FORESTED LANDSCAPE DYNAMICS IN SAKI-EAST LOCAL GOVERNMENT AREA OF OYO STATE, NIGERIA

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Abstract
The prime objective of this study is to apply Remote Sensing and GIS technology in examining the trend and pattern of land cover changes observed between forested and non-forested landscapes in Saki east LGA of Oyo State, Nigeria. This was done for the purposes of determining changes in the vegetation cover for a period of 27 year. Satellite Imageries were obtained from Global Land Cover Facility (GLCF) and GLOVIS. Landsat Thematic Mapper of 1992, 2001, 2010 and Operational Land Imager of 2019 were obtained at 30m resolution. The Image analysis was done and created using ArcGis 10.5 (ESRI, Redland, CA). Satellite imagery was classified into two major categories, Forested landscape and Non-forested landscape. Results from satellite imageries also showed that forested landscape decreased from a total land area of 139,510 ha (84.53%) in 1992 to 102,480 ha (62.09%) in 2019. The amount of land area lost by forested landscape is being added up by the non-forested landscape. 2.53% of forested landscape was lost to non-forested between 1992-2001, with 18.05% and 1.86% lost between 2001-2010 and 2010-2019 respectively. However, percent change per year in lost of forested landscape observed was 0.28%, 2.01% and 0.21% between 1992-2001, 2001-2010 and 2010-2019 respectively. It was concluded that changes observed in forested landscape was due to deforestation to provide raw materials for wood industries, and space for agriculture and building of house for the increasing population in the area. The implications of deforestation for biodiversity and climate change have been highlighted.

Keywords: *land use land cover, forested landscape, Saki-East LGA, deforestation*

Introduction

Changes on pattern of Land use and land are major elements that are very important in the history of global expansion and land use and cover change (LUCC) with its impacts on the environment has been one of the increasing focus of global changes (Chase et al., 2000; Oladele and Oladimeji, 2011). Land use can be described as the use man put the land which has direct relationships to it. It is a product of interrelationship between a society's cultural background, skills and its physical needs on one hand, and the natural potential of the land on the other (Ram and Kolakar 1993; Denton and Ogunkunle, 2014). Furthermore, land use can be described as the arrangements, activities and inputs that man undertake on a certain land cover type (FAO 2000; Denton and Ogunkunle, 2014). According to these definitions land use reflects human activities such as the use of the land for industrialization, residential developments and agricultural expansion etc.

Studies have shown that the pace, magnitude and spatial reach of human alterations of the land surface are unprecedented. Changes in land cover i.e biophysical attributes of the land surface and land use i.e human purpose or intent applied to these attributes are among the most important human ecological footprint (Lambin et al. 2000, 2001, 2003; Agbola et al.). Globally, land cover has been altered principally by direct human activities such as agriculture and livestock raising, forest harvesting and management, urban and suburban construction and development and this has significant effects on the natural environment. Furthermore, in Oke Ogun (Saki-west) area of Oyo State, deforestation continues to put forested landscape at risk of conversion to non-forest. This is due to the high rate at which timber and NTFPs majorly, charcoal is being produced. These acts put the forest landscape to destruction, distruption and fragmentation which consequently has adverse effects on the landscape. This opens the landscape for more non-forestry activities like agriculture, industrialization etc. With global outcry on the consequences of continuous unsustainable forest destruction topping major intellectual discourses, the needs to examine the changes on status of forested landscape in the area requires a work of this nature.

According to Fasona and Omojola, (2005) and Denton and Ogunkunle, (2014), studying land use dynamics is essential in order to examine various ecological and developmental consequences of land use change over a space of time. Therefore making land use mapping and change detection relevant inputs in decision-making for implementing appropriate policy responses. In studying land use changes pattern, remotely sensed data such as aerial photographs and satellite imageries are undoubtedly the most dependable for extracting information. Change detection is a technique that is used to highlight conversion of land from one use to another within a given time frame (Jaysal and Ram 1999; Denton and Ogunkunle, 2014). Therefore this study used remotely sensed data obtained from GLGC for identifying the changes on forested landscape through satellite image

processing and (GIS) geographical information system techniques over a period of time in Saki west local government area of Oyo State.

