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# **Land Cover Change and the Associated Socio-Economic Driving Forces in Uruan Local Government Area, Akwa Ibom State**

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## ***Abstract***

*The study assessed the socio-economic drivers of land cover change and its implications on the livelihood opportunities in Uruan Local Government Area Lands at images of 1986, 2003 and Nigeria-Sat 1 of 2013 were obtained from United States Geological Surveys and used for the study. The images were processed using unsupervised classification algorithm in Erdas Imagine 9.2 and post classification change detection technique was subsequently carried out in ArcGIS 9.2. 75 Global positioning System (GPS). Points were also collected for the purposes of ground trothing/accuracy assessment of the processed images. Furthermore, a field survey was carried out where 10 villages randomly were selected from 47 villages in the study area, with four hundred (400) copies of the questionnaire administered to households of the sampled villages using the systematic random sampling technique. A total of five broad land cover classes were identified and mapped. These were open water, swamp forest, bush fallow, compound farmland and built up. The maps were used to assess changes in land cover for 1986, 2003 and 2013. Natural increment, migration, wood extraction, government investment, public attitude and bush fallowing were used as socio-economic drivers of land cover changes in the study area. The study revealed that, these land cover classes have experienced various forms of transformation with built-up and swamp forest being the most affected. Such changes are largely due to the socio-economic drivers such as natural increment, uncontrolled wood extraction, and public attitude. The study identified the loss of swamp forest, decrease crop yields and loss of means of livelihood as implications of the changes in the study area. It was recommended that effective policy implementation to check unsustainable practices such as unnecessary deforestation and wood extraction from the natural forest, which have been found to aggravate land degradation in the study area, be put in place.*

***Keywords:*** *Images processing, Land cover change, socio-economic, driving forces.*

## **Introduction**

Over the last 10,000 years, about half of the earth surface has witnessed tremendous change largely due to the result of alteration of land cover by humans (Lambin et al., 2008). According to Veldkamp and Lambin (2001) in Ramankatty and Coomes (2016) an important challenge facing

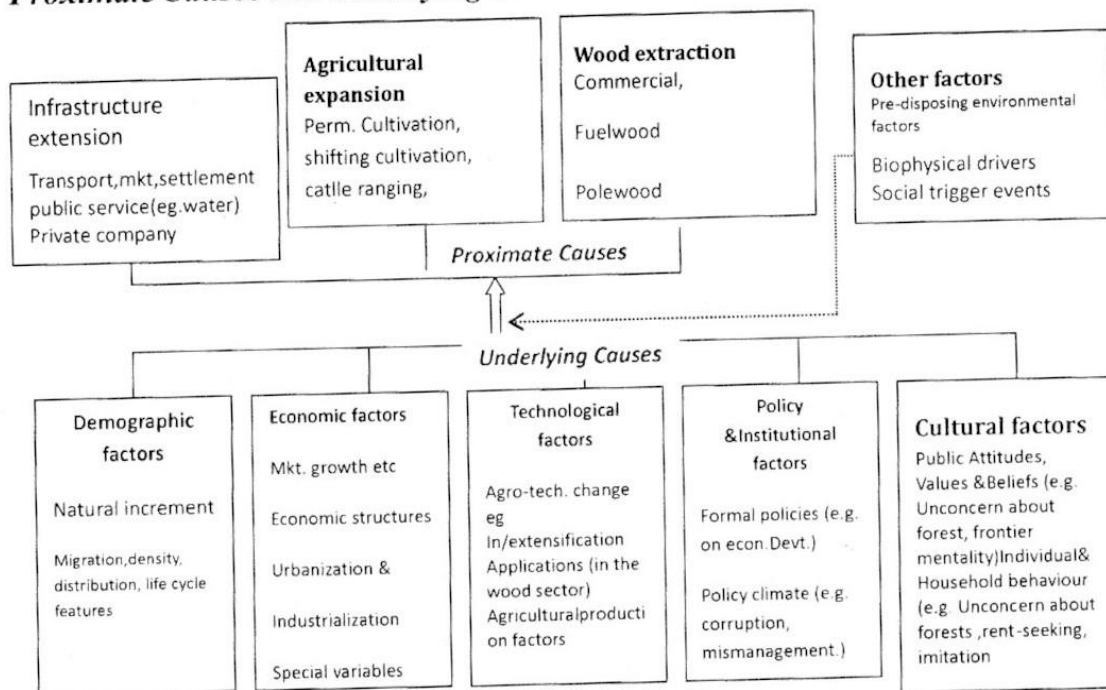
global change science is the prediction of future states of land cover. Foley et al. (2005) stress that land use and cover change is a major cause of global environmental change. In the opinion of Skokanová, Falt'an and Havlíček (2016), the structure of a cultural landscape is largely determined by human decisions: by direct or indirect impacts of human activities. In terms of Nigeria, FAO (1997) remarked that the country has the world's highest deforestation rate of primary forests and has lost half of its primary forests in the last twenty years through logging, subsistence agriculture and collection of fuel woods. In a related study, Balogun and Salami (2016) stress the need for an early monitoring of the biofuel production activities in Nigeria so that the country can maximize the benefits and perhaps control land cover change resulting from such activities. This is basically as a result of increase in human activities over the surface of the earth. Such changes must therefore be understood and tracked in order to check the negative effects of the change on other components of the environment. This calls for land cover change detection, analysis and assessment of the change drivers. It is a fact that the process of change is very complex, having been driven by a number of factors which interplay in a complex manner to produce the perceived land cover change scenario. The goal of land cover change analysis revolves around two central and interrelated issues; the drivers and the impacts of the land cover changes. The drivers of the change are the causes and processes that bring about the change, while the impacts are the consequences of the change (Dami, et al, 2011). Anthropogenic changes in land cover are being increasingly recognized as critical factors influencing global change.

