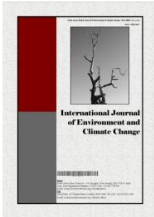

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Landuse Pattern and Landcover of Akure Forest Reserve and Its Environs

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Authors' contributions

This work was carried out in collaboration among all authors. Author AAS designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author OOO managed the analyses of the study. Author TJA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

This study investigated the pattern of land use and land cover of forest reserve in Akure, Ondo State, Nigeria. Currently, deforestation constitutes one of the global development challenges. The broad objective of this study is to identify land use and land cover class within the study area using satellite imagery (ies) to determine the rate/trend of change of this Forest Reserve from 1988 to 2018. The research method includes the use of Geographical Positioning System, and processing of field data through GIS and Remote sensing tool (ILWIS). The research was able to identify various land use and land cover within the Akure forest reserve with the help of GIS and remote sensing tools, the boundary of Akure forest reserve and its environs was delineated, and further result of the classification of Landsat shows that as at 2018 the forest reserve is covered with majorly light vegetation with 51.79%. The study recommended that there Department of Forestry and Ministry of Physical Planning and Urban Development must ensure Policy that will encourage local people and institutional participation in forestry management and conservation along with safeguarding indigenous people's traditional rights and tenure with rightful sharing of benefits.

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Keywords: Land use; land use pattern; land cover; forest reserve and environment.

1. INTRODUCTION

Forest is a land, which is covered with more than 10 percent of trees and an area of more than half a hectare [1]. Forests currently cover around 30% of the Earth's land surface, but are being lost at an "alarming rate" [2]. Forest reserves are portions of lands where commercial harvesting of wood products is excluded in order to capture elements of biodiversity that can be missing from sustainably harvested sites [3]. Deforestation also refers to indiscriminate cutting or over-harvesting of trees for timber or pulp, or to clear the land for agriculture, ranching, construction, or other human activities (Sauraz, 2017). The topic of deforestation has become one of the major global issues since the 1980s. In spite of worldwide concern about tropical deforestation, there remains no exact estimated value of the global deforestation rate and the published values vary largely. One of the reasons behind this is the different understanding of the term deforestation. Between 1923 and 1985, at least 26 different calculations of closed forestland were made and they ranged from 2400 million hectares (ha) to 6500 million hectares [4].

1.1 Statement of the Research Problem

Over the years, sustainable management of forest resources has been of primary concern due to its potential impact on biological diversity and importance in maintaining global ecological functions [5]. In spite of its importance, the natural tropical high forest has continued to diminish rapidly in the African continent, thus dwindling sustainable forest management. The level of community nutrition is sometimes linked to fuel wood availability and cost, majority of the people residing on the African continent use fuel wood as their main source of energy for cooking. In many areas, due to increasing population the existing wood resources are over exploited. It is claimed that there are now places in the Sahel region where fuel wood has become so expensive that it absorbs about half the monthly budget of some poor families in urban areas.

