Analysis of Land Use/Land Cover Change Using Geospatial Techniques in Ukwuani Local Government Area of Delta State, Nigeria

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***Abstract*:-This study examines the use of Geographic Information System (GIS) and Remote Sensing (RS) in mapping Land Use and Land Cover (LULC) change in Ukwuani Local Government Area (LGA) between 1990, 2002, and 2014; to detect the changes that has taken place in the study area within the period of study. The study aim is to detect and map the LULC changes in Ukwuani Local Government Area of Delta State over the period of 36years (1990-2014). In this study, three data set of Landsat Satellite images were layer stacked after which supervised classification in EARDAS imagine software was carried out and mapping in Arc GIS software. Four land use and land cover categories were classified into Built-up areas, Cultivation, Vegetation, and Waterbody. The result of the study shows a rapid growth in built-up land between 2002 and 2014 while the periods between 1990 and 2002 witnessed an increment in this class also. Findings of the study also show that there would be an accelerated increase in built-areas because of development that is coming to the study area in recent years. The study, therefore, recommends building towards the outskirts through the provision of incentives and forces of attraction that are available at the city centre in these areas. The study further recommends that the government should encourage afforestation in the study area to reduce the loss of biodiversity, inducing high rates of extinction and a worldwide depletion of biological diversity at genetic, species and ecosystem levels.**

***Keywords*: GIS, Land cover, Land use, Nigeria, Remote Sensing, Ukwuani**

I. INTRODUCTION

The land is a portion of the earth's solid surface distinguishable by boundaries or ownership. Land use shows how people of a particular area use the landscape, whether conservation, development or mixed uses. Land cover describes the vegetal attributes of the land. It tells how much and the area is covered by forest, wetland, waterbody, etc. Land use and land cover dynamics are widespread, accelerating, and significant processes driven by human actions but also producing changes that impact humans (Agarwal, et al, 2002). These dynamics alter the availability of different biophysical resources including soil, vegetation, water, animal feed and others. Consequently, land use and cover changes could lead to a decreased availability of different products and services for human, livestock, agricultural production and damage to the environment as well. In Nigeria, the availability of natural resources as well as their dynamics and management vary considerably from area to area. Changes in land use and land cover conditions and agriculture, water management practices in irrigation could be responsible for the problems associated with hydrological resources of some lake in Nigeria. Inappropriate allocation and utilization, lack of capacity to develop and use poorly accessible water resources, loss of water due to its seasonality and runoff are some of the problems associated with the water resources in the basin. Therefore, producing more food under conditions of increasing water scarcity and without creating further environmental degradation is a challenge being faced many countries of the global south.

Geographic Information System (GIS) and Remote Sensing (RS) is a set of tools for collecting, storing, retrieving at will, transforming, and displaying spatial data from the real world for a particular set of purposes (Burrough, 1986). The purpose of using GIS and Remote Sensing in detecting land use land cover dynamics in academic researches cannot be overemphasized. GIS, Global Positioning System (GPS) and RS have become indispensable tools in almost all environmental endeavours. This concept has been employed in various studies including urban, rural and atmospheric studies and assessment of developmental change over time (Salami and Balogun 2006).

To understand the land use land cover (LULC) change and its effects on the ecosystem, health, and other systems, it will be necessary to make significant advances in documenting the rates and causes of LULC changes. Our current understanding of historic LULC change in Nigeria is not adequate. Future understanding of LULC changes needs to be greatly improved with systematic methods and designs addressing land-use changes in the country. To understand the forces of change, it will be necessary to conduct studies that explicitly reveal the variations in change characteristics. Thus, the historical and contemporary data needed to develop models that project LULC for specific intervals into the future could be produced.

According to Sherbinin (2002), land use is the term that is used to describe human uses of land, or immediate actions modifying or converting land cover. On the other hand, land cover refers to the natural vegetative cover types that characterize a particular area. Land-use change is the

proximate cause of land-cover change. The driving forces to this activity could be economic, technological, demographic, scenic and or other factors. Hence, Land Use and Land Cover dynamics is a result of complex interactions between several biophysical and socio-economic conditions which may occur at various temporal and spatial scales. Among others, the two International Conferences on the United Nations Conference on Environment, Development (UNCED) (Rio, 1992) and the World Summit for Sustainable Development (Johannesburg, 2002), called for substantive studies of land-use and land-cover changes and since then, it has become a global issue. This is because the effects of land-use and land-cover are directly related to the livelihoods of people in line with Goal 2 and 15 of the Sustainable Development Goals (SDGs).

