Original Research Article

ANALYSIS OF LAND USE AND LAND COVER DYNAMICS IN ORLU, NIGERIA.

ABSTRACT

This research set out to ascertain the land use and land cover changes that have taken place in Orlu L.G.A from 1986 to 2013. Two fundamental tools applied were GIS and remote sensing which were used for the assessment of LULC. Remote sensing provided multi temporal images, while GIS was used to analyze the data from a geographic perspective. Field observation was also carried out in the area in order to assess the level of urbanization as well as the trend of development. The result of this analysis provided four major classifications of land use and land cover which include; bare-surface, built-up, water body and vegetation. The built up area was observed to have increased rapidly between 2000 and 2013 with a value of 46.207% while there was a drastic decrease in bare surface and water bodies as a result of the trend in development of this area within this period. Vegetation cover reduced from58.03% in1986 to about 52.09% in 2013. It is evidentthat Orlu is developing gradually with respect to land use change as there has been rapid increase in socio-economic activities of the population. Consequently, there is an increase in the runoff level in the area as a result of various construction works going on in the area. This has resulted in high rate of siltationin the water bodies and their consequent shrinkage.

Keywords: Anthropogenic activities, Geographic Information System, Landuse, Landcover, Multi-temporal Dynamics, Remote Sensing.

1.0 INTRODUCTION

Land is a fundamental factor of production and through much of the course of human history; it has been tightly coupled to economic growth [1]. Changes in land use and land cover(LULC) therefore predates history and are the direct and indirect consequences of human actions to secure essential resources [2]. More recently, industrialization has encouraged the concentration of human population within urban areas (urbanization) and hence decreased the population of rural areas, accompanied by the intensification of agriculture in the most productive land and the abandonment of marginal land [3]. All of these causes are observable simultaneously around the world today.

Land use and land cover change is a general term for human modification of earth's surface. Though humans have been modifying land to obtain food and other essentials for thousands of years, current rates, extents and intensities of land use and land cover changes are far greater than ever in history, driving unprecedented changes in ecosystems and environment processes at local, regional and global scales. These changes encompass the greatest environmental concerns of human populations today, including climate change, biodiversity loss and the pollution of water, soils and air. Monitoring and mitigating the negative consequences of land use and land cover changes while sustaining the production of essential resources has therefore become a major priority of researchers around the world.

Deforestation is one of the major causes of land cover change and it is the most pervasive concern in developing countries [4, 2]. 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. 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. This information also assists in monitoring the dynamics of land use resulting from changing demands of increasing population. The World Resources Institute [5] estimates that only one-fifth of the world's original forest cover remains. Due to anthropogenic activities, the earth surface is being significantly altered in some manner and man's presence on the earth and his use of land has had a profound effect upon the natural environment, thus resulting in an observable pattern of change in the land use/land cover over time ranging from initial conversion of natural forest into cropland to on-going grassland management [6].

Land use and land cover change has become a central component in current strategies for managing natural resources and monitoring environmental changes. Since environmental change is ubiquitous throughout the world, analyzing symptoms of emerging environmental change at local levels are essential. [3], noted that information about change is necessary for updating land cover maps and the management of natural resources. The information about the changing land cover is spatially revealed through a remotely sensed data.

Viewing the Earth from space is now crucial to the understanding of the influence of man's activities on his natural resource base and changes on the land over time. Hence remote sensing data and technique and geographic information systems (GIS) provide efficient methods and opportunities for analysis of land use and land cover dynamics and tools for land use planning and modeling [7; 8]. In situations of rapid and often unrecorded land use change, observations of the earth from space provide objective information of

human utilization of the landscapevis-a-viz, what, where and when changes occur as well as the rate of change [9]. Such data also provide an important link between intensive, localized ecological research and regional, national and international conservation and management of biological diversity [10].

An increasing number of scholars are exploring the potential to gather data on land use and land cover dynamics in most emerging urban centers. Attempts have been made to document the land use and land cover of Orlu in the past from aerial photographs [11,12]. The result from their studies were commendable but lacked the multispectral capabilities of assessing the trend of land cover change over years using remote sensing and GIS techniques.

Therefore, this study aimed at mapping out the status of land use and land cover of Orlu using multi-temporal imageries spanning between 1986 and 2013, with a view to analyze the changes that have taken place in this area over a 27years period, using both Geographic Information System and satellite remote sensing data.