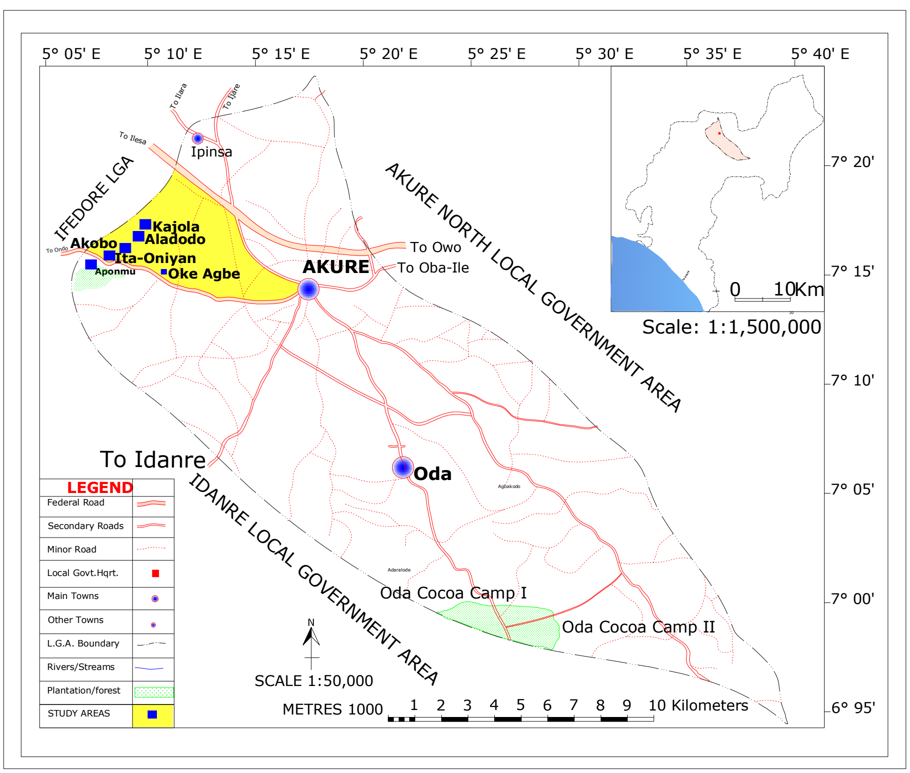

Fig. 1. Map of Akure South showing the position of Akure forest reserve and its environs
Source: Federal Survey Department (Digitized by Author, 2019)

Some families could only afford one meal per day as a result of high cost of fuel wood and other alternative sources of energy for cooking [6].

1.2 Objective of the Study

The objective of this study is to identify land use and land cover class within the study area using satellite imagery (ies).

1.3 The Study Area

Akure Forest Reserve and its environs lies on longitude (07°12.54´ N - 07° 13.83´N and 005° 02.29´E - 005° 03.63´ E) in the rainforest vegetation zone of South-Western Nigeria. The study area is situated along Ondo-Akure road at about 20 km^2 south of Akure. The reserve covered a total land area of 69.92 km^2, of which 11.73% (8.2 km^2) was reported to have been encroached upon by farmers who took over the land to plant cocoa and other food crops [7]. Akure forest and its environs is characterized by two major seasons; dry and wet seasons. Heavy rains characterize the wet season, while the dry season exhibits dryness.

The sun shines throughout the year and the average monthly ambient temperature is between 28.40°C and 31.26°C. The water level of Akure river reduced drastically, while the pond dropped to bottom level during the dry season. The wet season is characterized by increased water current velocity, while the pond overflows its bank thereby making the surroundings marshy. The topography of the reserve is relatively flat with some undulations. The soil is sandy loam overlying laterite gravel by the decomposition of underlying schist and quartz (Akinyemi et al. 2002). Akure Forest reserve is managed by Department of Forestry, Ondo State, of Nigeria.

2. LITERATURE REVIEW

Land use/land cover change is a key driver of global change [8] and has significant implications for many international policy issues (Nunes and Auge, 1999). In particular, land use/land cover (LULC) changes in tropical regions are of major concern due to the widespread and rapid changes in the distribution and characteristics of tropical forests (Myers 2016; Houghton 2017). However, changes in land cover and in the way people use the land have become recognized over the last 15 years as important global environmental changes in their own right [9]. To understand how LULC change affects and interacts with global earth systems, information is needed on what changes occur, where and when they occur, the rates at which they occur, and the social and physical forces that drive those changes [10]. The information needs for such a synthesis are diverse. Remote sensing has an important contribution to make in documenting the actual change in land use/land cover on regional and global scales from the mid-1970s [10].

