African Journal of Environment and Natural Science Research
ISSN: 2689-9434
Volume 3, Issue 4, 2020 (pp. 77-85)
www.abjournals.org

APPLICATION OF REMOTE SENSING AND GIS TECHNIQUES IN LAND USE CHANGES: A CASE STUDY OF A FOREST RESERVE IN THE SOUTHWESTERN NIGERIA

Asifat Janet Temitope[1] and Ogunbode Timothy Oyebamiji[2]

[1]Department of Geography, Obafemi Awolowo University, Ile-Ife, Nigeria
[2]Department of Environmental Management and Crop Production, Bowen University, Iwo, Nigeria

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 26.169km^2 in 1986 to 15.318km^2 in 2016. Also, the cultivated/disturbed forest land increased from 22.238km^2 to 41.499km^2 in 2016 whereas the built-up areas decreased from 12.215 km^2 to 3.805km^2. 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, Osun State, Nigeria

INTRODUCTION

Land use is the exploitation of the land cover by man to satisfy his social, cultural, spiritual, economic and physical needs (Lambin,et al.,2000). Jensen (2005), 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 (Bazezew et al., 2015, United Nations Framework Convention on Climate Change (UNFCCC, 2015)) but have suffered unprecedented destruction due to unsustainable use and management of resources (Foahom, 2001, Food Agriculture Organisation, 2014).

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 Gasu et al., (2016), 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 (Enaruvbe et al., 2014).

In recent times, roughly a third of the world landscapes are being used for crop productions or grazing of cattle (Ramankutty, et al., 2005). 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. Mukete and Sun (2014), 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 (Ademiluyi et al., 2008). According to FAO (2010), conversion of forest land for uses like cultivation, mining, and human structures such as urban infrastructure other than its natural cover, resulted in to deforestation. Natural vegetation is altered through the use of land for various purposes such as logging, building, agriculture and other forest related activities (Mukete et al., 2017.

According to Enaruvbe et al., (2014), 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. Ogunleye et al., (2004) and Akinyemi (2013) 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 (Ogunleye et al., 2004).

Shifting cultivation as practiced for forest conservation among indigenous people living around tropical forest is also a main driver of tropical forest cover changes (Asselen and Verburg, 2013). Furthermore, Mukete et al., (2017), 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, Geist et al., (2005) 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 (Terborgh, 2000). 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 (Olaleye et al., 2009). 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, Fasona et al; (2005) 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 method of conserving this forest.

The specific objectives of this research were to assess the characteristics of land use over a period of 30 years (1986 to 2016) 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 7º 45' to 8^0 30'N and longitude 4º 70' to 5^0 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 1200mm and 1450mm and the mean annual temperature is about 27^0C (Akinsanola et al., 2014). 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 micarantha, 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 has been converted to farms and plantations (Greengrass, 2009). 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.

African Journal of Environment and Natural Science Research
ISSN: 2689-9434
Volume 3, Issue 4, 2020 (pp. 77-85)
www.abjournals.org