According to Pimentel (1993), as cited in Bewket (2003), for almost all food requirements, people of the world depend on land resources, except for only 3% of the food which is coming from aquatic resources. Therefore, this important resource needs careful management for the sake of sustained ability to feed the world population. Even though natural processes may also contribute to changes in land cover, the major driving force is human-induced land uses (Allen and Barnes, 1985). To understand the various implications of land cover change, understanding of land-use change is essential. Different human driving forces mediated by the socio-economic setting and influenced by the existing environmental conditions, lead to an intended land use of an existing land cover through the manipulation of the biophysical conditions of the land (William et al 1994). The fact that human beings are the major contributors to land cover changes and are the ones experiencing the consequences of these changes makes it important to understand the interaction between humans and the terrestrial environment. This need becomes more imperative as changes in land use become more rapid affecting the livelihoods of societies.

Human populations and their use of land have transformed most of the terrestrial biosphere into anthropogenic biomes (anthromes). Such transformation has caused a variety of new ecological patterns and processes to emerge and has been significant for more than 8000 years (Ellis, 2006). Recently, issues related to LULC change have gained interest among a wide variety of researchers, ranging from those who favour modelling Spatio-temporal patterns of land conversion to those who try to understand the causes, impacts and consequences (Peter et al, 2015). Land use affects land cover and changes in land cover affect land use. A change in either, however, is not necessarily the result of the other. Changes in land cover by land use do not necessarily imply a degradation of the land. However, many shifting land-use patterns driven by a variety of social causes, result in land cover changes. These changes affect biodiversity, water and radiation budgets and other processes that come together to affect climate and biosphere. Human activities which are mainly driven by socio-economic factors bring out changes in non-built-up and built-up land despite restrictions by physical conditions.

Land cover can be altered by forces other than anthropogenic. Natural events such as weather, flooding, fire, climate fluctuations and ecosystem changes may also initiate modifications upon the land cover. There are also incidental impacts on land cover from other human activities such as forest and lakes damaged by acid rain from fossil fuel combustion and crops near cities damaged by tropospheric ozone resulting from automobile exhaust (Meyer and Turner, 1994).

Concerning the above problems, so many researches have been carried out on land use land cover to help urban and rural planners in decision making within and across the globe. Mark and Kudakwashe (2010) in a study in Shurugwi district in the Midlands Province of Zimbabwe observed the increase in cropland. He attributed this increase to the Land Reform and Resettlement Program. Large areas of forests were cleared for different farm-related activities like opening new farming plots, wood for fuel, poles for building both homes and cattle pens, among other activities. The built-up area around the water bodies in Davangere city, Karnataka, India has almost doubled between 1970 and 2005, at the cost of the agriculture land and scrubland (Begum et al. 2010).

Prakasam (2010) studied land use/land cover change over a period of 40 years in Kodaikanal taluk, Tamil Nadu. In this study, major changes were observed like the area under built-up land and harvested land increased whereas the area under forest and water body decreased. Javed and Khan (2012) studied land use land cover change due to mining activities from 2001 to 2010. The study revealed that significant decrease has been observed in dense forest area, cultivated land and water body, however settlement, wasteland land and uncultivated land has increased mainly due to anthropogenic activities.

Bisht and Kothyari (2001) have carried out land cover change analysis of Gurur Ganga watershed in Uttaranchal. The study from 1963 to 1996 and 1986 to 1996 revealed that the area under agriculture and settlement has increased whereas the forest and barren land show decline in the area. Dhinwa et al. (1992) studied the land-use change of Bharatpur district, the analysis in the study reveals that forest cover has been depleted whereas wasteland undulating terrain with or without scrub and rock outcrops has been increased during 1986 to 1989. Wizor and Eludonyi (2020) utilized GIS and RS in mapping LULC changes in the University of Port Harcourt host communities, mainly Choba, Aluu and Alakahia, between 2005-2010 and 2010-2015, to recognise the changes that have taken place in these periurban areas. The study revealed rapid growth in built-up land between 2010 and 2015.

Zubair (2006) researched change detection in land use and land cover in Kwara State, Nigeria while Ade and Afolabi (2013) monitored urban sprawl in the Federal Capital Territory of Nigeria using GIS and RS. Fabiyi (2006) also researched urban land-use change analysis of a traditional city

from RS data in Ibadan metropolitan area, Nigeria. Olusola (2012) also did research work on the assessment of rapidly changing urban land use with the aid of RS data and GIS. Mmom et al. (2013) examined the land use and land cover changes in Port Harcourt metropolis and its environs using GIS and RS techniques. The authors came up with the assertion that an analysis of land use/land cover changes is essentially the analysis of the relationship between man and land. Land use and land cover changes have become a central component in current strategies in managing natural resources and monitoring environmental changes.

There are so many other studies on LULC change detection all over the world, but there is no known research work on LULC change detection using geospatial techniques in Ukwuani LGA of Delta State, Nigeria. This is the gap that this present study seeks to fill. The aim of this study, therefore, is to geospatially map the LULC change in Ukwuani LGA of Delta State, Nigeria.

