APPLICATION OF GIS AND REMOTE SENSING IN LAND USE AND LAND COVER CHANGE IN COCOA PRODUCTION – IDANRE, SOUTHWESTERN NIGERIA

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Abstract

Cocoa, which is one of the government's cardinal crops for economic diversification, is the subject of study in this paper. Due to age-long neglect and diversion to mono-economy of crude oil, Nigeria has witnessed a drastic decline in cocoa production and hence, loosed its enviable position in the world cocoa-producing nations' ranking. Remote sensing and Geographic Information Systems (GIS) tools are therefore used to study land use land cover change on cocoa cultivation for over a period of two and halves decades (1986-2010) in Idanre local government area. Various techniques used are acquisition of Landsat satellite imageries for three epoch years (1986, 2002 and 2010), pre-processing operations, and confusion matrix of the data and overlay operations. The study shows drastic reduction in cocoa plantation between the years (1986-2002), but there was an appreciable increase in the year (2002-2010) due to various government interventions to salvage the industry from total collapse. More efforts are therefore suggested to be intensified for the cultivation and development of cocoa in the study area and in all Cocoa-producing States by various stakeholders in the industry to ensure its sustainability, wealth to the farmers and increase in Gross Domestic Product (GDP) for the Country.

Key words: Cocoa, Remote sensing, GIS, Economy, Cocoa-Producing States.

1. Introduction

Cocoa is an important crop around the world, which serves as a cash crop for the growing countries and a key import for processing and consuming countries. Cocoa tree is a tropical plant grown in hot, rainy climates mainly 20 degrees north and south of the equator, (Fairtrade foundation, 2011). Cocoa, which was reported to have originated in the Amazon basin, was introduced into Europe in the fifteenth century. And in the late nineteenth century, cocoa production spread to West Africa. (Olujide et al, 2006).

The highest producer of Cocoa in the world is Cote d'ivore with production of 1,472,574 tons in 2016. This is followed by Ghana (858720 tons), Indonesia (656817 tons), Cameroon (291521 tons), Nigeria (236521 tons), Brazil (213843 tons), Ecuador (177551 tons), Peru (107922 tons), Dominican Republic (81246 tons), Colombia (56163 tons) (Fairtrade foundation, 2016). In a related development, there have been an increase in the consumption of cocoa and its derivatives in developed countries such as Netherlands, United States, Germany, Malaysia, France, Belgium, United Kingdom, Spain, Singapore and Italy in their order of demands respectively (WCF, 2012).

Cocoa was first cultivated in the western region of Nigeria in 1890 (Adegeye, 1996). Its cultivation gained prominence rapidly in Nigeria such that by 1965, Nigeria became the second largest producer in the world (Adegeye, 1996). The total current hectares under cocoa cultivation have been estimated to be 639,348Ha. In general, cocoa-producing states lie within the rainforest zone of Nigeria which includes Ondo (149,687Ha), Cross-Rivers (123,747Ha), Osun (106,111Ha), Ogun (80,252Ha), Ekiti (60,589Ha), Edo (57,259Ha), Oyo (41,447Ha), Kogi (10,200Ha), Abia (4,230Ha), Delta (150Ha), and Akwa-Ibom (1,892Ha). Others are Kwara (3,578Ha), Taraba (200Ha) and Adamawa (6Ha). (Cocoa Research Institute of Nigeria's Information Booklet, 2007).

However, over 50% of the total quantity of cocoa produced for export or utilized locally per annum comes from Ondo State (Adegeye, 1996), yet the country has not been able to meet the world market needs considering its contribution to global supply of this crop.

Different factors have been identified to contribute to decline in the supply of cocoa to international demands by various schoolars. Ajobo, (1980), and Egbe (1989) have identified poor soil quality as a factor, while Olujide and Adeogun (2006) alluded to cocoa growers' farm hygiene and management practices as cogent reason for decline in production. In the same vein, Ajayi *et.al;* (2010) emphasize agro-meteorological elements such as temperature, rainfall, humidity, vegetation, soil organic matter content, porosity and permeability as factors that can boost cocoa production.

