body and the forest. Within the period; bare lands, grasslands, water body and forest had reduced **(Fig. 9)**.

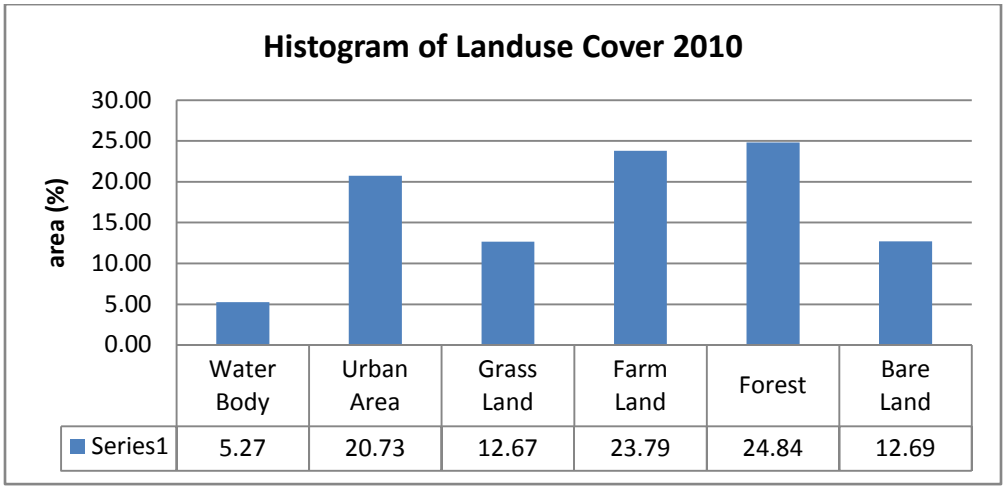

Fig.9: *Histogram of Land use Cover (2010) of the Study Area*

4. SUMMARY AND CONCLUSION

The dynamics of the land cover in Calabar River Catchment has been attributed to increasing human activities through deforestation such as urbanization and agricultural activities. Urban and farm land use types play the dominant roles in the land use changes in the region. This means that Calabar river catchment is increasingly being urbanized while at the same time engagement of the inhabitants in agriculture as a major economic activity. For instance, within a 30 years trend of land use changes (1980 - 2010), urban and farmland land use types encroached on grassland, forest, bare land and water body by 17.54% and 13.59% respectively; reductions in grassland by 12.01%, forest 11.01%, bare land 4.62% and water body 3.5%. A study of this magnitude has set the pace and raised the consciousness for planners and decision makers a quick assessment of the potential impact of human activities and initiation of appropriate steps to minimize the action in the study area. This would enhance sustainable watershed and environmental management in the ever-changing land use in the region and beyond.

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