1.1 Study Area

The study area Ukwuani LGA is located in Delta North Senatorial District of Delta State, Nigeria which is usually referred to as Anioma (Figure 1). Ndokwa Land consists of three robust LGAs: (Ndokwa West, Ndokwa East, and Ukwuani). Ndokwa land lies between latitudes 50 48" N and 50 60" N and longitudes 60 08" E and 60 32" E of Delta State. Ukwuani land is bordered on the North by the Benin Division, on the south by the Ijaw Division, on the South-West by Urhobo and Isoko Divisions, on the East by the Niger River, on the North-East by Ika and Asaba Divisions. The important rivers in the region are Niger, Ethiope, Adofi, and Umu while the Ase creek is the major creek.

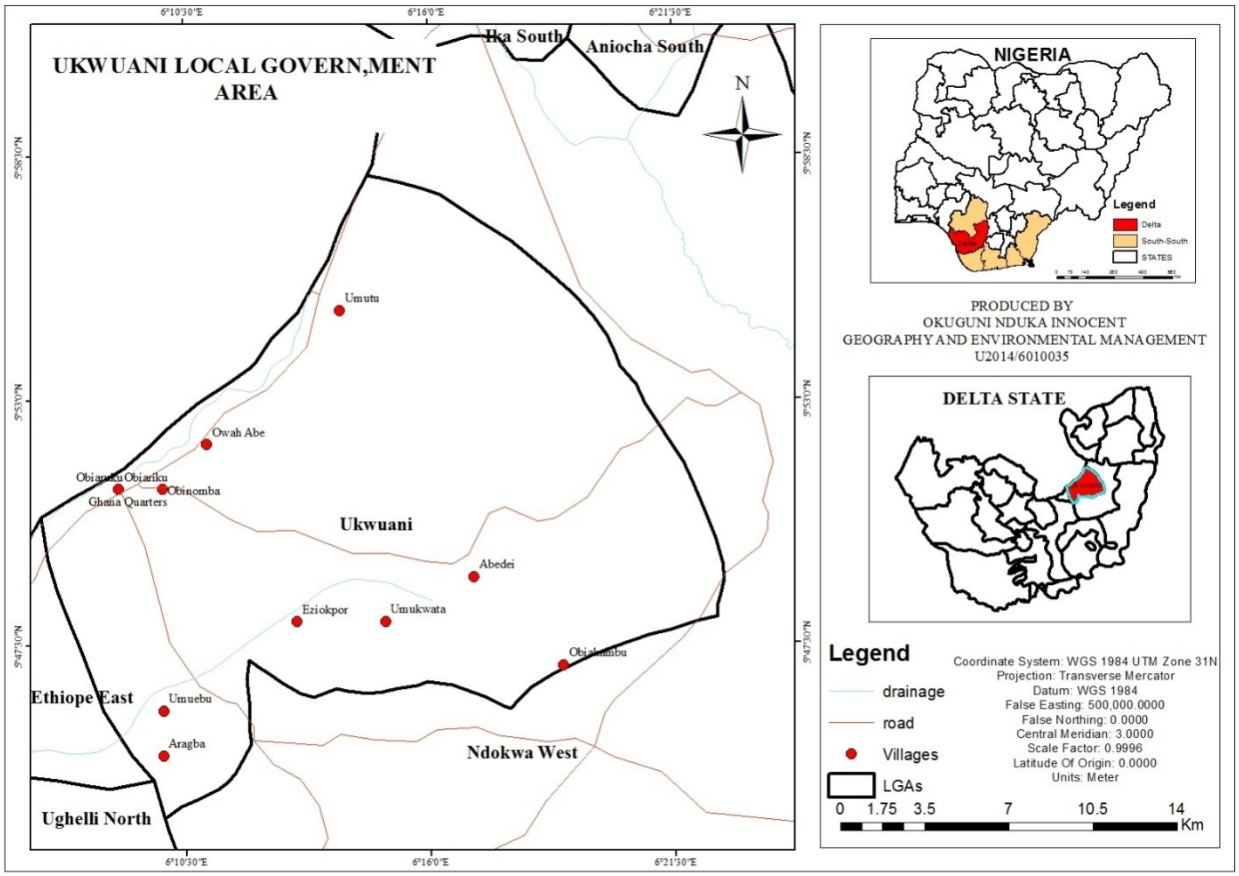

Figure 1: Study Area

Ukwuani Local Government of Delta State is a part of the Niger Delta Structural Basin in which three major sedimentary cycles have occurred since the early Cretaceous. The subsurface stratigraphic units associated with the cycles are the Benin, the Agbada and the Akata Formations. The surface rock throughout the state consists of the OgwashiUku formation. The Benin formation is about 1800m and consists of loose and unconsolidated sands. There is little hydrocarbon associated with it. The underlying Agbada Formation which consists of sandstone and shales is, however, rich in hydrocarbons. It is up to 3000m and is underlain by the Akata Formation. The Ogwashi Asaba Formation that underlies the northeast consists of an alternation of lignite seams and clay.