The Nigerian government is reviving the agricultural sector to shift from its sole dependence on crude oil for foreign exchange earnings. Thus, the Cocoa growing zone of southwest Nigeria is important to the national economy. With the increasing demand for land to grow export crops and to meet other needs such as settlement expansion; Landuse is changing. Landuse data and mapping are essential inputs for the process of formulating, implementing, and monitoring policy with the aim of reducing the impact of land-cover/land-use (LC/LU) change (Folayan, 2010). Therefore, Geographic Information System (GIS) and Remote Sensing Technology with other allied technologies have been the veritable tools to carry out monitoring, inventory, analysis and decision making purposes for environmental studies such agriculture, forestry, mining and geology. . These tools are needed to understand some of the challenges of cocoa production, which are causing a decline in its cultivation and inevitable low supply to world market through a change detection approach of lands noted for its plantation.

Cocoa as a cash crop is supposed to be the mainstay of our national economy, but it has witnessed a drastic decline in its production in few years now. Most of the cocoa growing zones experienced one problem or the other such as old age of the farmers, activities of pests and diseases on cocoa trees, reduction of trends in acquisition of seedlings for replanting and impact of fire devastation on cocoa farm among others (CRIN, 2007).There is a daily increase in demands of cocoa seeds at global market as stated by World Cocoa Foundation (2014): ""Average year-over-year demand growth has been just over 3% since 2008. One of the primary drivers of this increase is the growing

middle class in China, India and Brazil". In view of this, the change detection approach is needed through remote sensing/GIS techniques to investigate the change in land use in cocoa-producing communities in order to arrive at workable solution that can boost cocoa production in these areas for export trade and economic growth of the country.

This study look into how human-induced land use and land cover change activities have affected cocoa production in cocoa largest producing area by treating land use land cover (LULC) change as a factor responsible for the low output of cocoa production in the study area.

2. The Study Area

Idanre is a hilly town located about 20km southeast of Akure, Ondo State capital and 335 kilometres from Lagos. It has an area of 1,914 square kilometres and population of 129,795; FRN Official Gazette, (2009). It is located between Longitude 5° 00'and 5° 30' east of the Greenwich Meridian and Latitude 6° 20' and 7° 50' north of the Equator. It lies wholly within the tropics. In the northwest, it shares boundaries with Ekiti Southwest local government area, in the east it is bounded by Akure and Owo local government areas. In the west, it is bounded by Ondo and Ifesowapo local government areas. This local government has three major districts namely: Owena District, Ododе Idanre District and Alade District, which comprise of 11, 61 and 18 towns and villages respectively. The major occupation in Idanre is cocoa farming. As one drives into the town, the tarred road is halved by cocoa seeds. Even, most farmers have turned a part of the road into sunbaked cocoa ground and cocoa merchant stores can be seen all over the nooks and crannies of the town.

3. Material and Method

The study was carried out making use of the Landsat data of three epoch years – 1986, 2002 and 2010 (Table 1). The preprocessing of the operation carried out using Erdas Imagine 9.2 for image processing which involve geometric correction and constrast enhancement to assist in visual interpretation of the Landsat images. The ArcGIS 10.2 was used to clip the data using the study area shapefile. However, further preprocessing operation was executed on 2010 data to remove the wedge lines from the scene caused by defect in its scan line corrector (SLC). The six groups of land use-land cover change of Idanre local government was classified using maximum likelihood algorithm with the help of Erdas Imagine software. In addition, the ground control points of the area were determined using the GPS receiver (Garmin etrex 10). Other ancillary data used are the high-resolution data and the population figures of 1991 and 2006 of the study area (FRN Official Gazette, 2009).

In order to produce accurate land use maps from remotely sensed data, image interpretation is an important skill to learn. Supervised classification hence allows the user to define the training data (or signature) that tells the software what types of pixels to select for certain land use. For this paper, the Landsat image scenes of year 1986, 2002 and 2010 were imported to ERDAS

IMAGINE 9.2 software environment. Image geometric correction and image-supervised classification were performed for the 3 images of 1986, 2002, 2010.

Table 1. Images used and their attributes

Acquired Dates/Scenes	Landsat sensors	Spatial resolution(m)	Landsat type	Spectral bands
1986/04/12 P190R055	Multispectral Sensor (MSS)/Thematic Mapper ™ 5	30	Landsat 4	4 Bands
2002/01/03 P190R055	Enhanced Thematic Mapper Plus (ETM+)	30	Landsat 7	7 Band 1 Blue, Band 2 Green, Band 3 Red, Band 4 NIR, Bands 5 Shortwave, Band 6 Thermal, Band 7 Shortwave Infrared, 8-Panchromatic (PAN)
2010/12/01 P190R055	Enhanced Thematic Mapper Plus (ETM+)	30	Landsat 7	7 Band 1 Blue, Band 2 Green, Band 3 Red, Band 4 NIR, Bands 5 Shortwave, Band 6 Thermal, Band 7 Shortwave Infrared, 8-Panchromatic (PAN)