In Nigeria, despite ongoing research efforts on LULC patterns; there remains a need for development of basic datasets providing quantitative and spatial land use/land cover information. Moreover, there appears to be a gap in the available information at national and local scales for use in regional and national decision making process and rational planning. The same is true in the south-western part of Nigeria. Despite the great economic importance of this region, there have not been systematic studies of land use/land cover changes [11]. Adejuwon and Jeje, [12], in an earlier study mapped vegetation/land use associations in the Ife area using 1:40,000 panchromatic aerial photographs.

2.1 Impact of Land Use/Land Cover Change on Biodiversity

Conversion, deforestation, degradation, and fragmentation threaten the integrity of ecosystems worldwide. Historically, humans have been modifying land to obtain the essentials for their survival, but the rate of exploitation was not the same as it is today. Over the last few decades, numerous researchers have improved measurements of land cover changes. The understanding of the causes and predictive models of land use/cover change were improved under the Land Use and Land Cover Change (LUCC) project of the International Geosphere-Biosphere Programme (IGBP) and International Human Dimensions Programme on Global Environmental Change (IHDP) [10]. Recent research has largely rejected these simplifications and replaced them by a representation of much more complex and intricate processes of land use/cover change. In the year 1991, a new and expanded approach to the study of Global change was attempted where global change scientists were joined by social scientists to examine both the human causes and global consequences of altered land use/land cover patterns on the planet [13].

Nowadays, biological species live in increasingly fragmented habitat islands embedded in a matrix of human civilization. At present, loss of biodiversity, inducing high rates of extinction and a worldwide depletion of biological diversity at genetic, species and ecosystem levels, can be linked to the destruction of natural habitats as a result of land use change at different scales (e.g., farmland expansion, deforestation, urbanization, etc.) and is presently considered one of the most urgent environmental problems [14]. Today, the monitoring and mediating the adverse consequences of land use/land cover change while sustaining the production of essential resources has become a major priority of researchers and policy makers around the world [15].

2.2 Land Use/Land Cover Studies Using Remote Sensing and GIS Techniques

In order to use land optimally, it is necessary to have the information on existing land use land cover. It is also important to have capability of monitoring the dynamics of land use resulting out of both changing demands of increasing population and forces of nature acting to shape the landscape. Land is in a continuous state of transformation because of various natural and man-made processes. The study of spatio-temporal patterns of intra and inter urban form and understanding of the evolution of urban systems are still primary objectives in urban research. Therefore, the information about change is necessary for updating land cover maps and the management of natural [14].

Land use/land cover change detection process of identifies the differences in the state of an object or phenomenon by observing it at different times [16]. Change detection is an important process in monitoring and managing natural resources and urban development because it provides quantitative analysis of the spatial distribution of the population of interest. Jenkins [14] list four aspects of change detection, which are important when monitoring natural resources. They include; firstly, detecting the changes that have occurred; secondly, identifying the nature of the change; thirdly, measuring the area extent of the change and lastly, assessing the spatial pattern of the change. The basis of using remote sensing data for change detection is that changes in land cover result in changes in radiance values, which can be remotely sensed. Techniques to perform change detection with satellite imagery have become numerous because of increasing versatility in manipulating digital data and increasing computer power.

3. MATERIALS AND METHODS

The data for this study was gotten from secondary sources and this include geographic data such as: Thematic Mapper (TM), satellite imageries and Enhanced Thematic Mapper Plus (ETM+) Landsat images of the study area for the year; 1988, 1998, 2008 and 2018 were obtained from Global Land Cover Facility (GLCF), USGS and Earth Science Data Interface to assess the changes in the land use land cover with the use of GIS tools at medium resolution for the years. Remote sensing application of ILWIS software and GIS were used for map scanning and digitizing. These capture imageries from Google website (www.googleearth.com) spot image of Akure Forest Reserve and its environs were transferred into the GIS environment where further processing and analysis were carried out.