The entire Delta State is a region built up by the sedimentation of the Niger Delta and consists of the delta in various stages

of development. Four major physiographic units are identifiable within it. First is the freshwater swamp which is the most active area. It is located close to the River Niger. The second is the mangrove swamp area described as an intermediate delta stage, the third is the upland and swamp, which is also called the coastal plain while the fourth is the upland Niger valley, which is a narrow strip above the delta and relatively flood-free. The town of Asaba is located in this region. The River Niger drains this eastern flank of the state and discharges into the sea through its several distributaries such as the Forcados, Escravos and Warri rivers and creeks such as the Bomadi creeks, amongst others. Ukwuani LGA of Delta State is situated in the tropics and therefore experiences a fluctuating climate.

II. MATERIALS AND METHOD

For the study, Landsat satellite images of three different years were obtained and these various years are, 1990, 2002 and 2014 respectively. These Landsat images were obtained from USGS (U.S Geological Survey). High-resolution Satellite Image of the study area was also obtained from Google Earth. It is also important to state that Ukwuani LGA which was carved out using the local government boundary map and the administrative map was obtained from NASDRA; these data were georeferenced to universal transverse Macator projection in Zone 31N.

The following four software was used for the study:

- ArcGis 10.4: this software was used to complement the display and processing the data (for map embellishment and composition).
- Eardas Imagine: This application was used for the layer stacking of the Landsat images of the various years used in the project and also for subsetting, signature creation and classification of the images
- Microsoft Excel: This software was used to generate statistics and also generate the bar graph for the visual presentation of the detected changes in the land use land cover.
- Microsoft word: This software was used basically for the presentation of the research.

Base on the priori knowledge of the study area for over 10 years, brief fieldwork and additional oral interview in the study area, a classification scheme was developed and four classes were used for the classification (Table 1).

Table 1: LULC Classification Scheme

Code	LULC Classes	Color
1	Built up	Red
2	Water body	Blue
3	Cultivation	Yellow
4	Vegetation	Green

Six main methods of data analysis were adopted in this study. They are the calculation of the area in hectares of the resulting LULC types for each study year and subsequently comparing results, overlay operation, image recoding, maximum likelihood classification (supervised classification), layer stacking/band combination and signature creation. These various methods were used to identify changes in the land use types.

The comparison of the land use/land cover statistics assisted in identifying the percentage change, trend and rate of change between 1990 and 2002 and 2014 and 1990.Trend Percentage Change = (Observed Change/Sum of Change) x 100.

III. RESULTS AND DISCUSSION

3.1 Visual Presentation of the Detected Changes with Maps

This section of the study deals with the visual presentation of the detected changes in the Landsat images used in the study for the three different years.

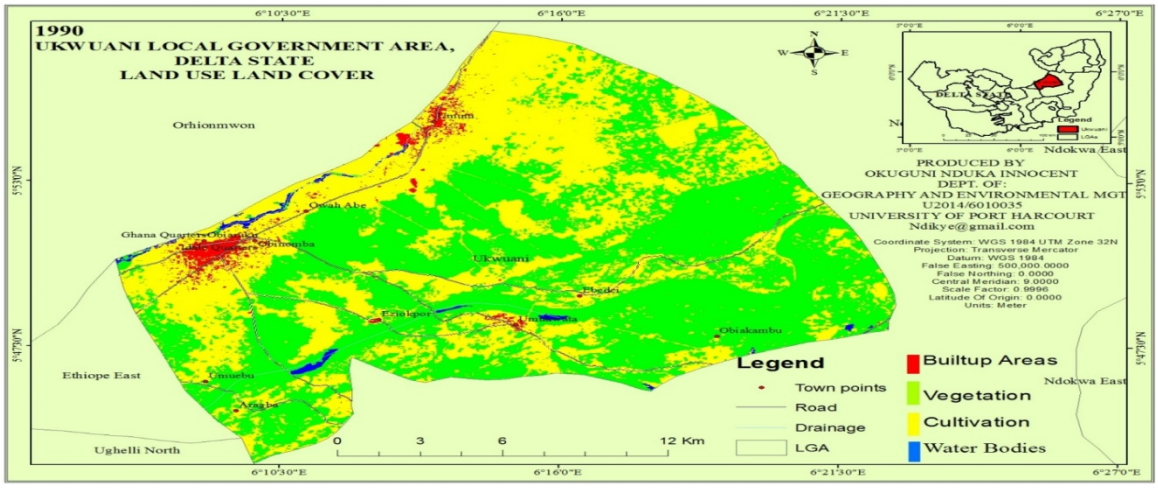

Figure 3: Map Derived from the Landsat Image of 1990 (Projected to UTM zone 32N)

Figure 3 is the starting year of the study. The map shows the distribution of LULC of Ukwuani LGA in the year 1990. On the map, the area covered by red indicates the built-up areas, green shows the vegetation, yellow shows the cultivation and areas covered by blue shows the water bodies in the study area. On the map also, there are roads, drainages, major town points and the neighbouring LGA boundaries.