2.0 STUDY AREA

The study area for this project isOrluLocal Government Area in Imo state Southeast Nigeria. It lies within latitude 5°43'45" to 5°53'00" and longitude 7°0'00" to 7°7'30" with a population of 142,717 [13]. It is the third largest city in Imo state locatedin a sedimentary rock formation and lies within the Awka-Orlu uplands in a zone of sandy lateritic soil (Fig. 1). The climate is typically humid, the same as is obtainable in the Southeastern region of Nigeria. Two distinct seasons are familiar with the climate of the area. The rainy season, that begins in April and ends in October, with higher intensity in June and late September, and the dry season, which begins in November and ends in March. The annual rainfall varies between 1,990mm and 2,200mm.

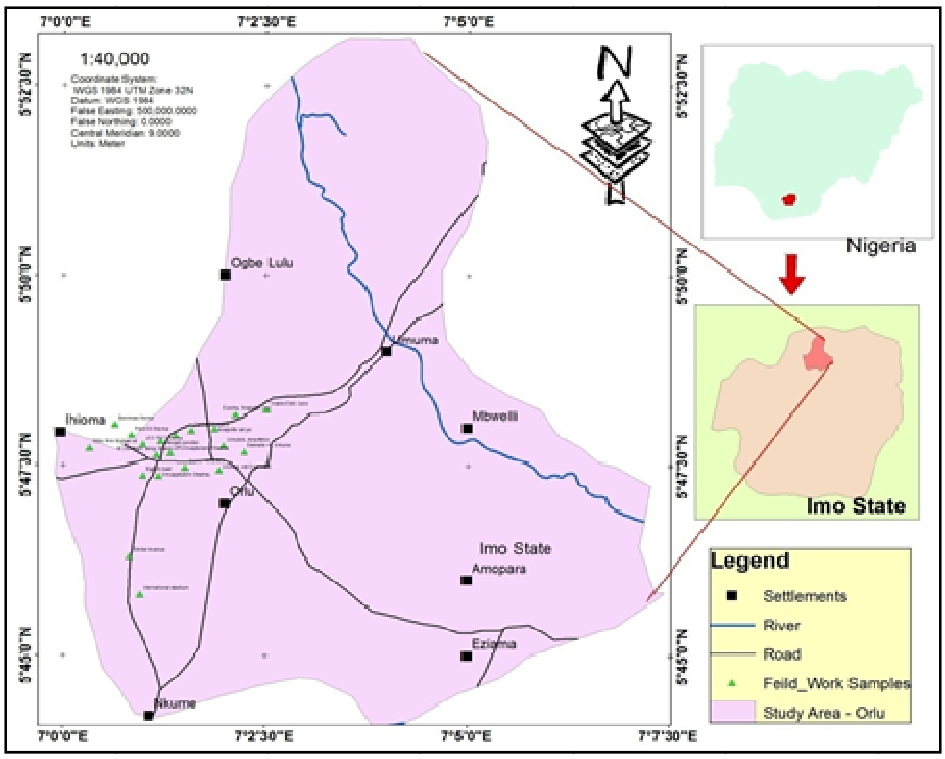

Fig. 1: Map of Study Area

Temperature is generally high with little variation during the year. The mean annual temperature is about 27^0C with an average annual relative humidity of 75 percent which is high during the rainy season. The vegetation ofOrlu is rain forest and the topography is undulating. Inhabitants produce agricultural products such as palm produce, cocoa and rubber. The staple crops are yam, cassava, cocoyam and maize. The economy of the area depends largely on agriculture and commerce and the chief occupation of the people is farming.

3.0 Research Methodology

Data used for this study were obtained from both primary and secondary sources.

The primary data was obtained fromdirect field observations with ahandheld GPS (Extrex Garmin Version 16.0) device. The GPS was used to acquire the coordinates of specific areas used in assessing the terrain of the study area. While secondary data was the major data used for decadal assessment of the vegetation of the area. The secondary data was a geospatial data which include the following satellite imageries: Landsat 5 thematic mapper of 1986, Landsat 7 enhanced thematic mapper of 2000 and the NigeriaSat-X image of2013 as well as journal literaturesand articles.

