

Application of Remote Sensing and GIS Techniques in Land Use Changes: A Case Study of a Forest Reserve in the Southwestern Nigeria

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ABSTRACT

Unabated exploitation of biodiversity and its consequential effects on natural environment has been of a serious concern to stakeholders globally. Thus, this study examines land use changes in Oba Hill forest reserve, Osun State, Southwestern, Nigeria between 1986 and 2016 using remote sensing technique. The study utilised satellite imageries from Landsat TM 1986, ETM 1996, 2006, and ETM+ 2016. The research revealed that the undisturbed forested area declined from 26.169 km² in 1986 to 15.318 km² in 2016. Also, the cultivated/disturbed forest land increased from 22.238 km² to 41.499 km² in 2016 whereas the built up areas decreased from 12.215 km² to 3.805 km². The forested lands were decreasing while the cultivated/disturbed land areas were on the increase. This implies that more of the forested lands were opened up for cultivation and other purposes while part of the built-up areas were also taken over by shrubs. Thus, there is degradation in the natural resources as a result of excessive and unguided exploitation of forest resources. It is recommended that government should put in place appropriate policies towards sound management of our natural resources to ensure a sustainable development.

Keywords: Oba hill; Land use changes; Forest degradation; Remote sensing; GIS

INTRODUCTION

Land use is the exploitation of the land cover by man to satisfy his social, cultural, spiritual, economic and physical needs [1]. Akinyemi [2] also asserted that land use is the activities that take place on the land and represent the current use of property such as residential purposes, shopping centres, tree nurseries, parks, reservoirs, etc.

Forests, globally are home of diverse benefits such as regulation of climate, habitat for plants and animals and sources of fodder, timber and non-timber forest products but have suffered unprecedented destruction due to unsustainable use and management of resources.

The World forest resources have continued to reduce basically because of anthropogenic activities that are caused by the need to meet the demand for industrial and social development necessary for economic growth. According to Akinsanola et al. [3] forest covers are getting depleted daily at a greater rate due to serious anthropogenic activities that made the earth surface also

to be significantly altered in several ways. Man's needs for social, economic and cultural development resulted in to resources and environmental degradation through deforestation of tropical forest.

In recent times, roughly a third of the world landscapes are being used for crop productions or grazing of cattle. Major changes in human activities, especially through large scale agriculture have been identified as the major cause of the drastic changes in land cover and land use patterns globally. Another major consequence of the globally recognized rapid land cover change is the loss of biodiversity and ecosystem functioning. The rate of biodiversity loss has been accelerating rapidly throughout the industrial era. Among other scholars observed that, species are now becoming extinct at 1.000-10.000 times the natural rate. The consequence of this is general ecosystem degradation which is often measured using the Natural Capital Index (NCI) framework which involves calculating the extent of natural area which is determined from land-use maps [4]. According to FAO, conversion of forest land for uses like cultivation, mining, and

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human structures such as urban infrastructure other than its natural cover, resulted in to deforestation. Natural vegetation are altered through the use of land for various purposes such as logging, building, agriculture and other forest related activities [5].

According to Bazezew et al, [6] it was asserted that increasing population pressure on the natural environment, the need for fertile agricultural land and the search for more forest products and services as industrial raw materials have increased the forest disturbances and eventual deforestation and degradation. Stated that increasing intensity of agricultural activity was the main driver of deforestation in which most of the native forest has been converted to agricultural land. Low diversity in the Olokemeji forest reserve was as a result of farming activity which has led large hectares of forest land to become impoverished secondary forest, bare and degraded land, grasslands and plantation of exotic species.

Shifting cultivation as practiced for forest conservation among indigenous people living around tropical forest is also a main driver of tropical forest cover changes, asserted that the driving forces of land cover changes could be food preferences, demand for specific products, environmental conditions, land policy and developmental programs and that no single cause can solely lead to deforestation. Also asserted that, multiple factors in synergetic interactions dominate land change processes and that these causal clusters vary from one region to another and time, and that agricultural expansion is one of the probable causes of land use and land cover changes.