Methodology

Study area

Saki-East local government was created alongside 182 others created by the federal government during General Sanni Abacha administration in December 1996. The council was carved out of the defunct Ifedapo local government area. Saki-East comprises of five major towns namely: Agbonle, Ago-Amodu, Ogbooro, Oje-Owode, and Sepeteri. The Zoological Old Oyo National Park is located in Sepeteri and the landmass is about 200 km^2 while the terrain is undulating and paling Savannah grassland with dotted rocks and hills. The common trees are shea butter and locust bean trees (Delgado et al. 2003). The local government council is bounded in the north by Oorelope local government, to the south by Atisbo and Olorunsogo to the East and Saki-West to the west. Saki-East local government covers a land area of 1,569 km^2 and a population of 110,223 based on 2006 census (FAO, 1991). The map of the area is presented in fig. 1

Sources and Processing of Data

Remotely sensed data are very important in GIS application and remote sensing. This type of data can be found in various forms but for the purpose of this study, same resolutions obtained from GLCF (Global Land Cover Facility) and GLOVIS, which covered the study area for the period between 1992 and 2019 at nine (9) years interval. The four images used for the study were the Landsat thematic mapper image of 1992, 2001, 2010 and the operational land imager of 2019 with 30 meters resolution as evident in Table 1 while the land use classification scheme is presented in table 2.

Table 1: Data Types and Sources

S/N	Satellite type (LANDSAT)	Year	Bands	Resolution	Source	Path/Row
1	TM	1992	2,3,4	30M	GLCF	191/55 and 191/54
2	ETM	2001	2,3,4	30M	GLCF	191/55 and 191/54
3	ETM	2010	2,3,4	30M	GLCF	191/55 and 191/54
4	OLI	2019	3,4,5	30M	GLOVIS	191/55 and 191/54

TM – Thematic Mapper, ETM – Enhanced Thematic Mapper, OLI – Operational Land Imager

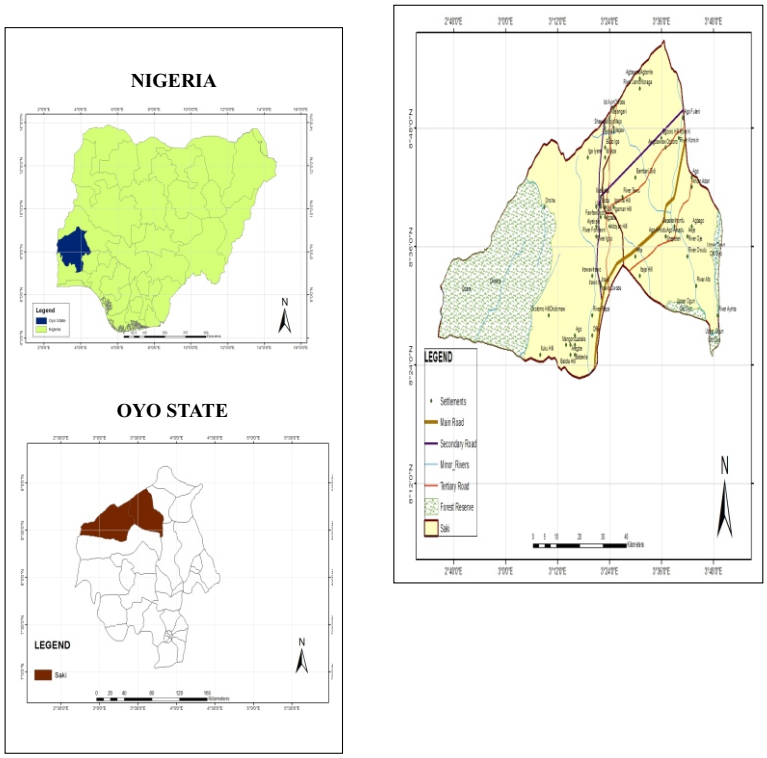

Table 2: Land Use Classification Scheme

Land use classification	Description
Forested landscape	An area of land covered with mature trees and other plants growing close together
Non-forested landscape	Areas that have been populated with permanent residents or covered with scanty grass and exposed rocks, bare lands and areas covered with water bodies.

The landscape classification and change detection was performed following the methodological framework shown in figure 2. Image analysis was done and created using ArcGis 10.5 (ESRI, Redlands, CA). The bands of the acquired imageries were enhanced using histogram equalization, rectified to a common UTM coordinate system (WGS 84) and then radiometrically corrected. A supervised classification with a maximum likelihood algorithm was conducted to classify the imageries using three bands of red (b4), green (b3) and blue (b2).

Pre-processing activities were carried out in order to enhance the quality of the image and readability of the features. Data preprocessing is a process whereby all the existing data in form of maps, images and Tables are converted into a suitable form for permanent storage within the GIS database. The software, ArcGis Version 10.5 was used to carry out the various spatial operations on the satellite imageries. The imageries were classified into two major categories, Forested landscape and Non-forested landscape. After completing a detailed delineation of each landscape, the area of each landscape was measured in hectares and percentages for the different years. Two major analyses used in this study included: (a) Area calculation of the land use and land cover (b) Rate of deforestation (%). However, the methodological framework adopted for this work is presented in figure 2.