Tools of data analysis include software'ssuch as;

a. ERDAS IMAGING 9.2:Erdas Imagine 9.2 was used for spatial, spectral and radiometric enhancement. Spatial enhancement was carried out using a resolution merge model. It was also used to generate the land use land cover maps for the study area covering the 3 periods of assessment. The LULC classification adopted the [14] class features using the maximum likelihood model of the supervised classification which revealed the current land use in the area in the results output.

b. Arc-GIS 10.0: Arc-Map was used for the vectorizationand digitizing of the images to generate the map of the study area. ArcCatalogue was used in creating a personal geo-database and shape-file used to generate the study area map. Also it was used to generate the area variability of the different land cover feature assessed.

c. Other ancillary software used were:

Microsoft office word 2013, Microsoft office excel 2013 etc.

Techniques for Data Analysis

The mapped out area for the analysis was subjected to a supervised classification analysis and at this stage the domain of the spatial parameters mentioned above were adopted and subjected to maximum likelihood classifier of the ERDAS software.

Land-use and land cover classification was done using the [14], USGS classification scheme. Results describing the various disparities in vegetation, settlements, and the nature of the terrain are presented in maps, tables and histogram.

4.0 RESULT PRESENTATION AND DISCUSSION

The results in a table form extracted using ArcMap, shows disparities in spatial parameters using the number of pixels classified and the corresponding area in hectare. Furthermore, the tables was displayed in pie charts, histogram etc., for enhanced visual interpretation of the results.

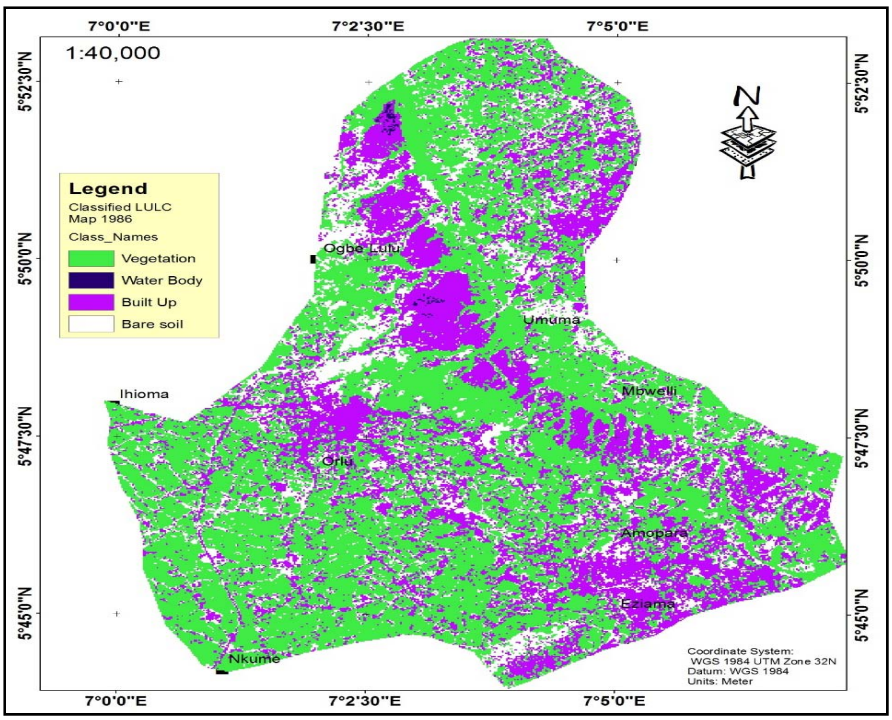

Fig. 2: Classified LULC Map 1986

Table 1: The Raster Attributes for 1986 Results

Class Name	Red	Green	Blue	Histogram	Opacity	Area(H)	Area (%)
Unclassified	0	0	0	0	0	0	0
Bare soil	1	1	1	28165	1	2287.702	17.68514
Built Up	0.75	0.04	1	44886	1	3645.865	24.18446
Water Body	0.15	0	0.44	163	1	13.23968	0.10235
Vegetation	0.25	0.92	0.27	86044	1	6988.924	58.02806
Total				159258	4	12935.73	100

Table 2: Error Matrix I

Classified Data	Water body	Vegetation	Built-up	Bare surface
Water body	84	6	4	0
Vegetation	2	3982	8	0
Built-up	1	2	2437	0
Bare surface	0	6	26	44
Column Total	87	3996	2475	44