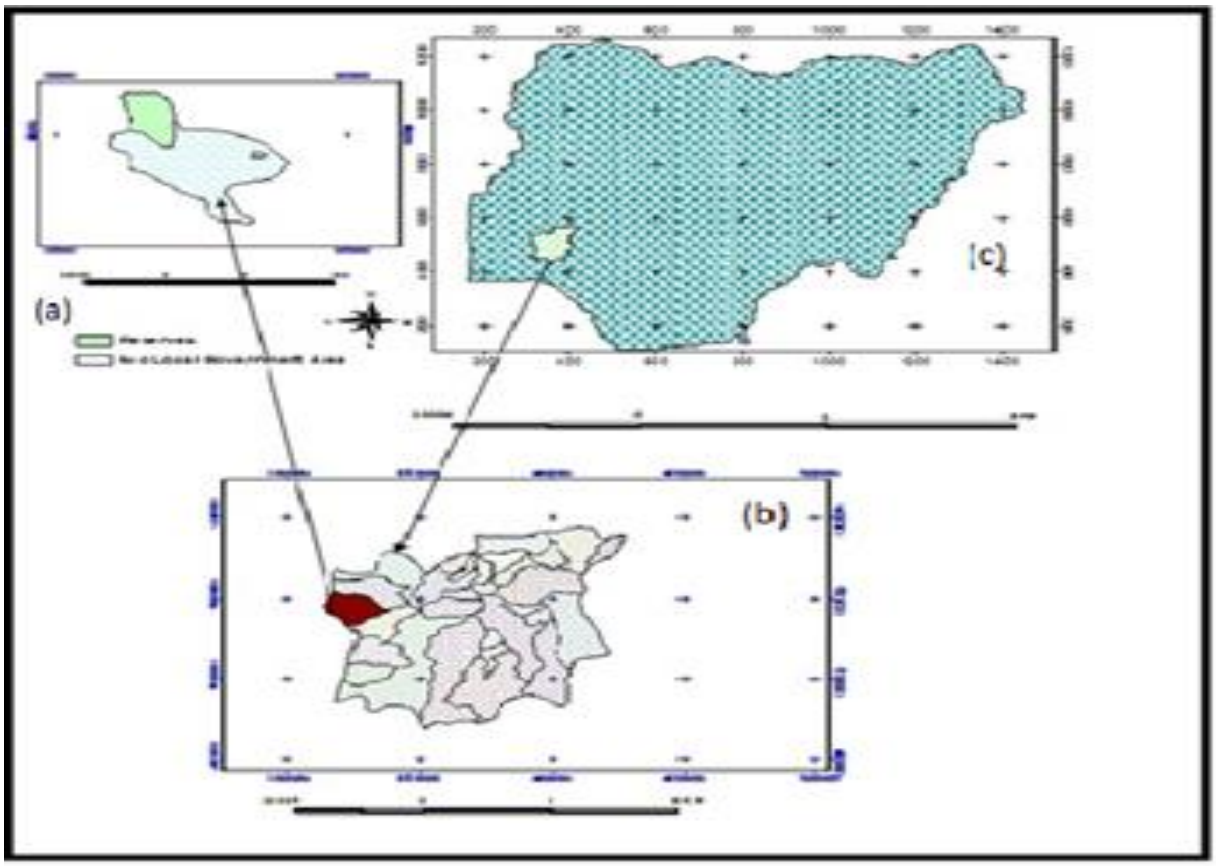

Figure 1: Map of Osun State (a) Showing the Location of Oba Hill FR (b) Map of Osun State (c) Map of Nigeria

METHODS OF DATA COLLECTION

Data Collection and Analysis

Landsat images of ten years interval were used, which are; 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 (Landsat TM 1986, 1996, ETM 2006 and OLI 2016) covering the entire study area were used to produce the land cover map using ArcMap 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 (Perumal et al., 2010) and reliable method of image classification (Akgun, et al., *2004*, Patil et al., 2012, and Vanjare et al., 2014).

African Journal of Environment and Natural Science Research
ISSN: 2689-9434
Volume 3, Issue 4, 2020 (pp. 77-85)
www.abjournals.org

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 26.169km^2 representing (43.16%) of the total area. The cultivated/disturbed forest land otherwise referred degraded forest accounted for 22.238km^2 (36.69%) and the built-up/developed area accounted for 12.215km^2 (20.1%) of the study area. The 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 12.5334km^2 (20.7%) and the cultivated/disturbed forest land was 38.555km^2(63.6%). The built-up/ developed forest land decreased to 9.5337km^2 (15.7%) from 12.215km2 of 1986. This showed that more 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 11.18km^2 (18.4%), the cultivated/disturbed forest land was 33.34km^2 (55.0%) and the built –up/developed area increased to 16.087km^2(26.6%). This suggested that more land had been developed more than what it was in 1996. The pixel representing undisturbed forest land constituted 15.318km^2(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 3.805km^2(6.29%). This suggested that 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 implied the usurpation of the built-up area by forest.

Table 1: Land Use/ Land Cover of Oba Hill FR between 1986 and 2016

Feature Classes	**1986**		**1996**		**2006**		**2016**	
	Area (km^2)	%	Area (km^2)	%	Area (km^2)	%	Area (km^2)	%
Undisturbed	26.169	43.16	12.5334	20.7	11.1861	18.4	15.318	25.27
Cultivated/Disturbed	22.2378	36.69	38.5551	63.6	33.3486	55.0	41.499	68.44
Built-Up/Developed	12.2154	20.1	9.5337	15.7	16.0875	26.6	3.8052	6.29
Total	**60.6222**	**100**	**60.6222**	**100**	**60.6222**	**100**	**60.6222**	**100**

Land Use and Land Cover Changes Comparison Analysis

Table 2 represents the changes in the land use and land cover of the study area between 1986 and 2016. The changes in the undisturbed forest land between 1986 and 1996 was -13.635km^2. The cultivated and disturbed forest land showed changes of 16.312 km^2 while the