In general, the study of impact of land cover change has received more attention and publicity than the drivers simply because it is the impacts that are readily felt. In most cases, the appreciation and consideration of the drivers is low. Land cover change over time is an inevitable phenomenon occurring globally due to both temporary and permanent interest of the inhabitant in a particular area. Land cover changes are local and place specific, occurring incrementally in ways that often escape our attention (De-sharbinin, Kline and Raustiala, 2002). According to Briassoulis (2000), "the precise meaning of the 'drivers' of land cover change is not always clear, commonly accepted and/or understood by all those who engage in studies of land cover change. According to the work, frequently, certain driving forces are emphasised over some others and there is confusion as to the semantic categories to which of these causes of land cover change belong". According to her, the principal distinction is made regarding the origin of the drivers of land cover change. In the light of this, the work distinguished between biophysical and socio-economic drivers, which distinction according to her, is almost unanimously accepted.

While the biophysical drivers of land cover change are therefore the characteristics and processes of the natural environment including landforms, topography, weather and climate variations, geomorphic processes, volcanic eruptions, and plant succession, the socio-economic drivers on the other hand, consist of demographic, social, economic, political and institutional factors and processes such as population and population change, industrial structure and change, technology and technological change, the family, policies and rules, values, community organisation and norms and property regime. The regular use of land and land resources has high propensity to alter

the vegetation, soil characteristics, the terrain and other components of the environment. This alteration quite often assumes the forms of land cover conversion and modification. Land cover change leads to change in land use, and is therefore affected by socio-economic indicators such as rural income, agricultural productivity, wealth and education (Muller and Zeller 2002). To have a better understanding of the drivers of land cover change, Geist and Lambin (2002) presented the following schema in an attempt to analyse the causes of land cover change, and would be useful in streamlining change drivers as variables in this study.

### *Proximate Causes and Underlying Causes*



**Figure 2.1: Schema of the Driving Forces of Land Use/Cover Change**

*Source: (Geist and Lambin, 2002).*

Briassoulis (2000) also distinguishes between environmental and socio-economic impacts of land cover change. According to her, environmental impacts receive more attention than the socio-economic impacts. This is simply because socio-economic impacts are more subtle, longer-term and subject to the influence of many more complexes, less visible and verifiable than the former. But it should be noted that both are interrelated. Environmental impacts causes socio-economic impacts which then offers feedback to the former again, potentially causing successive rounds of land cover change (Briassoulis, 2000). As such, the sequence of land cover change therefore starts with forest clearing, cultivation, heavy grazing and ultimately, land abandonment and movement to another location (along newly built highways which serve soil drilling sites) where the sequence is repeated. Growing human populations exert increasing pressure on the landscape as demands multiply for resources such as food, water, shelter and fuel (Brandon, 1998). Land resources play important role in the economies of many countries. However, it appears that land resources are at a great risk because of severe exploitation. The uncontrolled conversion of forests into other land

cover types and uses is an internationally recognized problem. Trees are seen as obstacle to progress and their removal viewed as the first stage in development (Atser, Faith, Ituen and James, 2014).

In the rural areas of Akwa Ibom State, according to (Atser et al, 2014), yearly use of the land with no attention to sound land management practices to compensate for any form of change, or perhaps degradation that might have occurred over time, may permanently limit the ability of such land area to continue to yield the much needed productivity given such usage. Although it is obvious that the land cover has changed, nothing is being done to identify and scientifically investigate the important driving forces of such changes. In a related study, Ituen et al (2006) utilized lands at TM of 1986 and ETM of 2003 in determining LUCC and the associated drivers in northern Akwa Ibom State, Nigeria. The result which detected agricultural extensification in this rural area recognised the slash and burn mode of land preparation as the major driving force of LUCC. The work therefore concluded that effective policy framework amongst other things would help reverse this trend.