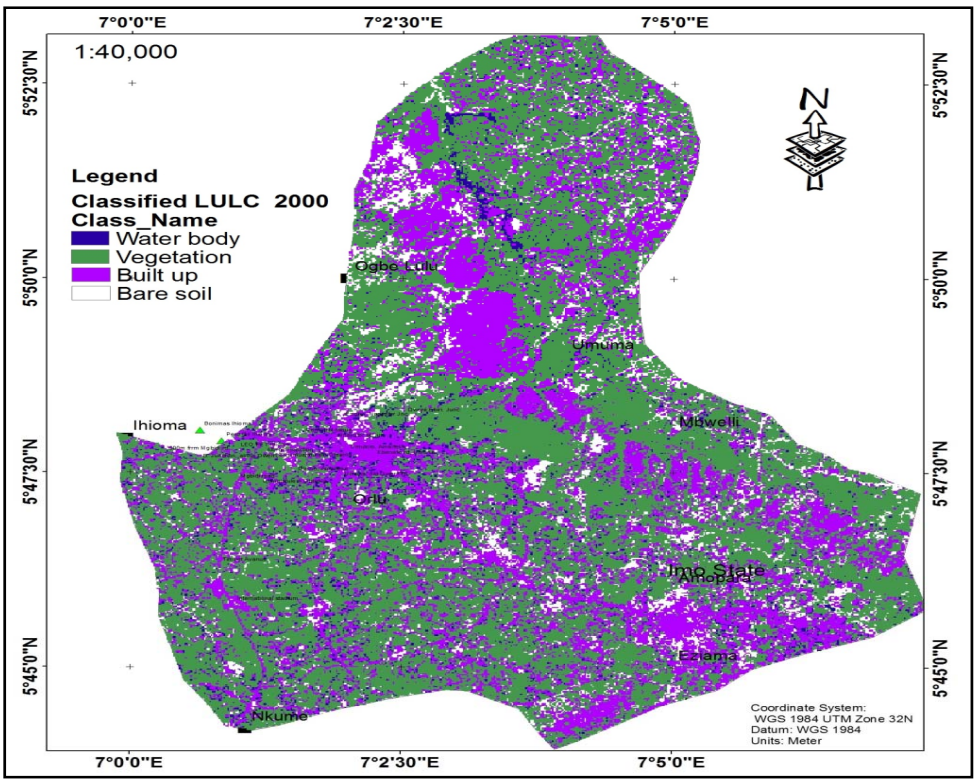

Fig. 3: Classified LULC Map of Orlu 2000

Table 4: The Raster Attributes for 2000 Results

Class Name	Red	Green	Blue	Histogram	Opacity	Area(H)	Area (%)
Unclassified	0	0	0	0	0	0	0
Water body	0.16	0	0.64	9488	1	459.2192	3.550023
Bare soil	1	1	1	23416	1	1133.334	8.761312
Vegetation	0.27	0.6	0.3	154658	1	7485.447	53.86671
Built up	0.69	0.01	1	79704	1	3857.674	33.82199
Total				267266	4	12935.67	100

Table 3: Error Matrix II

	Reference Data			
Classified Data	Water body	Bare soil	Vegetation	Built up
Water body	117	0	7	65
Bare soil	0	74	79	31
Vegetation	3	0	1899	21
Built up	7	1	19	1404
Column Total	127	75	2004	1521