Therefore, changes in land use/land cover and the need for biodiversity conservation are important issues that have gained attention in tropical forest research in recent years. This however, has led to intense debate on the most appropriate approach to be adopted in tropical forest conservation [7]. Land use data are necessary in the analysis of environmental processes and problems in order to understand the living conditions and standards which will be used to improve the present conditions. Land use change detection is therefore, necessary for the identification of major processes of change and the characterization of land use dynamics which occurred as a result of over-dependence on primary resources. In corroborating this assertion, stated that, the study on land use and land cover dynamics is important in order to examine various ecological and developmental consequences of land use change over a space of time. Such a study as this will invariably make land use mapping and change detection useful inputs for decision-making and implementation of appropriate land use management policy. Hence, the aim of this study is to assess the changes in the land use pattern in Oba Hill Forest Reserve, Osun State, Nigeria with a view to propose a sustainable methods of conserving this forest.

The specific objectives of this research were to assess the characteristics of land use over a period of 30 years using remote sensing techniques in the study area and also to examine the implications of the changes on the forest environment.

MATERIALS AND METHODS

Study area

The study was conducted in Oba Hill Forest Reserve located between latitude 7-45' to 80 30'N and longitude 4-70' to 50-61'E in Iwo local Government Area of Osun State, Nigeria. It is bounded in the north-east by Ola-Oluwa Local Government Area, in the north-west by Oyo State in the south by Ayedire LGA and in the east by Ejigbo LGA. Some communities such as Olori, Owu-Ile, Ifeodan, Ikonifin, Akinleye, Ipatara, Idi-Iroko among others surrounded this Forest Reserve. It was established in 1955 as a gazette forest reserve. It is located in the humid sub-equatorial climatic region which is characterised by high humidity and torrential down pour between March and October annually. The rainfall distribution of the study area is of double maxima with maximum rainfall in June/July and September/October while the mean annual rainfall is between 1200 mm and 1450 mm and the mean annual temperature is about 27°C [8]. The characteristic climate therefore encourages the growth of tropical evergreen rainforest with tall trees and dense undergrowth. Valuable woody trees found here are, *Anogeissus leiocarpus*, *Bridelia micrantha*, *Blighia sapida*, *Cinnamom aromaticum*, *Tectona grandis*, and *Gmelina arborea*. The communities around this FR are majorly agrarians and concentrate more on food crop farming. Types of the food crops are cassava, yam, coco yam, vegetables and the like and are majorly for subsistence farming. In other to boost agricultural production in the area the state government embark on farm settlement programme and almost all the forest reserve have been converted to farms and plantations [9]. The programme which made land accessible to interested farmers. Since then agricultural produce from this area have been finding their ways to markets in major urban centre such as Iwo, Ibadan, Osogbo and so on shown in Figure 1.

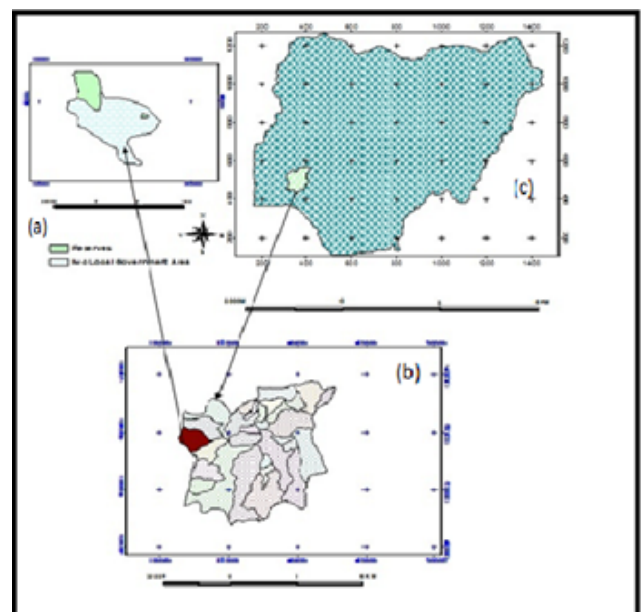


Figure 1: Map of Osun State (a). Inset: Map of Nigeria; (b) showing the location of Oba Hill FR; (c) showing Osun State.