Although land cover change drivers could be broadly grouped into biophysical and socio-economic, according to their origin, the review of related literature reveals local variability of the drivers. What significantly drives land cover change in area A may not be the same for area B. As such, local knowledge of the land cover change processes in areas considered and the interaction involved are indeed more useful in identifying the key drivers of interest.

In the light of the above, this study seeks to assess the socio-economic drivers of land cover change in Uruan Local Government Area, within the period of 27 years (1986- 2003-2013). The work relied on remote sensing data and field survey in a GIS environment to map the status of land cover change with a view to assessing the rate of changes on the land cover and its implication on livelihood in Uruan L.G.A.

## **Aim and Objectives**

### **Aim**

The aim of this paper was to assess the socio-economic drivers of land cover change in Uruan local government area of Akwa Ibom State, using remote sensing data and GIS techniques.

### **Objectives**

The following specific objectives were pursued in order to achieve the above aim:

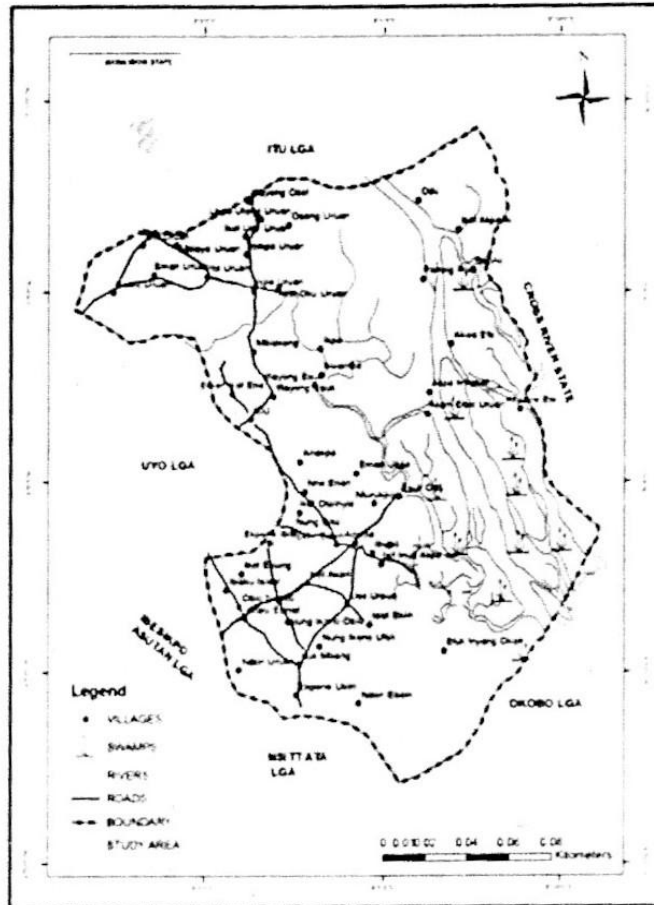
- i. To carry out land cover inventory and mapping of the area for the years 1986, 2003 and 2013.
- ii. To evaluate the socio- economic driving forces of land cover change in the study area.

### **Study Area**

Uruan L.G.A of Akwa Ibom state was used as the study area for this work. The area is located between latitudes 04° 52' 15.59" and 05° 8' 15.98" north of equator and longitudes 008° 02' 27.68" and



008° 05' 21.96" east of the Greenwich meridian. It is bounded in the north by Itu LGA, West by Uyo, Ibesikpo Asutan, and Nsit Atai L.G.A., to the south by Okobo L.G.A. and east by Cross River state. The local government area occupies a total landmass of approximately 422 square kilometers, with 47 villages. The population of the area is 158,306 inhabitants (AKSMED, 2014). The capital of the L.G.A. is Idu Uruan.



**Figure1a: The Study Area: Uruan Local Government Area.**

**Source: Akwa Ibom State Ministry of Lands and Town Planning, Uyo**

This study area belongs to the tropical humid climate with two main seasons, namely: the rainy and the dry seasons. The wet or rainy usually begins from the end of the month of April and lasts till the end of the month of October, while the dry season starts from November and lasts till the month of March or later.

In terms of relief, Uruan Local Government area has a rugged terrain, hill and ravines, especially in the northern region of the area where erosion activities predominate. In the southern region, the land is generally flat, though with undulating characteristics in some villages like Ndon Ebom, Eman Ukpa, Adadia, etc. Mangrove swamps are developed in the coastal and estuarine areas in the state, and do extend at a very rapid rate into the estuaries and flood plains of Uruan. The mangrove occupies tidal flats, laced with tidal channels and winding waterways of above twenty meters wide. There are small creeks that meander through the area. The swamps in the study area are not

fully utilized; hence its potential for rice cultivation is high and valuable. The area is drained by the Cross River. The river has many tributaries such as the Ikpa River, which drains the central part of the study area.