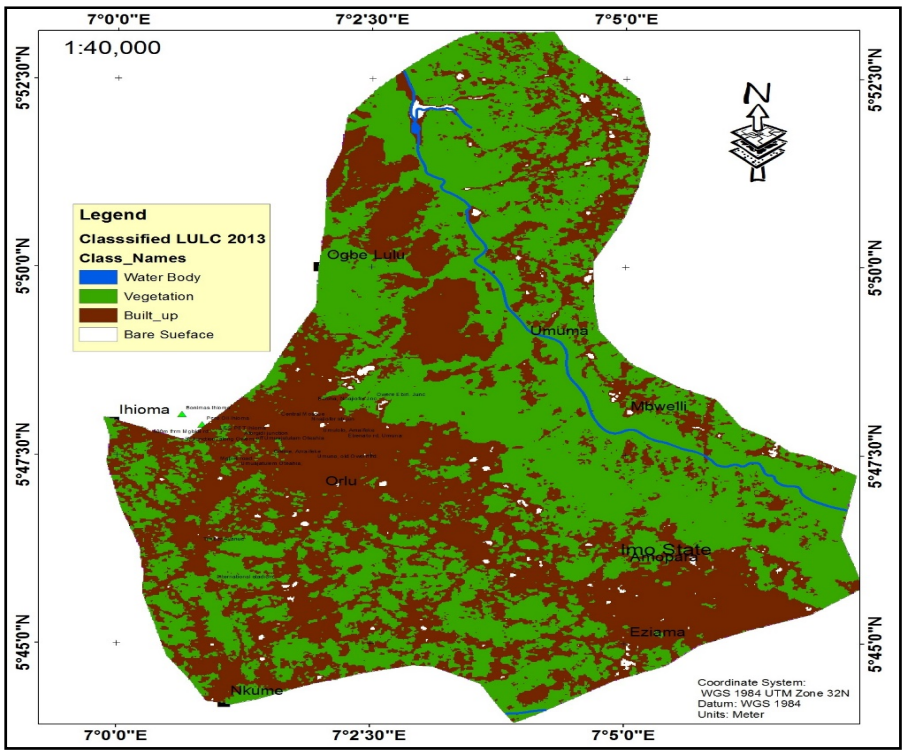

Fig. 4: Classified LULC Map of Orlu 2013

Table 6: The Raster Attributes for 2013 Results

Class Name	Red	Green	Blue	Histogram	Opacity	Area(H)	Area (%)
Unclassified	0	0	0	0	0	0	0
Bare Surface	1	1	1	1805	1	87.362	0.672762
Water Body	0	0.33	0.48	80	1	3.872	0.029818
Vegetation	0.65	0.29	0.31	142440	1	6894.096	52.09044
Built-up	0	0.87	0.83	123972	1	6000.245	46.20702
Total				268297	4	12985.57	100

Table 5: Error Matrix III

Classified Data	Water Body	Bare Surface	Vegetation	Built-up
Water Body	27	0	0	0
Bare Surface	0	95	0	0
Vegetation	0	0	126	0
Built-up	0	0	0	746
Column Total	27	95	126	746