4. RESULTS AND DISCUSSION

4.1 Land Use/Land Cover Maps and Statistical Results of Data

Figs. 2, 3, 4 and 5 show the results of the various processing itemized for the 1988 Landsat MSS, 1998 Landsat TM, 2008 Enhanced Thematic Mapping (ETM+) and 2018 Landsat LE data sets of Akure forest reserve and its environs. While Tables 1, 2, 3 and 4 are the corresponding statistical results of the itemized maps data. A supervised classification was performed on the false colour composite (bands 5, 4 and 3) into the following land use / land cover classes which are built up area, cultivation, gallery forest, vegetation and water bodies. The built up area is made up of the human settlement. The water bodies are of flowing and stagnant waters such as river, streams etc., as well as dams. The cultivation refers to farm land where vegetables and grasses are grown. The gallery forest which is also called secondary regrowth consists of plantation, light forest and afforestation area. The vegetation refers to dense vegetation and reserve forest.

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4.2 Classified Landsat MSS Data of Akure Forest Reserve and its Environs in 1988

Table 1 shows the Statistical Result of Classified Landsat MSS Data of Akure forest reserve and its environs in various land use / land cover for the year 1988.The light vegetation which have the highest hectares and percentage with 338286.83 (43.45%), the dense vegetation which is the second highest of the total land amount to 24143.53 ha (31.00%) also, cultivation area with 17601.80ha (2.26%), while the gallery forest (secondary regrowth) is 8108.05 (1.04%), the built up area account for 4171.53ha (0.54%) and lastly the water body is 82118.01 (10.55%). This shows that deforestation has started Akure forest reserve and its environs since 1988.

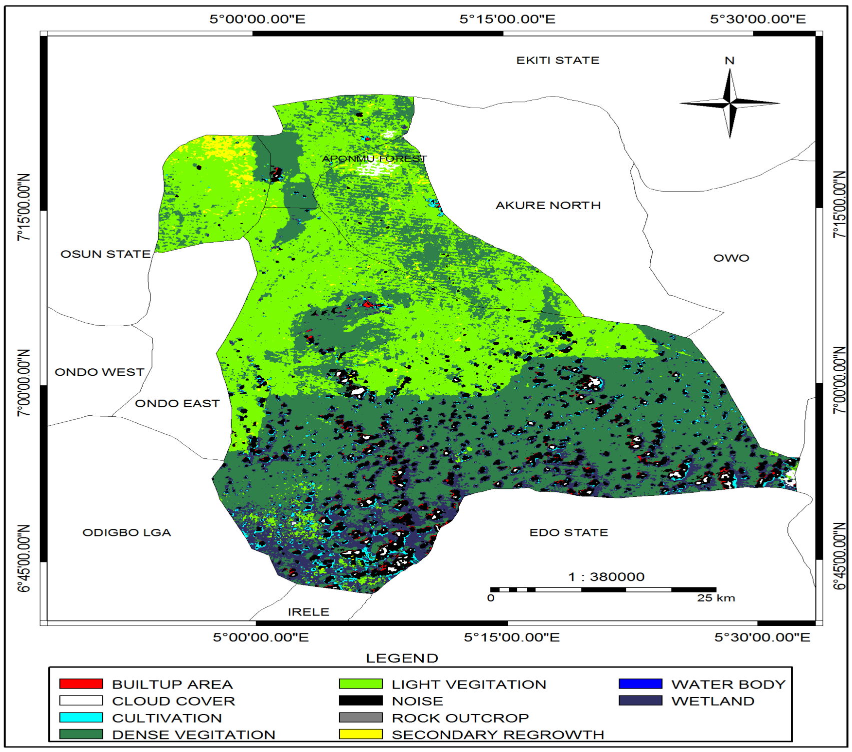

Fig. 2. 1988 Classified land use land cover Map of Akure forest reserve and its environs
Source: Author's fieldwork, 2019

Table 1. Result of classified Landsat MSS data of Akure forest reserve and its environs in 1988