Since the return to democratic rule in 1999, this area has witnessed government investment which has actually led to land acquisition for infrastructure development. Much of such developments have actually also touched on the lives of the people of Uruan LGA. Such developments include the Ibom five Star Hotel/Golf Resort at Nwaniba, the Dualization of Nwaniba Road, the Ibom International Airport, etc. These are expected to contribute in driving change in land cover in the area.

### **Materials and Methods**

To achieve the objectives of the study, a combination of datasets from secondary and primary sources were collected and utilized. The secondary data utilized included:

- (a) Lands at satellite images for 1986, 2003 and Nigeria Sat-1 of 2013 were acquired and used for the study. The 1986 and 2003 images were obtained from United States Geological Survey (USGS), while the 2013 image were obtained from the National Centre for Remote Sensing (NCRS), Jos.
- (b) A vegetation and land use/ cover map of the study area was also acquired from the Cross River Basin Development Authority (CRBDA). This was used as ancillary data for accuracy assessment of the 1986 classified image.

Primary data were obtained with the use of structured questionnaire and interviews.

The questionnaire was structured based on socio-economic data of land cover drivers. Such drivers include wood extraction, natural increment, migration, government investment, public attitude and bush fallowing. This was also used to acquire ground truth to the changes in land cover in the study area.

During the field survey, structured interviews and discussions were held with individuals and community leaders who were knowledgeable people in the communities that have resided in the study area for over 28 years. In order to obtain socio-economic data from households in the study area, a household survey was conducted.

Uruan Local Government Area has a total population of 158,306 based on 2015 estimates (AKSMED, 2014). There are 47 villages making up the Uruan Local Government Area. Using a combination of the stratified and simple random sampling procedures, (10) villages were selected: The villages included; Idu, Nwaniba, Ifiayong Usuk, Ndon Ebom, Mbiaya, Ita, Ituk Mbang, Nung Ikono Ufok, Ekpene Ukim, and Ibiaku. In administering questionnaire, households were chosen using the systematic random sampling procedure. In determining the sample size however, Taro Yamene Formula for finite population was used and a total of 400 questionnaires administered.

The map used in this research was obtained in the analogue format, scanned, georeferenced and digitized through heads-up digitising in ArcGIS 9.2 software. In order to integrate data from various sources, scales, and projections, the different maps were reprojected to Universal Transverse Mercator (UTM), world Geodetic Surveys (WGS) 1984 zone 32.

Erdas Image 9.2 was used to layer stack, Mosaic, create area of interest (AOI) and subsequently subset the three images. The said images were processed using the unsupervised image processing technique. The following schema summarizes the research methodology.

In order to assess the accuracy of land use cover maps extracted from satellite data, 1986 classified image was compared with that of land cover and vegetation map published by the CRBDA in 1986. Further, a field check was undertaken using GPS to captured longitudes and latitudes of 75 points randomly in the study area. This was used to assess the accuracy of the image classification on the 2013 classified image. These methods proved very reliable in generating valid land cover categories for the study.