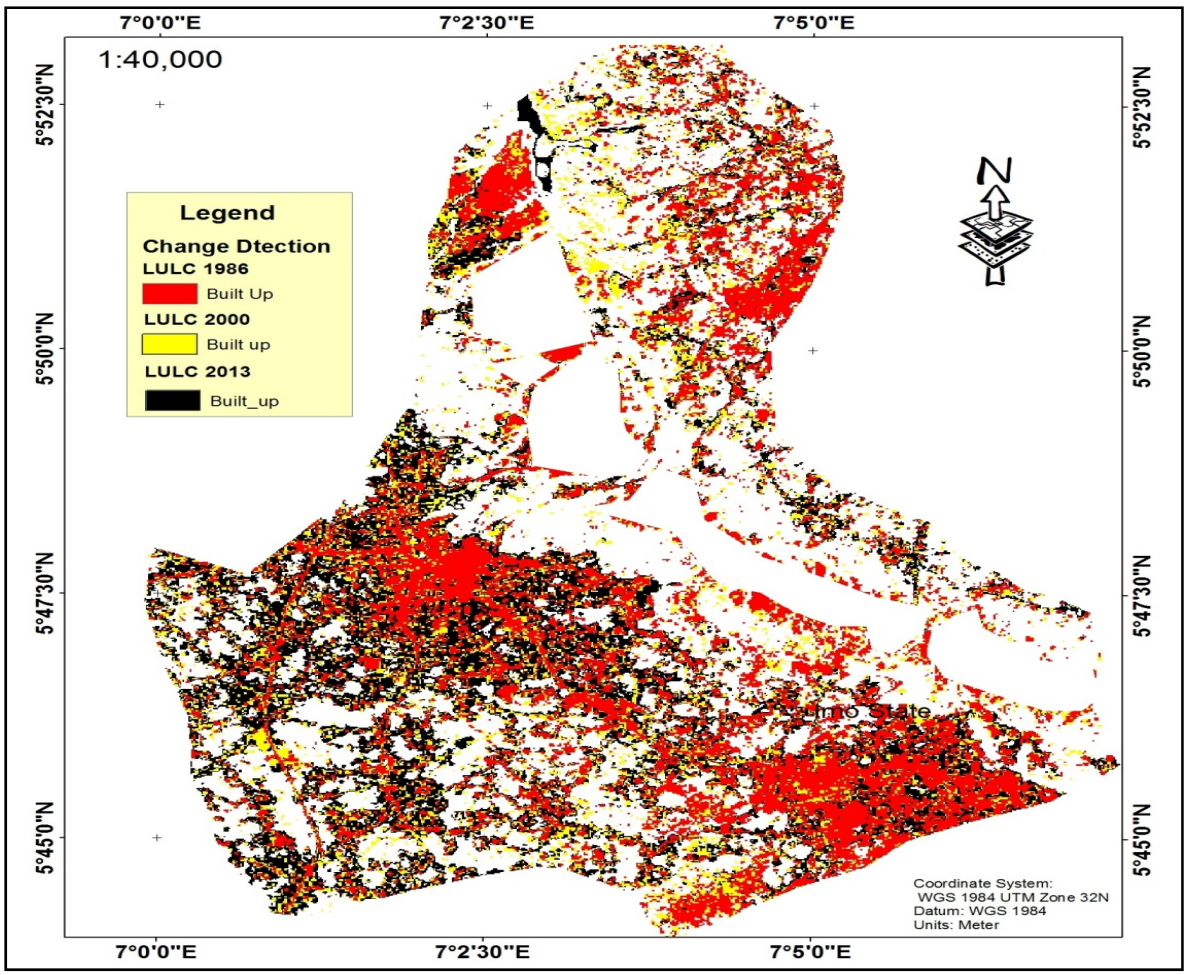

Fig. 5: Change Detection LULC Map ofOrlu 1986– 2013

Table 7: Change Detection 1986, 2000 and 2013

LULC CATEGORIES	*LULC 1986*		*LULC 2000*		*LULC 2013*	
	Area (Ha.)	Area (%)	Area (Ha.)	Area (%)	Area (Ha.)	Area (%)
Bare Surface	2287.702	17.69	1133.334	8.76	87.362	0.67
Water Body	13.23968	0.10	459.2192	3.55	3.872	0.03
Vegetation	6988.924	58.03	7485.447	53.87	6894.096	52.09
Built-up	3645.865	24.18	3857.674	33.82	6000.245	47.21
Total	12935.73	100	12935.67	100	12985.57	100

Table 8: Percentage Change

LULC CATEGORIES	1986 -2000		2000-2013		ANNUAL RATE OF CHANGE
	AREA (Ha.)	PERCENTAGE CHANGE	AREA (Ha.)	PERCENTAGE CHANGE	
Bare Surface	-1154.367725	-8.92387	-1045.9724	-8.085916	0.837953
Water Body	445.979525	3.44766	-455.3472	-3.520073	-6.96773
Vegetation	496.5233	3.83839	-591.3512	-4.571456	-8.40984
Built-up	211.80825	1.63739	2142.5712	16.563202	14.92581