African Journal of Environment and Natural Science Research
ISSN: 2689-9434
Volume 3, Issue 4, 2020 (pp. 77-85)
www.abjournals.org

built –up area had a difference of -2.6817 km^2. These changes showed decrease of forest land that was reserved, increase of the cultivated land and the built-up area receded. The implication of this was that more undisturbed forest land were cultivated thereby reducing the original size of the undisturbed forest land and the cultivated forest land increased. This scenario could have probably been attributed to increasing population growth, increasing demand for arable land for food crops and other human activities such as logging in the study area. This corroborated Mengistu and Salami (2007) that, disturbed or degraded forest constituted the largest land cover type in some parts of southwestern, Nigeria which the authors attributed to increasing population and economic activities. This also inferred that deforestation had occurred since the size (26.169km^2) in 1986 receded to (12.53.33km^2) in 1996. Changes in the land use in 1996 and 2006 showed that undisturbed forest land was -1.3347km^2 and the cultivated forest land and built - up area were -5.2065km^2 and 6.5538km^2 respectively. Both the undisturbed and disturbed forest land differences reduced further in 1986 and 1996. However, the built-up area gained more areal extent and increased from 9.54km^2 in 1996 to 16.09km^2 in 2006. The result further revealed that more than the size of built- up land areas in 1996 encroached had been gained back in 2006. This observation implies that there were increase in infrastructures that were put in place between 1996 and 2006. The changes in the size of undisturbed forest land between 2006 and 2016 was +4.1319km^2 indicating natural regrowth/regeneration. The result further revealed that the undisturbed forest land increased from 11.19km^2 in 2006 to 15.32km^2 in 2016, the cultivated forest land increased from 33 .35km^2 in 2006 to 41.50km^2 in 2016 and the built-up reduced from 16.09km^2 to 3.81km^2. The increase in undisturbed and cultivated forest land between 2006 and 2016 was attributed to natural regeneration of woody trees and subjecting the area to be fallowed in line with Osun State government directive in 2012 to close the forest from logging. (Plate 1). It was obvious from the result that the rate of regeneration that occurred from 2006 to 2016 for undisturbed forest land (+4.1319km^2) had not fully compensated for the undisturbed forest trees lost between 1986 and 2016(-10.849 km^2).

Table 2: Changes in Land Use/Land Cover of Oba Hill FR between 1986 and 2016

Category	Changes between 1986 &1996 (km^2)	Changes between 1996 &2006 (km^2)	Changes between 2006 & 2016 (km^2)	Changes between 1986 &2016 (km^2)
Undisturbed	-13.635	-1.3347	+4.1319	-10.849
Cultivated/Disturbed	16.312	-5.2065	8.1504	19.262
Built-Up/Developed	-2.6817	6.5553	-12.2823	-8.405

African Journal of Environment and Natural Science Research
ISSN: 2689-9434
Volume 3, Issue 4, 2020 (pp. 77-85)
www.abjournals.org