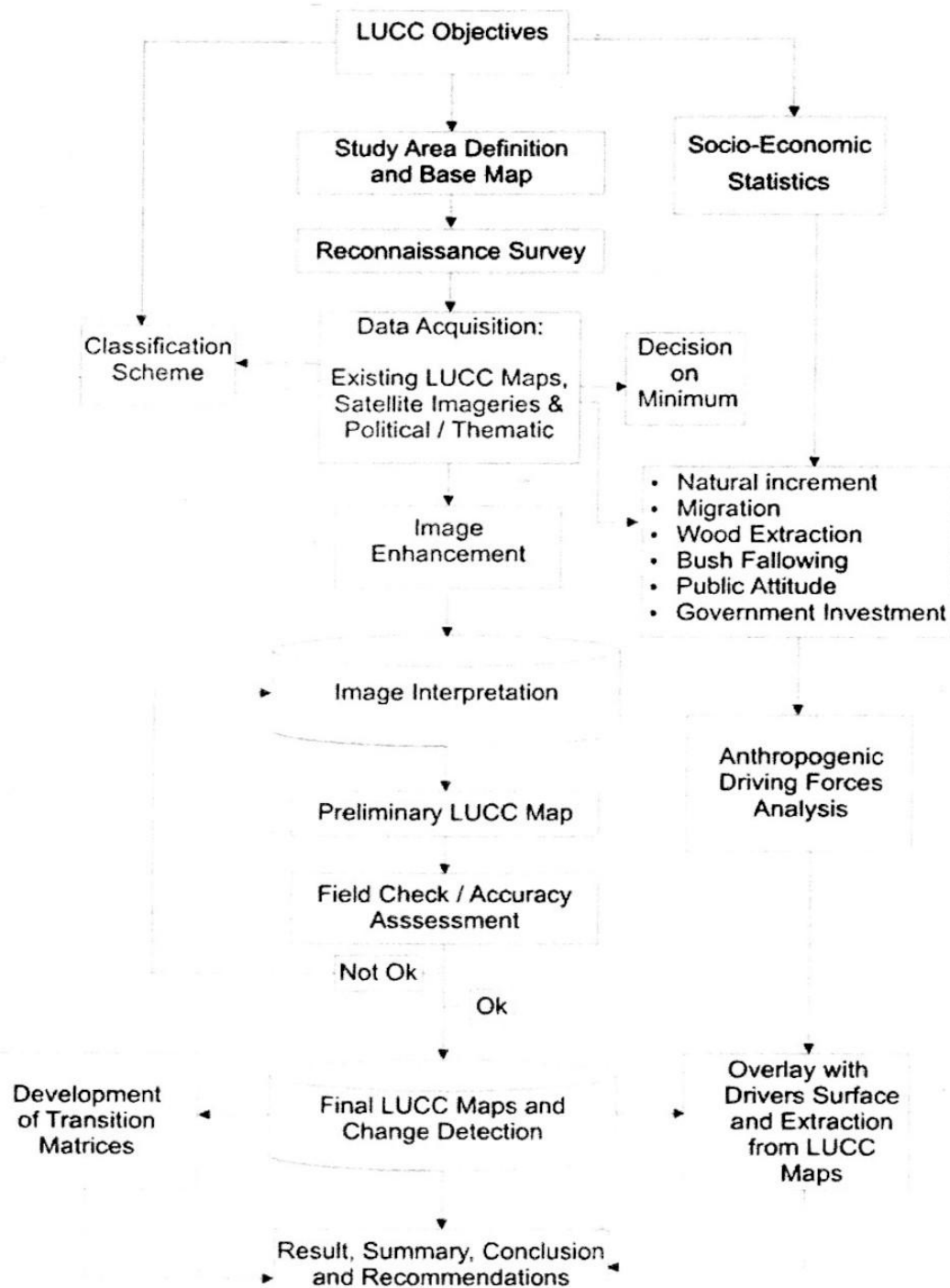


Figure 3.1: Schematic Diagram of the Research Work

Source: Modified from Ituen (2007)

## Results and Discussions: Land Cover Inventory and Mapping

In this section, the results of image analysis and change detection are presented. However, in order to capture changes that have occurred in the area, the data generated from the analysis have been summarized in tables for clarity. Tables 1, 2 and 3 indicate the land cover status of the study area for the years 1986 and 2003, 1986 and 2013, 2003 and 2013 respectively.

**Table 1: Land cover class inventory (1986-2003)**

S/N	Classes	1986(km)	2003(km)	Change (km)	Change (%)	Change/ yr. (km)
1	Open water	28.41	26.40	1.99	2.49	0.22
2	Swamp forest	234.96	195.84	39.07	49.03	2.31
3	Bush fallow	95.42	89.59	5.84	7.31	0.35
4	Compound farmland	62.01	77.64	-15.63	19.62	0.93
5	Built up	40.87	64.04	-17.16	21.55	1.11
	Total	461.58	453.51	79.66	100	

*Source Researchers Analysis (2015)*

**Table 2: Land cover class inventory (1986-2013)**

S/N	Classes	1986(km)	2013(km)	Change(km)	Change (%)	Change/ yr. (km)
1	Open water	28.3887	29.6302	1.2415	1.01	0.046
2	Swamp forest	234.8957	174.8886	60.00071	13.1	2.2225
3	Bush fallow	95.419	91.7067	3.7123	0.81	0.1375
4	Compound farmland	61.9994	88.494	26.4946	5.81	0.9813
5	Built up	40.8742	72.802	31.9278	6.99	1.1825
	Total	461.577	457.5215	123.3762	26.98	