Source: Global Land Cover Facility University of Maryland. http://glcf.umiacs.umd.edu/

The images were later imported to ArcGIS 10.2.2 software environment to reclassify and convert from raster to polygons, using the ArcGIS software. After this, the various land cover features such as forest, built up, rock outcrops, water bodies, farmland and cocoa were queried and classified out from the database. This was done in order to estimate the total amount of the land features in each class. Only land features for Built up and Cocoa cultivation was shown and the result is displayed below.

4. Result And Discussion

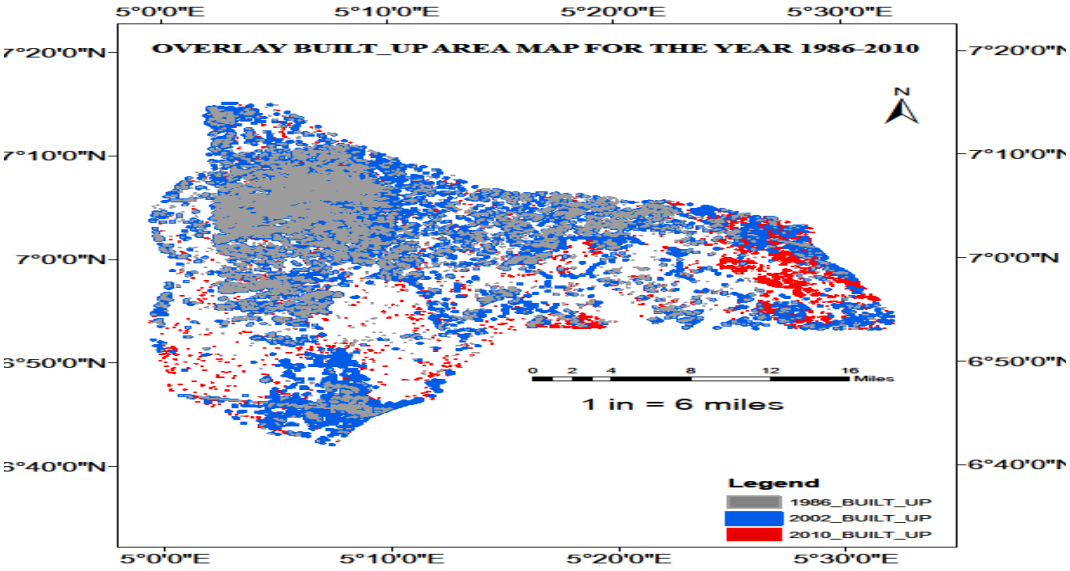

Figure 1: The Overlay Map of Idanre for 1986-2010 in Built up Area

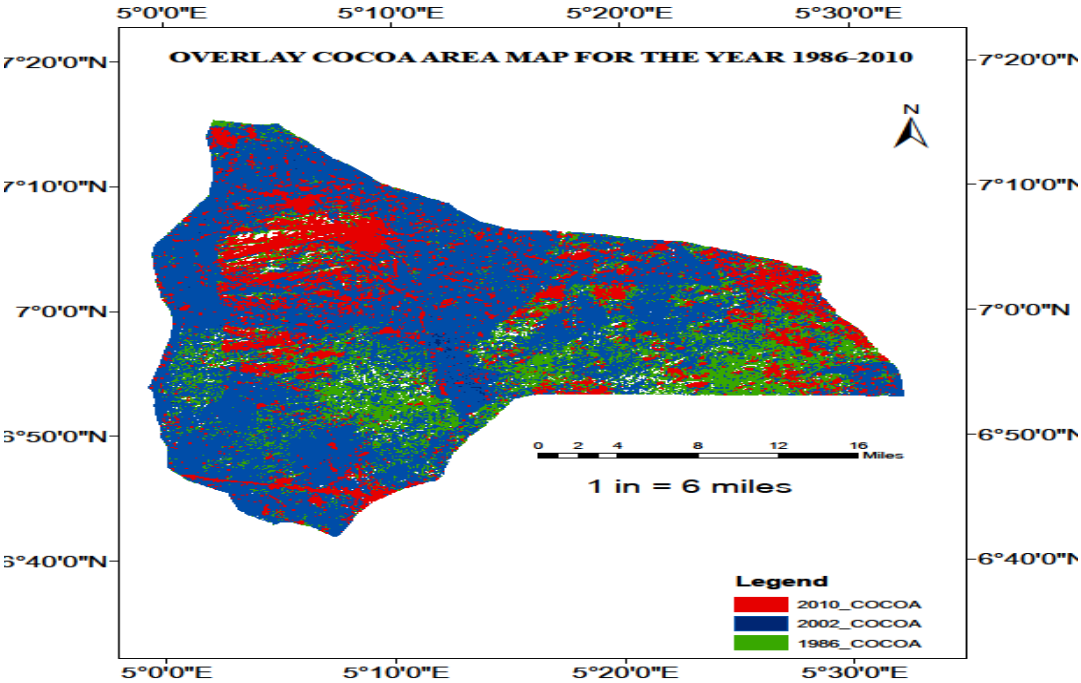

Figure 2: The Overlay Map of Idanre for 1986-2010 in Cocoa Area

The results gotten from the three epoch years in Idanre reveal some note-worthy changes requiring keen observation. The cultivation of Cocoa in Idanre in this period (1986) was encouraging (Table 2). Hamzat *et al;* (2006)

noted that cocoa industry in Nigeria owed its development in the early days to the initiative and enterprise skills of peasant farmers.

Between year 1986 and 2002, there was a decline in the cultivation of cocoa in the study area as shown from the result (Table 2). This was due largely to paradigm shift caused by oil discovery. Daramola (2004) reported that Nigeria cocoa output declined from over 300,000 tons to 155,000 tons with average annual growth rates declining from 8.3% during 1992-1996, which was the years that fell under the study in consideration. Human settlement and activities rose a little bit from previous 2.98% to 3.09%; thus cannot be a factor that causes reduction of cocoa cultivation to 16.67% from its previous position of 29.98%.

In the year 2002 to 2010, another interesting event took place in the history of cocoa in Nigeria. A new democratic elected government (1999-2007) established a committee in order to rehabilitate the old cocoa farms and improve the country's production. The National Cocoa Development Committee (NCDC) was inaugurated in 14 Cocoa producing States. To show the seriousness of the government at that time, the Deputy Governors of these States were nominated to