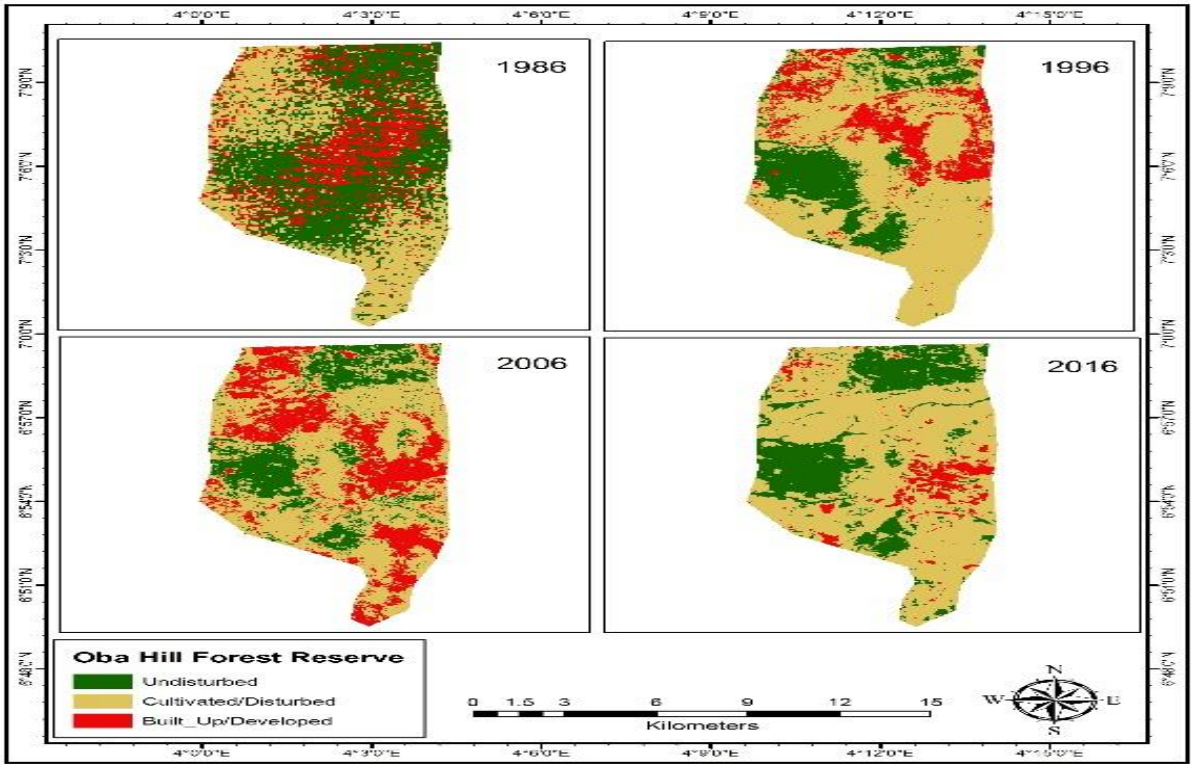

Figure 2: Changes in Land Use /Land Cover Changes between 1986 and 2016

Environmental Implications of Land Use and Land Cover Change in Oba Hill FR

This study revealed that the undisturbed or forested land reduced drastically from 26.169km^2 in 1986 to 15.318km^2 which implies that the forested land had been exposed to soil erosion which can lead to reduction of soil quality. The study area was also exposed to the climate change scenario since woody trees that can serve as carbon sink had been cut without replacement. Biodiversity in term of flora and fauna are endangered anywhere the woody trees are cut. The forested land that had served as habitant for animals had been removed therefore, animals taking shelter had either been killed or fled to other places.

In view of the consequences of land use changes in Oba Hill Forest Reserve, it is therefore recommended that government and other relevant stakeholders should put in place appropriate legal instrument and relevant policies to encourage the resuscitation of Oba Hill Forest Reserve to its initial and intended status.

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.

REFERENCE

Ademiluyi, I.A. Okude, A.S. and Akanni, C.O. (2008). An appraisal of land use and land cover mapping in Nigeria. *African Journal of Agricultural Research*, 3 (9): 581-586, Akinyemi, F. O. (2013). An assessment of land-use change in the cocoa belt of south-west Nigeria. *International Journal of Remote Sensing*, 34:2858–2875. doi:10.1080/01431161.2012.75316 7

Akgün, A., Eronat, A.H. and Türk, N. (2004) Comparing Different Satellite Image Classification Methods: An Application in Ayvalik District, Western Turkey. *20th ISPRS Congress Technical Commission IV, Istanbul, 12-23 July 2004*, 1091-1097. http://www.isprs.org/proceedings/x xxv/co ngress/comm4/papers/505.pdf

Akinsanola, A.A and Ogunjobi, K.O. (2014).Analysis of Rainfall and Temperature over Nigeria. *Global J. Human-Social Science:Geography, Geo-Sciences, Environmental Disaster*, 14(3):1-18.

Asselen, V and Verburg, H (2013). Land cover change or land-use intensification: simulating land system change with a global-scale land change model. *Global Change Biology* 19 (12): 3648-3667.

Bazezew, M.N, Soromessa, T. and Bayable, E. (2015). Carbon stock in Adaba-Dodola community forest of Danaba District, West-Arsi zone of Oromia Region, Ethiopia: An implication for climate change mitigation. *Journal of Ecology and the Natural Environment.* Vol.7 (1), pp14-22. DOI: 10.5897/JENE2014.0493

Daily Independent, (2014). Communal Crisis in Oba Hill Forest Reserve. September, 2014.

Enaruvbe, G. O., & Ige-Olumide, O. (2014) Geospatial analysis of land-use change processes in a densely populated coastal city: The case of Port Harcourt, south-east Nigeria. *Geocarton International Advance* doi:10.1080/10106049.2014.8834 35

Fasona M.J and Omojola A.S (2005) Climate Change, Human security and Communal Clashes in Nigeria. Paper presented at an International Workshop on Human Security and Climate Change, Asker, Norway, 21-23, June, 2007.