*Source Researchers' Analysis (2015)*

**Table 3: Land cover class inventory (2003 and 2013)**

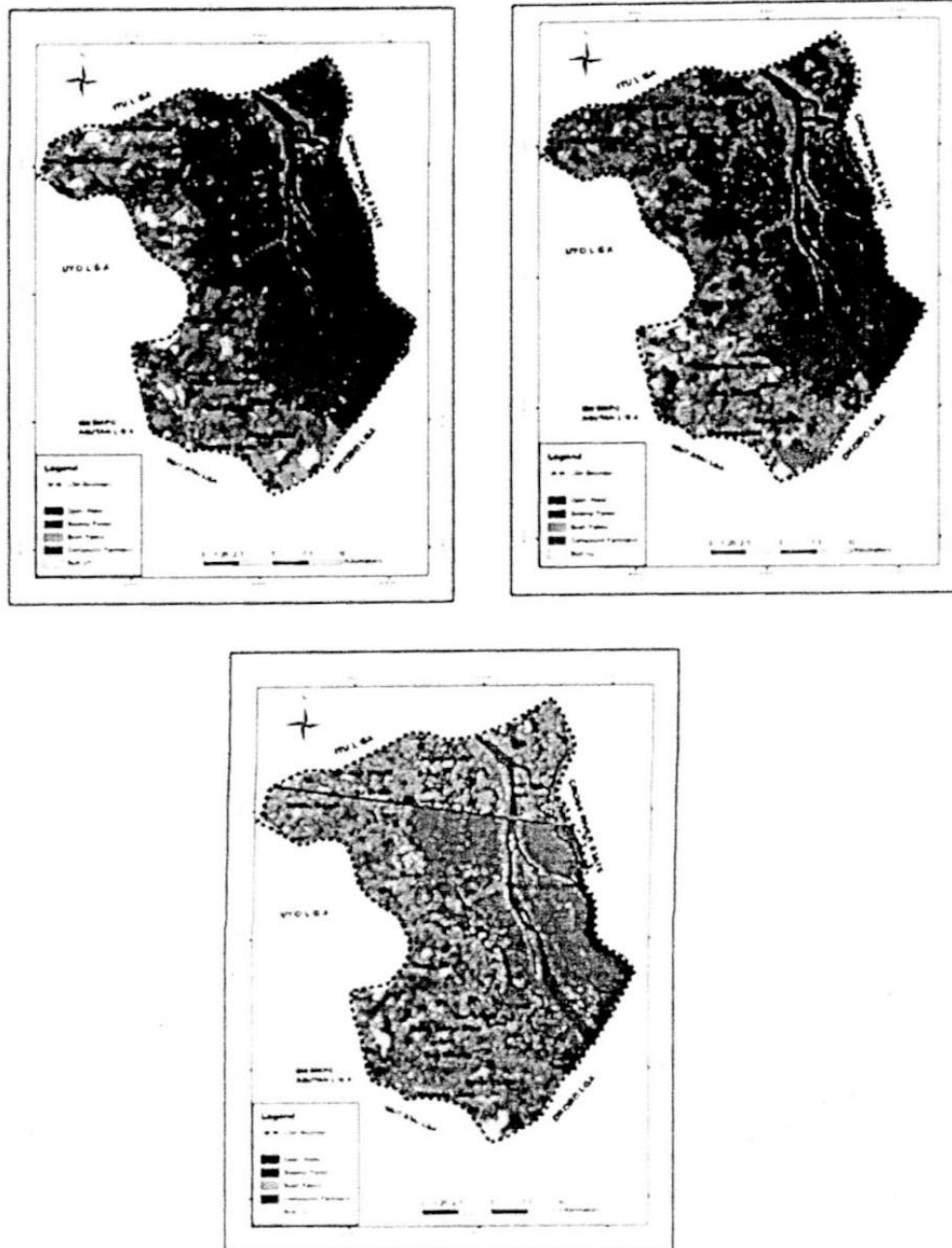
S/N	Classes	2003(km)	2013(km)	Change(km)	Change (%)	Change/yr. (km)
1	Open water	26.4031	29.6302	3.2271	7.03	0.3227
2	Swamp forest	195.843	174.8886	20.95444	45.63	2.0954
3	Bush fallow	89.5926	91.7067	2.1141	4.60	0.211
4	Compound farmland	77.6317	88.494	10.8623	23.65	1.0862
5	Built up	64.0354	72.802	8.7666	19.09	0.8767
	Total	453.5058	457.5215	45.9245	100	

*Source Researchers' Analysis (2015)*

Based on the land cover statistics between the base year 1986 and 2003 in Table 1, it is clear that during the 17 year period, there was a decrease of 1.98sq.km of open water. This however represents 2.49% of the total change. Similarly, open water increased by 1.25% between 1986 and 2013, and kept increasing between 2003 and 2013 by 3.23sq.km. This is however in line with global trends where climate change has induced expansion in water bodies generally. In terms of swamp forest, the study revealed a significant decrease of 39sq.km (49.03% change) between 1986 and 2003 in 17 years, 60sq.km (13.10% change) between 1986 and 2013 in 27years and 20.96sq.km (45.63% change) between 2003 and 2013 within 10 years. This implies that, throughout the study periods, swamp forest has been shrinking signifying possible increase in human activities within this study area. Another decrease was experienced in the area covered by bush fallow. Thus, bush fallow shrunk by 5.83sq.km (representing 7.31% of the total change within the study period) between 1986 and 2003, 3.72sq.km (representing 0.81% of the total change within the study period) between 1986 and 2013. However, between 2003 and 2013 bush fallow increased by 2.22sq.km (i.e. 4.60% change) between 2003 and 2013.

Compound farmland increased by 15.63sq.km (19.62%) between 1986 and 2003, 26.49sq.km (5.81%) between 1986 and 2013, 10.86sq.km (23.65%) of increased between 2003 and 2013. Equally, built-up increased by 17.16sq.km (21.55%) between 1986 and 2003, 31.93sq.km (6.99%) between 1986 and 2013 while 8.77sq.km (19.09%) increased between 2003 and 2013 (see Tables 1 to 3 and Figures 1 to 3 for details).