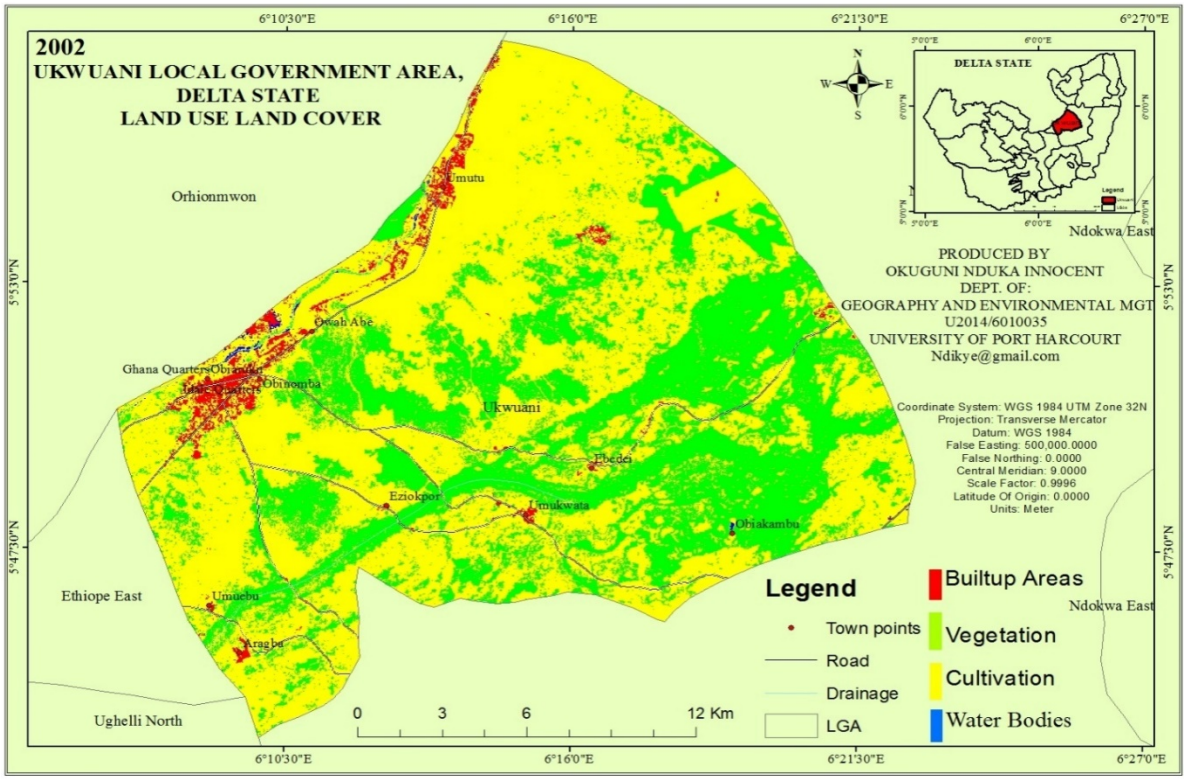

Figure 4**:** Map Derived from the Landsat Image of 2002 (Projected to UTM zone 32N)