Land use land cover	Area (m^2) 1988	Area (HA) 1988	% (1988)
Built up	41715300	4171.53	0.54
Cultivation	176018000	17601.80	2.26
Dense vegetation	2414035300	241403.53	31.00
Light vegetation	3382868300	338286.83	43.45
Noise	818072500	81807.25	10.51
Rock outcrop	0.00	0.00	0.00
Secondary regrowth	81080500	8108.05	1.04
Water body	0.00	0.00	0.00
Wetland	821180100	82118.01	10.55
Total	**7786428400**	**77842.84**	**100.00**

Source: Author's fieldwork, 2019

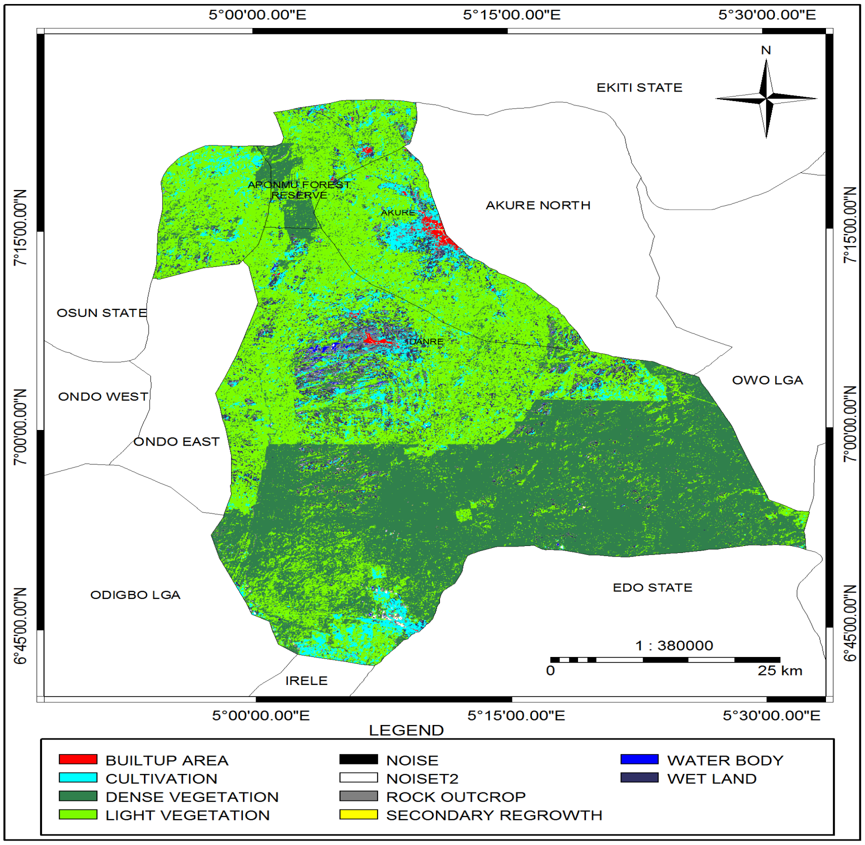

Fig. 3. 1998 classified land use land cover Map of Akure forest reserve and its environs
Source: Author's fieldwork, 2019

4.3 Classified Landsat TM Data of Akure Forest Reserve and its Environs in 1998

Table 2 shows the Statistical Result of Classified Landsat TM Data of Akure forest reserve and its environs in various land use / land cover for the year 1998. The dense vegetation which is the second highest in area with 28080.17ha (52.08%), Next to it is light forest, also, by cultivation area covers 101838.52ha (13.04%), while the gallery forest (secondary regrowth) is 3358.73 (0.43%), the built up area account for 4069.70ha (0.52%) and lastly the water body is 520.08 (0.07%).