oversee the activities of the committees. During this period, cocoa seedlings, farming inputs and loans were made available to cocoa's farmers to boost the production at affordable rate to encourage them back to the field. This was evidenced in Idanre as the area of land cultivated increased from the previous 16.67% to 43.68%. All these testify to the increase in cocoa production in the study area between year 2002 and 2010. From the foregoing therefore, it becomes clearer that government policy and commitment remain a strong factor influencing the growth of cocoa and agricultural practices in general in Nigeria's agriculture.

Table 2: Land use land cover for the year 1986, 2002 and 2010 in Hectare and Percentage

	1986		**2002**		**2010**	
	Hectare	**Percentage**	**Hectare**	**Percentage**	**Hectare**	**Percentage**
Cocoa	57255.61	29.98	318827.71	16.67	83398.77	43.63
Built Up	56864.48	2.98	5907.22	3.09	7897.70	4.14
Farms	16270.92	8.52	32186.56	16.86	27700.32	14.51
Forests	30541.07	15.99	77596.08	40.63	56770.63	29.69
Rocks	1083.99	0.57	5234.36	2.74	7503.23	3.93
Water Bodies	80117.04	41.96	38203.90	20.01	7682.10	4.02
Total	190955.11	100	190955.11	100	190955.11	100

5. Conclusion

Cocoa, which is the mainstay of Nigeria economy before the discovery of crude oil, was the target of this research work. Remote sensing and GIS techniques were used to analyse the impact of different land use and land cover on the development of cocoa in the study area, Idanre L.G.A). Remote sensing

as a veritable tool for acquiring earth observation data at a larger scale was used to acquire necessary data needed for this study. The GIS tool was also used to analyse the data acquired and the result was generated for the three epoch years of 1986, 2002 and 2010.

At the end of the analysis, various land use classes were obtained and the results show some increase in cocoa cultivation before 1986, the decrease in the year 2002 and increase in the year 2010, with changes in other land use/land cover in the study area.

It is therefore advisable that all necessary measures are ensured for the boost in cocoa production in Idanre, Ondo State and the nation at large for economic sustainability and wealth of the farmers.

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