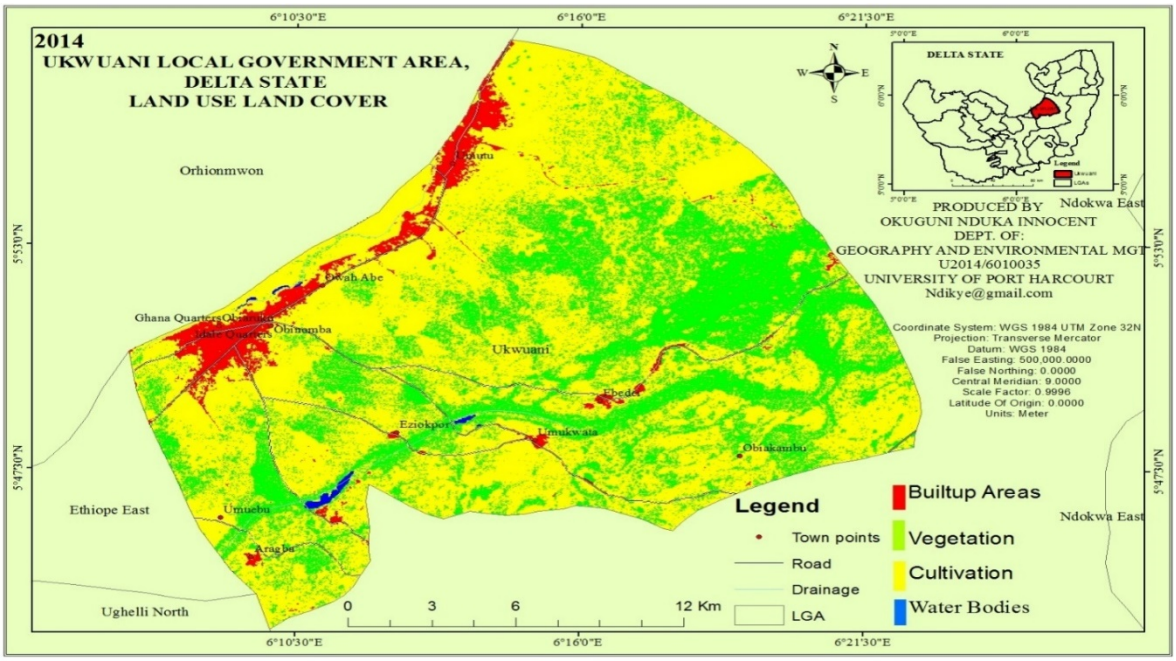

Figure 5: Map was Derived from the Landsat Image of 2014 (Projected to UTM zone 32N)

3.2 LULC Distribution

The static LULC for each study year as derived from the maps above are presented in Table 2. On Figure 6, the brown colour represents the result gotten for the 1990 classes, the Red colour represents the results of the 2002 classes and the blue colour represent the results gotten for the 2014 classes.

Table 2: LULC Distribution (1990, 2002 and 2014)

Class	1990 Km^2	2002 Km^2	2014 Km^2	Change (1990-2002)	Change (2002-2014)	% of Change (1990-2002)	% of Change (2002-2014)	Freq. of Change (1990-2002)	Freq. of Change (2002-2014)
Built Up	8.70	10.75	22.69	2.04	11.94	23.46	111.10	0.17	0.99
Cultivation	108.24	301.75	313.70	193.51	11.95	178.78	3.96	16.13	1.00
Vegetation	251.60	161.41	137.81	-90.19	-23.60	-35.85	-14.62	-7.52	-1.97
Water Body	3.12	1.37	1.08	-1.75	-0.29	-56.07	-21.08	-0.15	-0.02
Total	368.55	475.28	475.28						

The figures presented in Table 2 represent the static area of each LULC category for each study year. Built-up in 1990 occupies just 8.70km2 of the total classes. This is because the major means of livelihood was mainly agricultural activities and people were not interested in building houses, instead they live in hamlets inside their farms.