4.4 Classified Landsat ETM+S Data of Akure Forest Reserve and Its Environs in 2008

Table 3 shows the Statistical Result of Classified Landsat ETM+ Data of Akure forest reserve and its environs in various land use / land cover for the year 2008. The light forest with is the highest hectares cover with 237807.06ha (30.44%). Follow by savannah forest, with 173953.98ha (22.27%). the dense vegetation with 154947.41ha (19.83%), The cultivation area/bare land which is 153456.36ha (19.64%), the built up area amount to 19081.38ha (2.44%), while the gallery forest (secondary regrowth) is 7682.99 (0.98%), and lastly the water body is 255.47(0.42%).This implies that more of the dense forest has been cultivated for agricultural purpose, and there is gradual increase in urbanization.

4.5 Classified Landsat LE Data of Akure Forest Reserve and its Environs in 2018

Table 4 shows the Statistical Result of Classified Landsat LE Data of Akure Forest Reserve and its environs in various land use / land cover for the year 2018. The cultivation area which is the highest amount to 375414.48ha (51.72%) follow by light forest with 152745.84ha (21.04%), while the built up area is 121103.37ha (16.68%), the gallery forest (secondary regrowth) amount to

3842.19ha (0.53%) and lastly the water body is 226.08ha (180.03%). It implies most of virgin land and light forest area are converted into agricultural land use.

Table 2. Result of classified Landsat MSS data of Akure forest reserve and its environs in 1998

Landuse landcover	Area(m^2)1998	Area(HA)1998	%1998
Built up	40696974.0	4069.70	0.52
Cultivation	1018385241.8	101838.52	13.04
Dense vegetation	2028805560.0	202880.56	25.97
Light vegetation	3811552978.5	381155.30	48.79
Noise	89185862.3	8918.59	1.14
Rock outcrop	250128326.3	25012.83	3.20
Secondary regrowth	33587349.8	3358.73	0.43
Water body	5200836.8	520.08	0.07
Wetland	527883711.8	52788.37	6.76
Total	**7811980886.3**	**781198.08**	**100.00**