Methods of data collection

Data collection and analysis: Landsat images of ten study area in Landsat images of 1986, 1996 ETM 2006 and OLI of 2016 covering the study area, were obtained from the United States Geological Survey website on Earth Resources Observation and Science Centre. The satellite imageries of the area were processed using ArcMap 10.1 software to bring out the classes of land use types in the study area. The secondary data utilised was the map of Osun State showing the study area; Oba Hill forest reserve. This map was acquired from the Ministry of Environment, Department of Forestry, Osun State. And was geo-referenced to extract the shape fill and get the areal extent of the study area using Google Earth.

The satellite imageries covering the entire study area were used to produce the land cover map using Arc Map 10.1. Supervised classification was adopted and maximum distance algorithms method were used to classify the land use and land cover into undisturbed/ forest, disturbed/cultivated land and built-up areas respectively. The maximum likelihood algorithm was used in this study because it was an accurate and reliable method of image classification [10].

RESULTS AND DISCUSSION

Classification of land use in Oba hill forest reserve

Table 1 presents the major categories of land uses identified in the study area between 1986 and 2016 these are undisturbed forest land, cultivated/disturbed forest land and built-up/developed areas. The pixel statistics of land use in Landsat TM 1986 shows that the undisturbed forest land was mean 26.169 km² representing (43.16%) of the total area. The cultivated/disturbed forest land otherwise referred degraded forest accounted for 22.238 km² (36.69%) and the built-up/developed area forest in accounted for 12.215 km² (20.1%) of the study area. The land to undisturbed forest land was higher than any other features and the built-up/developed area was smaller. The field observation revealed that most portions of the forest reserve were set aside for agro- forestry to serve as forest management strategy. In 1996, the undisturbed forest land was 12.5334 km² (20.7%) and the cultivated/disturbed forest land was 38.555 km² (63.6%). The built-up/ developed forest land decreased to 9.5337 km² changes (15.7%) from 12.215 km² of 1986. This showed that more area developed land had been cultivated because the land area cultivated increased from (36.69%) in 1986 to (63.6%) in 1996. The images of 2006 showed that the undisturbed forest land was 11.18 km² (18.4%), the cultivated/disturbed forest land it was here 33.34 km² (55.0%) and the built-up/developed area increased in to 16.087 km² (26.6%). This suggested that more land had been developed more than what it was in 1996. The pixel representing undisturbed forest land was constituted 15.318²km (25.27%) of the entire study area in 2016. The cultivated/disturbed forest land shared off 13.44% of the size in 2006 but (68.44% in 2016) and the built-up/developed area reduced drastically to 3.805 km² (6.29%). This suggested that was probably developed areas which might be huts were cleared for farming,

cultivation of forest trees or left fallowed. Also reported land dispute between Oyo and Osun state (Daily Independent, 22 Sep, 2014) (because the forest reserve is located at the boundary) such dispute which often claimed lives and could have led to the abandonment of farms and other infrastructures. This could have equally implies the usurpation of the built up area by forest.

Feature Classes	1986		1996		2006		2016	
	Area (km ²)	%	Area (km ²)	%	Area (km ²)	%	Area (km ²)	%
Undisturbed	26.16	43.16	12.53	20.7	11.18	18.4	15.31	25.27
Cultivated / Disturbed	22.23	36.69	38.55	63.6	33.34	55	41.49	68.44
Built-Up/Developed	12.21	20.1	9.533	15.7	16.08	26.6	3.805	6.29
Total	60.62	100	60.62	100	60.62	100	60.62	100

Table 1: Land use/ Land cover of Oba Hill FR between 1986 and 2016.

CONCLUSION

Land use changes in the forest reserve of Oba Hill over a period of 30 years were examined with the use of satellite imageries. The results showed that the FR has undergone immense anthropogenic incursions over the period to the extent that the entire forest has almost been degraded due to agricultural activities and or shrubs growth in place of economic trees that were initially planted there. The implication of these findings is that carbon release into the atmosphere from the forest could have contributed to the global warming scenario being experienced globally. This is apart from the exposing the soil to surface wash through the deforestation activities, degraded biodiversity and fauna displacement from the forest. It is therefore imperative that government and other stakeholders put in place necessary legal tools and education towards checkmating the degradation effects which such anthropogenic activities could cause the natural environment.

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