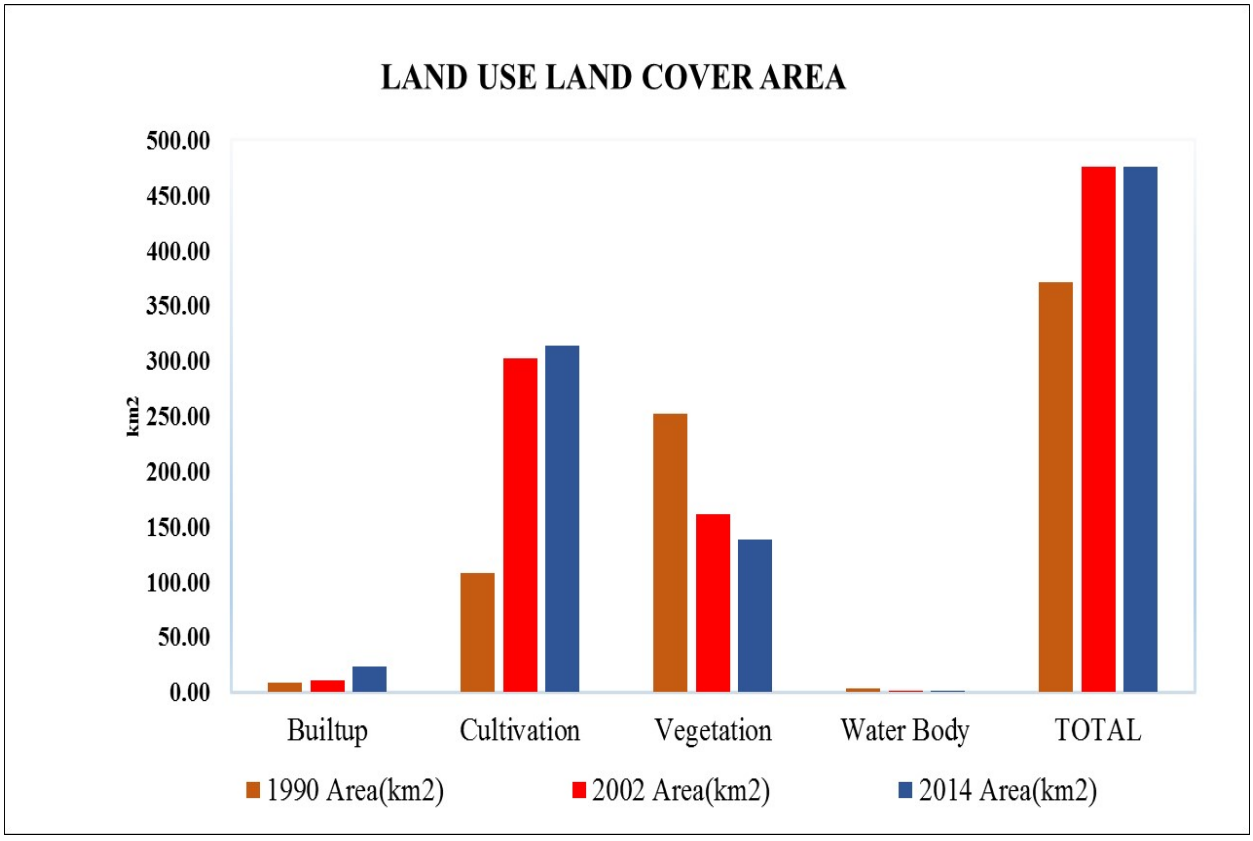

Figure 6: LULC Distribution Chart in the Study Area.

From Table 2 and Figure 6, in 1990, cultivation seems to be practiced predominantly, occupying a land area of 108.24km2 of the total classes. This may be because the LGA was typically a traditional setting than where farming seems to form the basis for living. Vegetation, however, was covering 251.60km2 land area due to the fact the population of the area was still small and there was a lot of land area that has not been altered. This result is consistent with the result of Achionye et al (2018) on LULC transition in the Warr vegetation zone of the Niger Delta, Nigeria which concluded

that there is a reduction in the mangrove and non-mangrove vegetation in the study area as against a haphazard increase in built-up areas.

Built-up areas significantly increased to 22.69 Km2 in 2014. This significant increase in built-up areas is likely due to the increase in the population of the LGA arising from the increased crude oil exploration and exploitation activities and the establishment of a private University in the LGA. The study of Wizor and Eludonyi (2020) is clear on the rapid increase of built-up land within the ten years investigated (2005-1015) in the University of Port Harcourt host communities, Nigeria.

3.3 Major Causes of LULC Changes in the Study

Table 7: Class Statistics of the Various Years

Field Statistics			
Classes	1990Area (km^2)	2002 Area (km^2)	2014 Area(km^2)
Built-up	8.70	10.75	22.69
Cultivation	108.24	301.75	313.70
Vegetation	251.60	161.41	137.81
Water Body	3.12	1.37	1.08
TOTAL	371.67	475.28	475.28

From the results in Table 7, built-up areas were observed to be increasing in the various years used for the project. This is as a result of development in the LGA. Crude oil was discovered in Ebedei community in Ukwuani LGA, and when the oil exploitation started, it brought about employment opportunities and people started moving to that area to settle in search of good jobs and this also attracted the attention of the state government in the area leading to the provision of basic infrastructures like primary health care centres, good roads, primary and secondary schools. Thus, built-up areas increased from 8.70km2 in 1990 to 10.75km2 in 2002 and 22.69km2 in 2014. This agrees with the study of Mmom et al (2013) which showed a rapid increase in built-up areas around the city of Port Harcourt. The study of Wali et al (2019) on LULC change in the wetland ecosystem of Port Harcourt metropolis, Nigeria, further corroborates this result.

Crude oil exploration and exploitation alone did not bring about these significant changes, the designation of Obiaruku Community as the headquarter of Ukwuani LGA also brought about development in that part of the study area because administrative buildings and administrative activities became prominent in the area. Obiaruku axis of the study area has a common boundary with Ethiope East LGA where Delta State University is located which also brought about changes/development in the study area. The establishment of a private University in Amai community also brought about the increment of built-up areas and the reduction of cultivation and vegetation in the study area in the various years used in the study.

As a result of these developments, some areas that were initially covered by vegetation were cleared as people started cultivating them due to the increasing population in the study area. This is because farming is still a major means of livelihood of the population living in the LGA. This accounted for the reason why cultivation keeps increasing while vegetation keeps reducing in the various satellite images used for the study. Cultivation increased from 108.24km2 in 1990 to 301.75km2 in 2002 and 313.70km2 in 2014. Due to the increasing population, areas initially covered by vegetation started decreasing from 251.60km2 in 1990 to 161.41km2 in 2002 and 137.81km2 in 2014. The in-depth study of Xiaojuan et al (2018) on LULC changes and their influence on the ecosystem in Chengdu city, China, which showed notable loss of farmland and forest land from 1992-2018 corroborates the result of this present study.