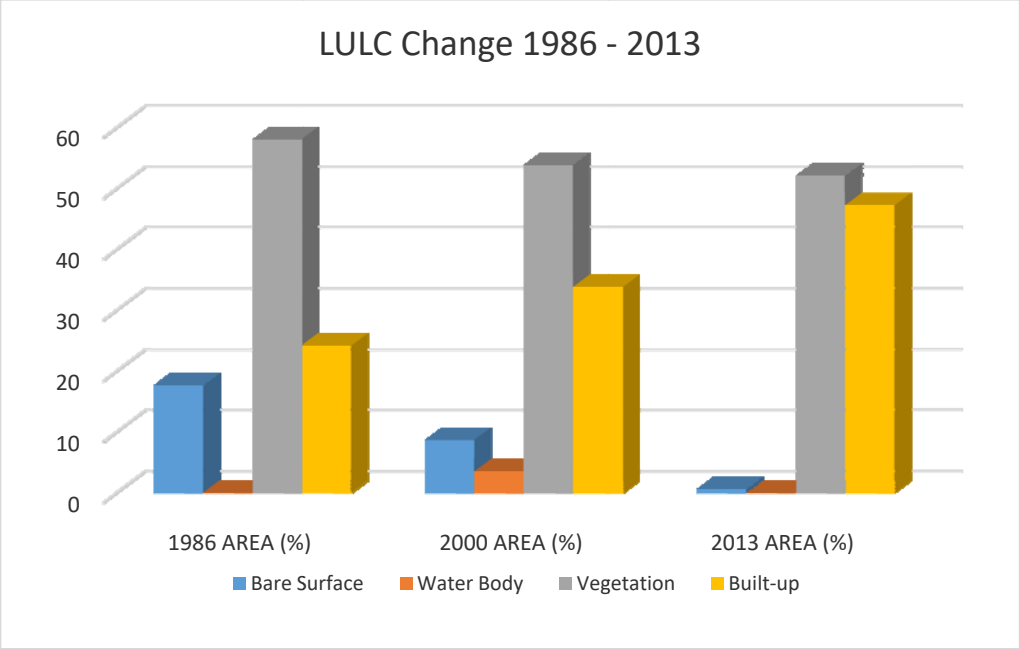

Figure 6: LULC change 1986 - 2013

There is no doubt that human activities have profoundly changed land use and land cover in Orlu L.G.A as observed within the period 1986 to 2013. Field observations indicates that the major drivers of this change are; Increase in commercial land use and Increase in built up areas.

The high rate of increase in the commercial activity in Orlu L.G.A has brought about a significant change in the land use and land cover of the area. Another driver of this change in land use and land cover is increase in built up areas. The built up found in this area include basically buildings and road constructions.

It is quite observed that the number of buildings as well as the construction of roads found in this area has significantly increased as a result of development. As a result of the changes that have taken place especially from 2000 to 2013, it is hence induced that the built up areas has increased from 24.18% to about 47.20% as represented in the Change detection table 7 as a result of gradual development that is taking place in the area.

The land use land cover analysis result of 1986 (table1), revealed that bare surface occupied a total surface area of 2287.702 hectares constituting 17.69% of the total area. Vegetation occupied 6988.924 hectares making up the largest land surface area with a total of 54.03%. Built up surfaces occupied 3645.865 hectares resulting to the second largest surface cover in the study area covering total of 28.18% of the land surface. And finally Water body occupying the least area coverage summing up to 13.24 hectares. The result therefore depicts that farming was the major occupation of the population as land was converted to agricultural use.

5.0 SUMMARY OF FINDINGS

According to the land use land cover result of 2000, it was revealed that bare surface occupied a total surface area of 1133.33 hectares constituting 8.76% of the total area. Vegetation occupied 7485.45 Hectares making up the largest land surface area with a total of 57.87%. Built up surfaces occupied 3857.674 hectares which became the second largest surface cover in the study area with fast emerging urban development covering a total of 29.82% of the land surface. And finally Water body occupying the least area coverage summing up to 459.22 hectares. Therefore, it is observed that development is gradually taking place with a trend of increase in built up areas.

From the land use land cover result of 2013, it was observed that bare surface occupied a total surface area of 87.362 hectares constituting 0.673% of the total area. Vegetation occupied 6894.096 hectares making up the largest land surface area with a total of 53.1%. Built up surfaces occupied 6000.245 Hectares resulting to the second largest surface cover in the study area covering a total of 46.21% of the land surface. And finally Water body occupying the least area coverage summing up to 3.872 hectares. It is also observed that built up area is also increasing over time.

5.1 CONCLUSION AND RECOMMENDATIONS

Finally, it can intuitively beconcluded that the trend of development taking place in Orlu L.G.A is basically with increase in built up which is as well used for commercial activities in the area. There is equally no significant increase in vegetation as well as water bodies in this area. Urbanization has also caused a rapid

decrease in bare surface as the people convert the bare surfaces in this area into other land uses especially commercial activities and constructions.

From the change detection analysis, vegetative cover of the study area was observed to reduce in a linear pattern from 1986 to 2013 that it drastically reduced from 58.03 % to 52.09% of the total land cover. However, there was a gradual increase in the built up area of the land cover from 1986 to 2000. This indicates that there was gradual developmental activities in the study area within the years. However, in 2000 there was a peak increase in the built up areas which was about 46.2 percent of the total coverage of the land use land cover in the area as shown in table 6. It can as well be concluded that Orlu L.G.A is developing rapidly and the trend of this development enhances the socio-economic activities of the population with respect to the various commercial activities practiced in the area.However the implication of this trend based on the research findings is that unregulated urbanization currently ongoing in the study area, will have dire consequences on surface water resources as increased paved surfaces will lead to higher volume of surface runoff and siltation of surface water thereby affecting ecosystem functions. Equally, there is the possibility of microclimate alterationresulting from reduced vegetation cover and increased paved surfaceshence resulting in escalation of urban heat island.This study therefore recommends that urban planning authority should regulate the massive urban growth in the area to avoid ecological decay. The Local Government Council should ensure agricultural and forest reserve land are not compromised to ensure adequate or sustainable development in the area.

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