Method of Data Analysis

The comparison of the land use statistics assisted in identifying the percentage change, trend and rate of change between the period of assessment (1992 and 2019) was obtained from the maps presented in figure 2a, 2b, 2c and 2d. In order to achieve this, a table showing the area in hectares and the percentage change for each year (1992, 2001, 2010 and 2019) measured against the two land classification (forested and non-forested) was developed. Percentage change (to determine the magnitude of change) was then calculated. For obtaining annual rate of change, the percentage change was divided by the number of study years: 1992 – 2001 (9 years); 2001 – 2010 (9 years), 2010 – 2019 (9 years).

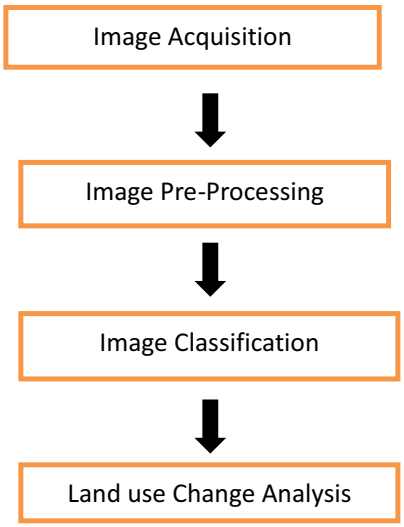

Figure 2: Classification and change detection methodological framework

Calculation of Rate and Trend of Change on Forested landscape

Percentage change to determine the trend of change can be calculated by dividing observed change by the base year multiplied by 100

$$Tpc = \frac{Obc}{By} \times 100 \quad \text{.....Equation 1}$$

$$\%\ \text{Rate of Change(deforestation rate)} = \frac{Obc}{\text{No of Study years}} \times 100 \quad \text{.....Equation 2}$$

Where Tpc = Trend percentage change;
Obc = Observed changes
By = Base year

Table 3: Landscape category distribution of 1992, 2001, 2010 and 2019 in Saki East LGA

Landscape	1992		2001		2010		2019	
	AREA (ha)	%	AREA (ha)	%	AREA (ha)	%	AREA (ha)	%
FOREST	139,510	84.53	135170	82	105550	63.95	102480	62.09
NON-FOREST	25520	15.47	29860	18	59480	36.05	62550	37.91
TOTAL	165030	100	165030	100	165030	100	165030	100

Table 4: Percent changes (%) in land use categories between 1993 and 2017 for Saki East LGA

Landscape	1992 – 2001		2001 - 2010		2010 – 2019	
	Area (ha)	% Change	Area (ha)	% Change	Area (ha)	% Change
Forest	-434	-2.53	-29620	-18.05	-3070	-1.86
Non-Forest	434	2.53	29620	18.05	3070	1.86

Table 5: Percent decreased and changes per year on forested landscape in Saki East LGA

YEAR	FORESTED LANDSCAPE (HA)	DURATION	% DECREASED	% CHANGES/YR
1992	139,510	-	-	-
2001	135,170	1992 – 2001	-2.53	-0.28
2010	105,550	2001 – 2010	-18.05	-2.01
2019	102,480	2010 – 2019	-1.86	-0.21

Results and Discussion

The post-classification comparison of the three periods for the two classification scheme identified for the study was presented in table 3, 4 and 5. Table 3 shows that the total land area of Saki East LGA was 165,030 ha. Out of it, the forested landscape had 139,510 ha (84.53% of the total land area) and non-forested landscape measured 25,520 ha (15.47%) in 1992 while in 2001 forested landscape have been reduced to 135,170 ha (82% of the total land size of the area) while the non-forested landscape had increased with about 2.5%. The 2010 Saki East LGA map showed forested and non-forested landscapes to be 105,550 ha and 59,480 ha respectively while the 2019 showed 102,480 ha, occupying about 62.09% of the total land area (forested landscape) and 62,550 ha, about 37.91% of the total land area (non-forested landscape) (Table 3).