3.4 Impact of LULC Changes on Human and The Environment

Table 8: Change Detection between 1990-2002 and 2002-2014

Change Detection		
Classes	Change (1990-2002)	Change (2002-2014)
Built-up	2.04	11.94
Cultivation	193.51	11.95
Vegetation	-90.19	-23.60
Water Body	-1.75	-0.29

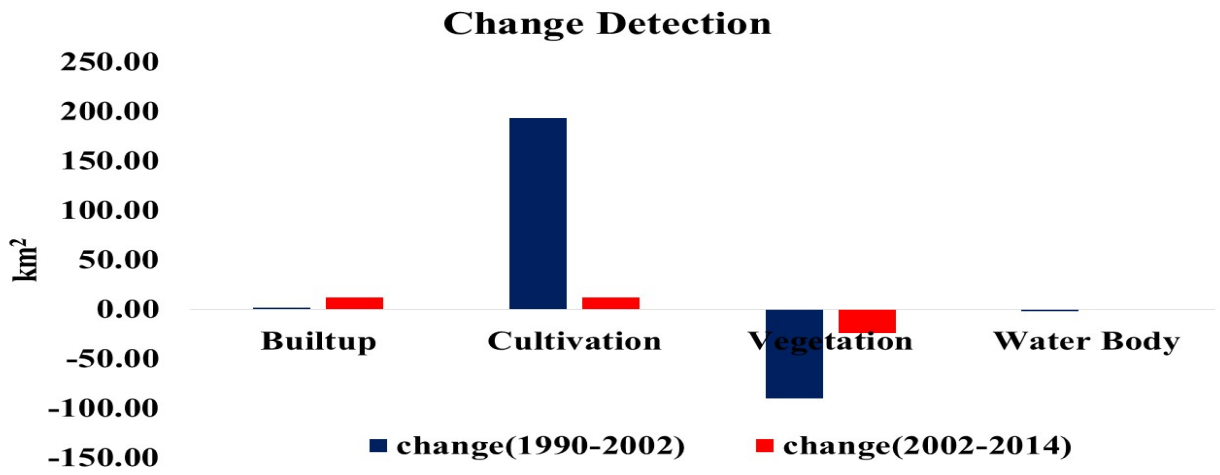

Figure 7: Change Detection between 1990-2002 and 2002-2014

Figure 7 shows the effect of LULC changes in the different classes. These changes are as a result of anthropogenic activities arising from the increasing population in the study area. There was an increase in cultivation which have to do with different farming practices and the effect can be traced back to the practices, the effects on the environment varies based on the wide variety of agricultural practices employed in the study area. These impacts on the environment include loss of soil nutrients, climate change, deforestation, irrigation problems and environmental pollution as a result of chemicals and fertilizers used in agricultural activities, and also reduction of oxygen (O2) in the environment. The decrease in the area covered by vegetation leads to loss of biodiversity and also environmental degradation. The increase in the built-up areas has both negative and positive effect on the environment; the positive effect is that it shows the level of development and standard of living in the study area while the negative impact on the human environment in the study area is that increase in building activities leads to loss of space, concretization, high surface run-off, poor percolation of precipitation and indiscriminate waste disposal. The decrease in the water bodies in the various Landsat images used in the study area have negative impacts which include loss of aquatic life, loss of soil nutrient, reduction in the water table and underground water as regards to reduction in percolation and infiltration.

IV. CONCLUSION AND RECOMMENDATIONS

This study emphasizes the LULC changes taking place in Ukwuani LGA, Delta State, Nigeria. It is very vital for Ukwuani LGA and indeed all peri-urban and urban areas in Nigeria to explore and respond to LULC transformations to ensure sustainable urban and regional development planning. It is our firm belief that this study can be a reference point and basis for improving high-level decision-making particularly with regards to the management of land resources. The importance and efficiency of geospatial techniques (GIS, map visualization and RS) in capturing, manipulation and analysis of Spatio-temporal data) was demonstrated in this study.

Four LULC classes (Built-up, Cultivation, Vegetation and Waterbody) were distinctly produced for each study year (1990, 2002 and 2014). The results indicate a rapid growth in built-up land between 1990 and 2002 and also in 2002 and 2014. From the changes detected and from the authors' observations in the study area, it is obvious that the built-up areas will continually increase. The result further showed that the areas covered by vegetation has continually declined while cultivation has increased sharply due to the rapid increase in population. This decline in vegetation and an increase in cultivation to a large extent reflects the livelihood of majority of the people living in the study area who depend on agriculture.

Under the current urban and regional development planning model in Nigeria, the government should take into cognizance, the LULC changes that are occurring in most rural, peri-urban and urban areas to be able to make an effective plan for the people living in these areas. Encouragement should be given to people to build towards the outskirts through the provision of incentives and forces of attraction that are available at the city centre in these areas. With the continual reduction of vegetation in the various years used for the study, the study further recommends that the government should encourage afforestation and resources conservation in the study area to reduce the loss of biodiversity with its associated negative consequences of high rates of extinction and a worldwide depletion of biological diversity at genetic, species and ecosystem levels. It is also believed that these actions will reduce the level of carbon (iv) oxide and increase the level of oxygen in the human environment. Finally, there should be constant monitoring of LULC in Ukwuani LGA, other peri-urban and urban areas in Nigeria by academic researchers, and all tiers of government using geospatial techniques to know the extent, rate and direction of change for effective land management and planning.

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