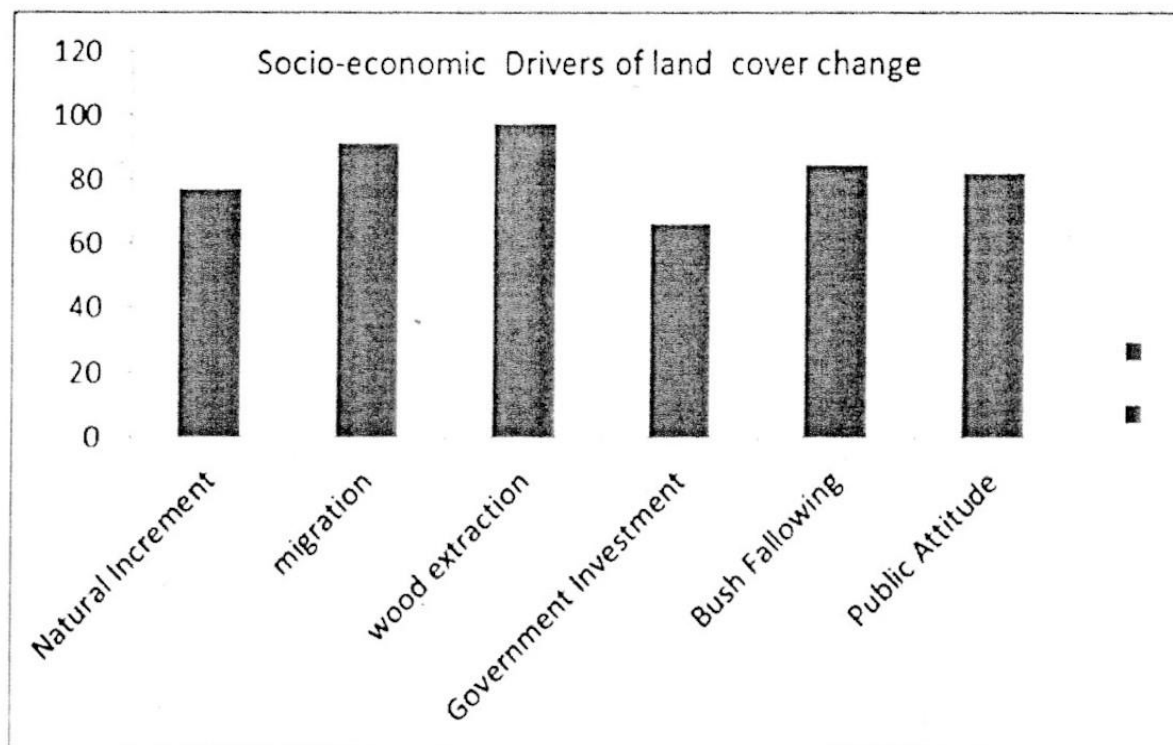
**Figure 1:** Land Cover Status of the Study Area for 1986 **Figure 2:** Land Cover Status of the Study Area for 2003 **Figure3:** Land Cover Status of the Study Area for 2013

### Assessment of the Socio-economic Drivers of Land Cover Change

The socio-economic drivers were identified through information obtained from questionnaire and interview. As shown in Figure 4, of the socio-economic drivers of land cover change in the study, wood extraction was identified as the highest socio-economic driver that drives land cover change in the study area with 18.8%. This therefore explained the massive reduction in the size of the

swamp forest presented earlier. Uruan L.G.A. is very close to Uyo the capital city of Akwa Ibom State. This close proximity to Uyo implies that most of the firewood needs of the city are sourced from this swamp forest. The interviewees in the study area also corroborated this fact. Generally, this is rightly so, as the swamp forest is constantly and unsustainably exploited and logged for timber, firewood and canoe making by the households in the study area

After wood extraction is migration 18.4%. With the opening up of the area through massive government investment in the area like the Le-Meridean international Golf resort, the dualization of Nwaniba road and the location of the Ibom International Airport, etc., land acquisition has been on the increase. Therefore, many urban dwellers looking for land for residential and other purposes now scramble around Uruan for such. This has brought about an accelerated urbanization of the area. The Land cover statistics in Tables 1 to 3 attest to this. Other assessed drivers include bush following 17.4%, public attitude 16.5 and natural increment is 15.3%.