Furthermore, between the years 1992 – 2001, a reduction of about 2.53% on forested landscape was observed which was added up by the non-forested landscape (table 4), with about 0.28% changes per year (reduction) on forested landscape (table 5). The period between 2001 – 2010 was observed as the highest period at which great conversion of forested landscape to non-forested landscape took place with about 18.05% of forested landscape converted to non-forested landscape (table 4) and about 2.01% reduction per year observed (table 5). There was massive clearance of land area for residential purposes and agricultural activities in the LGA, as the government of Oyo state embarked upon several projects to develop the state while the period between 2010 -2019 witnessed about 1.86% reduction of the total area of the forested landscape with 0.21% changes per year observed (table 5). The reduction however might be as a result of government campaign against indiscriminate clearing of land and illegal removal of vegetation cover.

The result tends to show that as forested landscape keeps reducing in areas, non-forested landscape is being adding up. The drivers for the changes observed on forested landscape may be due to increase in population. Since farming is the occupation of the majority of the people in the area, there is likelihood of more forested

landscape being converted to non-forested landscape like agricultural fields and residential apartments. When the anticipated human population increases, there is likelihood of furthering increase in the exploitation of land resources with the most dynamic changes observed in the forested landscape cover.

Changes in Landscape Pattern in Saki East LGA between 1992 and 2019

Changes in landscape pattern for the LGA for different periods have been examined for detecting changes in landscape pattern. It is clear from the results that forested landscape for the study LGAs keep decreasing for the studied periods (1992 – 2019), whereas the non-forested landscape increases. The images have shown that in all the local government areas, forested landscape decreases with periods (years of assessment) (figure 2a, 2b, 2c and 2d) indicating that in some years to come the landscape may disappear. However, man plays the most powerful and important role in contributing to such disappearance of the landscape. These changes observed in the study area might be as a result of modernization, urbanization and some economic activities going on in the area. Most of the forested land areas have been sold for companies who in turn cleared the economic indigenous and exotic trees on the land to build structures for accommodation and industries. However, this decrease has a serious negative implication for food and environmental security in the areas and the state at large. As forest lands are being lost /converted to other activities, farmers also lose their lands and trees therein to development. The result of this study is in agreement with the result obtained by Denton and Ogunkunle, (2014) who observed similar decreasing trend in forested land in their study of land use change in South-western Nigeria.

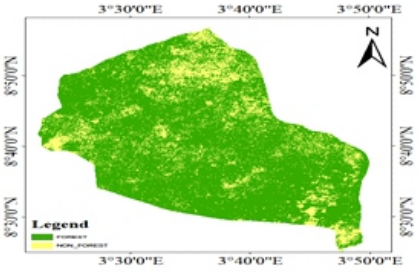

Fig **2a:** Land use map of Shaki East LGA (1992)
Source: Author, 2019

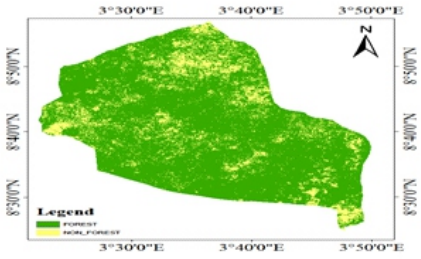

Fig 2b: Land use map of Shaki East LGA (2001)
Source: Author, 2019

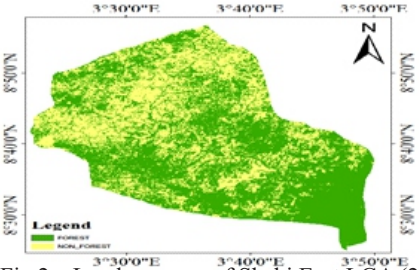

Fig 2c: Land use map of Shaki East LGA (2010)
Source: Author, 2019

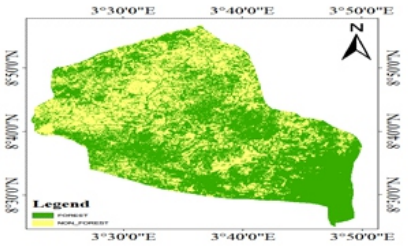

Fig 2d: Land use map of Shaki East LGA (2019)
Source: Author, 2019

Conclusion

This study has revealed that remote sensing and satellite imageries coupled with GIS can play important and excellent roles in understanding the dynamics and trend in changes occurring on landscape in Saki East LGA and Oyo state in general. The analysis provided valuable information into the trend in changes that have taken place in Saki East LGA from 1992 to 2019. The forested landscape in Saki East LGA has been decreased tremendously which may be due to development and agricultural expansion. Even though developments are good for the development of the state and wellbeing of the people, the trend and rate of changes on forested landscape in Saki East LGA needs to be checked and controlled, otherwise it will have a serious negative implication for food and environmental security in the areas and the state at large. This study provided means by which further study that aims at modeling and predicting future changes on forested landscapes can be conducted.

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