Foahom B. (2001). Biodiversity Planning Programme, integrating biodiversity in the forestry sector: Cameroon case study Paperprepared for the international workshop on "Integration of Biodiversity in National Forestry Planning Programme". CIFOR Headquarters August 13–16, 24 pp

Food and Agriculture Organisation (2010). *Global Forestry Resources Assessment 2010. Main Report FAO forestry paper163*. http://wwwfao.org//docrep/013/i/1757e/ i1757e.pdf

Gasu, M.B, Ebehikhalu, N, Bidmus, M.A and Dawam P. (2016) Geospatial Analysis of Land use Dynamics in Osogbo between 1986 and 2012. *Abuja Journal of Geography and Development* 4(1)

Geist H, Lambin E, McConnell W, Alves D (2005) Causes, Trajectories and Syndromes of Land–Use/Cover Change, UPDATE *Newsletter of The International Human Dimensions Programme on Global Environmental Change*, 03/2005, pp. 6-7

Greengrass, E.J. (2009) Chimpazees are close to Extinction in Southwesten Nigeria. *Pimate Conservation*, 24, pp 77-83.

Jensen, J. R. (2005). *Introductory Digital Image Processing: A Remote Sensing Perspective. Pearson Education, Inc.*, New Jersey.

Lambin, E. F., Rounsevell, M. D. A., and Geist, H. J. (2000). Are agricultural land-use models able to predict changes in land-use intensity? *Agriculture, Ecosystems and Environment*, 82, 321–331. doi:10.1016/S0167-8809(00)00235-8

Mengistu, D. A. and Salami, A. T. (2007) Application of remote sensing and GIS in land use/land cover mapping and change detection in a part of south western Nigeria. *African Journal of Environmental Science and Technology*, 5, 99–109.

Mukete, B and Sun, Y (2014). Assessing the Effectiveness of Urban Nature Reserves on Biodiversity Conservation. *Applied Ecology and Environmental Sciences* 2(6):130-134.

Mukete, B., Sun Y, Baninia, Y., Achem B., Bakia M., Saijad S. and Chalwe P. (2017). Perspectives of remote sensing and GIS applications in tropical forest management. *American journal of agriculture and forestry***.** Am. J. Agric. For., 5 (3) (2017), pp. 33-39, 10.11648/j.ajaf.20170503.11

Ogunleye, A. J., Adeola, A. O., Ojo, L. O., and Aduradola, A. M. (2004). Impact of farming activities on vegetation in Olokemeji forest reserve ,Nigeria. *International Journal of Global Nest*, 6, 131–140.

Olaleye, J.B., Abiodun, O.E. and Igbokwe, Q.C. (2009) Land Use Change Detection and Analysis using Remotely Sensed Data in Lekki Peninsula Area of Lagos, Nigeria, *FIG Working week, Surveyors Key Role in Accelerated Development, TS 8B– SIM in Planning and Development, Eliat, Isreal*, 3-8

Patil, M.B., Desai, C.G. and Umrikar, B.N. (2012)Image classification tool for land use/land cover analysis: A comparative study of maximum Likelihood and Minimum Distance Method. *Int. J. Geology, Earth and Enviromental Sci.*, 2(3): 189-196.

Perumal, K. and Bhaskaran, R. (2010) Supervised classification performance of multispectral images. *Journal of Computing*, 2: 124–129.

Ramankutty N, Archard F, Aves D, Turner II B.L, Defries R, Goldewijk K.K, Graumlich L. and Reid R.S (2005). Global Changes in Land Cover, UPDATE *Newsletter of the International Human Dimensions Programme on Global Environmental Change*, 03/2005, pp. 4-5.

Terborgh, J. (2000). The fate of tropical forests: A matter of stewardship. *Conservation Biology*, 14, 1358–1361. doi:10.1046/j.1523-1739.2000.00136.

UNFCCC (2015). United Nations Framework Convention on Climate Change. *Report of the conference of the parties on its twentieth session, held in Lima, Peru* 1st–14th December, 2014. http://unfccc.int/resource/docs/201 4/cop20/eng/10a02.pdf. Accessed 14th November, 2015.

Vanjare, A., Omkar, S.N. and Sathilmath,J. (2014) Satellite image processing for land use and land cover mapping. *I.J. Image, Graphics and Signal Processing*, 10:18-28.