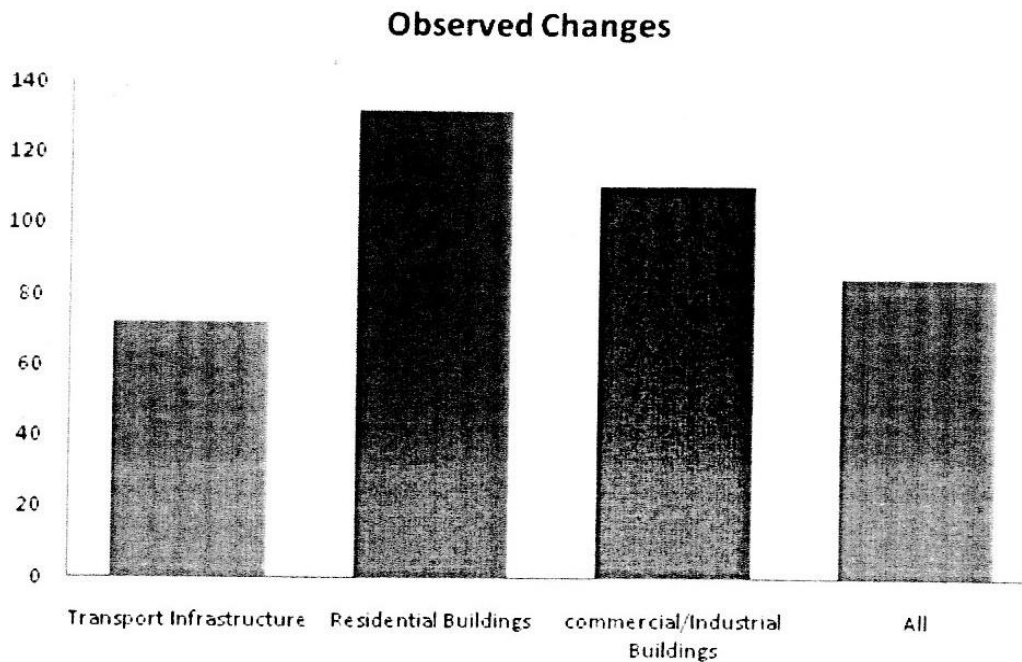
**Figure 4:** Socio-economic drivers of land cover change in the study area.

Source: Researchers analysis, (2015)

#### **Observed land cover changes by household in the study area**

On land cover changes observed by households in the study area, they acknowledged the significant changes in land cover.

Information gathered reveals that in the 1980s, the areas covered by residential, commercial and industrial buildings as well as transport infrastructure was small, and area covered by farmlands was expensive.



**Figure 5:** Observed land cover changes by household in the study area

Source: Researchers analysis, (2015)

### Conclusion and Recommendations

The study represents an attempt to understand the changes that occurred in the land cover of the study area between 1986 and 2013 with a view to assessing the socio-economic drivers of the land cover change and its implication on livelihood opportunities in the study area. To achieve this aim, two approaches were considered appropriate and integrated to provide a basis for sustainable land use planning. Firstly, a social survey was conducted to capture information on the socio-economic drivers and livelihood opportunities in the study area. The second approach involved the use of remote sensing techniques to detect changes that have occurred between 1986 and 2003, 1986 and 2013, and 2003 and 2013, using Landsat imageries. However, a combination of these two perspectives provided a deep understanding of the emerging realities in land cover utilization and management in the study area, as well as providing needful information for future planning.

The remotely sensed data was analysed using unsupervised classification in conjunction with a maximum likelihood algorithm in Erdas Imagine 9.2 software for inventory reporting. Arcmap 9.2 was used for the transition matrix. The result of the analysis revealed that open water has changed in the study area from 2838.87ha in 1986 to 2640.31ha in 2003 and 2963.02ha in 2013. Swamp forest changed from 23489.57ha in 1986 to 19584.3ha in 2003 and 17488.86ha in 2013. Bush fallow changes from 9541.9 in 1986 to 8959.26ha in 2003 and 9170.67ha in 2013. Compound farmland changed from 6199.94ha to 7763.17ha between 1986-2003 and 8849.4ha in 2013. Built-up expanded from 4087.42ha in 1986 to 6403.54ha in 2003 and 7280.2ha in 2013.

In terms of the socio-economic drivers, it was discovered that wood extraction and migration were



top on the list. Others included government policy, public attitude, etc. (see Figure 4). The land cover change has therefore negatively affected the livelihood opportunities of the people in terms of rich agricultural land converted to built-up and other related covers. This has exposed the people to poverty.

Based on the findings of the study, the following suggestions are made to help preserve the livelihood opportunities from further implication by land cover change in the study area:

1. Effective policy implementation should be embarked upon as a check against unsustainable practices which have been found to aggravate land degradation in the study area. The policy would help to check against unnecessary deforestation and wood extraction from the natural forest, as these may result into total destruction of our natural environment leaving little or nothing to future generation.
2. The socio-economic drivers of a land cover change should be studied regularly in response to changes in policies.
3. Relevant authorities should endeavour to carry out regular audit and monitoring on land cover changes and also encourage sustainable economic development.
4. Remote sensing and GIS technology should be integrated into land cover planning and management in the study area. The use of this technique in view of the huge benefits derivable from it will provide accurate and up-to-date information on the status of land for effective planning.

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