Source: Author's fieldwork, 2019

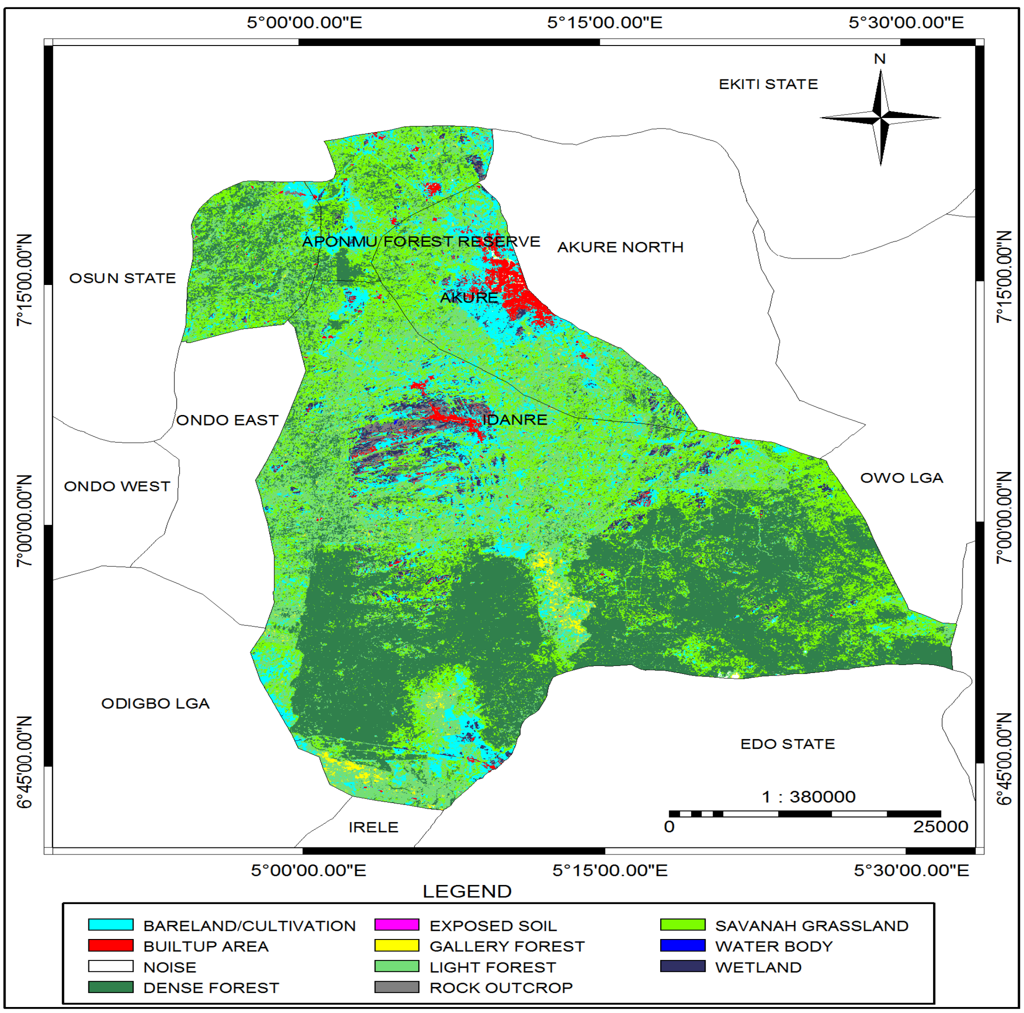

Fig. 4. 2008 classified land use land cover Map of Akure forest reserve and its environs
Source: Author's fieldwork, 2019

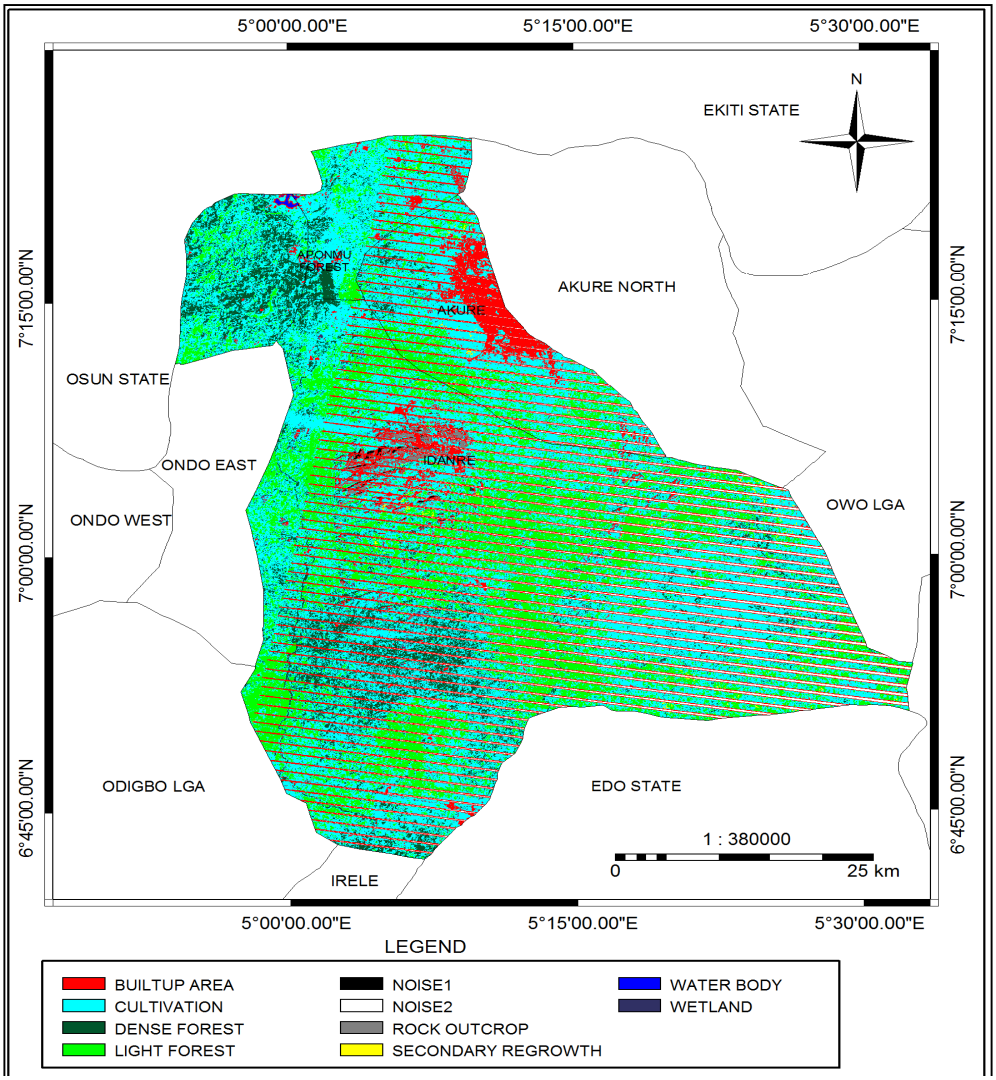

Fig. 5. 2018 classified land use land cover Map Akure forest reserve and its environs
Source: Author's fieldwork, 2019

Table 3. Result of classified Landsat MSS data of Akure forest reserve and its environs in 2008

Landuse and landcover	Area(m^2)2008	Area(HA)2008	% (2008)
Built up	190813770.0	19081.38	2.44
Cultivation	1534563618.8	153456.36	19.64
Dense vegetation	1549474092.0	154947.41	19.83
Light vegetation	2378070623.3	237807.06	30.44
Noise	32945672.3	3294.57	0.42
Rock outcrop	97623515.3	9762.35	1.25
Secondary regrowth	173953977.8	173953.98	22.27
Water body	237177.0	23.72	0.00
Wetland	212054107.5	21205.41	2.71
Total	**7812152271.0**	**781215.23**	**100.00**

Source: Author's fieldwork, 2019

Table 4. Result of classified Landsat MSS data of Akure forest reserve and its environs in 2018

Landuse and land	AREA (m^2) 2018	AREA (HA) 2018	%2018
Built up	1211033700	121103.37	3.43
Cultivation	3754144800	375414.48	7.66
Dense vegetation	640528200	64052.82	11.42
Light vegetation	1527452400	152745.24	51.79
Noise	0.00	0.00	0.11
Rock outcrop	48354300	4835.43	2.83
Secondary regrowth	38421900	3842.19	9.10
Water body	2260800	226.08	0.03
Wetland	35358300	3535.83	13.64
Total	**7257554400**	**72575544.00**	**100.00**

Source: Author's fieldwork, 2019

5. SUMMARY OF FINDINGS AND CONCLUSION

The research was able to identify various land use and land cover within the Akure forest reserve with the help of GIS and remote sensing tools, the boundary of Akure forest reserve and its environs was delineated, and further result of the classification of Landsat shows that as at 2018 the forest reserve is covered with majorly light vegetation with 51.79%. This study has shown thatas population increases there is decreased in both dense vegetation and light vegetation of the forest reserve. Deforestation cannot be stopped in the face of this rapid urbanization but it can only be solved by proper land use planning. This study therefore concludes that unless forest deforestation and forest degradation and management activities in Akure forest reserve and its environs are closely monitored and regulated, it will be costly socially, economically and environmentally. The apparent tradeoff between forest and agriculture can be minimized through spatial management and the use of degraded or low competition lands.

6. RECOMMENDATION

It is therefore recommended that in a bid to check mate the rate of deforestation of forestry and its resources in the study area, Department of Forestry and Ministry of Physical Planning and Urban Development must ensure policy that will encourage local people and institutional participation in forestry management and conservation along with safeguarding indigenous people's traditional rights and tenure with rightful sharing of benefits.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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