



## Research article

## Forest cover change and species distribution in Ago-Owu forest reserve, Osun State, Southwestern, Nigeria

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[Accepted: 01 July 2020]

**Abstract:** This study assessed the forest cover change and species distribution in Ago-Owu Forest Reserve, Osun State, South-western Nigeria. Both primary and secondary data sources were used. The primary data source included the use of Global Positioning System (GPS) to take coordinates of the sampled plots of 10 m × 10 m where enumeration and classification into families of woody trees were carried out. The secondary data were maps of the study area on a scale of 1:50,000. ArcGIS software version 10.1 was utilized. The results show that the un-disturbed forest land in 1986 declined from 234.98 km<sup>2</sup> to 233.66 km<sup>2</sup> in 1996, to 220.76 km<sup>2</sup> in 2006 and decreased to about 194.86 km<sup>2</sup> in 2016. The disturbed land area was 53.29 km<sup>2</sup> in 1986 and decreased to 42.16 km<sup>2</sup> in 1996. The disturbed land area increased from 42.16 km<sup>2</sup> in 1996 to 44.69 km<sup>2</sup> in 2006 and receded to 14.23 km<sup>2</sup> in 2016. The built-up in 1986 increased from 17.16 km<sup>2</sup> to 29.62 km<sup>2</sup> in 1996 and further increased from (39.95 km<sup>2</sup>) to 96.32 km<sup>2</sup> in 2016. The major woody trees species were *Gmelina arborea* and *Tectona grandis*. The result showed that natural and anthropogenic processes such as farming, demand for industrial soft wood and settlements expansions were responsible for the forest cover changes. The study concluded that conversion of natural forest into monoculture plantations should be discouraged while forestry laws and regulations should be enforced in order to reduce human activities that negatively impacted the forest reserves.

**Keywords:** Degradation - Forest resources - Human activities - Land use - Land cover - Sustainability.

[Cite as: Asifat JT & Orimoogunje OOI (2020) Forest cover change and species distribution in Ago-Owu forest reserve, Osun State, Southwestern, Nigeria. *Tropical Plant Research* 7(2): 357–365]

### INTRODUCTION

Man and forest have been coexisting for centuries and this is the main reason why the world forest resources continue to face reduction based on anthropogenic activities (Gibson *et al.* 2000). Change in forest cover resulted from man's need to meet the industrial and social demands. That is why; Goldewijk & Ramankutty (2004) posited that the rate of global deforestation increased between 1700 and 1990 and the impacts of large-scale forest depletion was severely felt in parts of South-East Asia, sub-Saharan Africa and South America.

Previous studies have established that tropical forests are the major habitat of numerous species of living things which are made up of biodiversity through webs of life (Mukhopadhyay *et al.* 2007, Borah *et al.* 2016) while African forests are homes to a large percentage of the world's plants and animals' species (Ifegbesan 2016, Yahya *et al.* 2019). Unfortunately, tropical rainforests especially in West African countries are under increasing pressure from growing human populations, consequent demands for new land for agricultural purposes, urbanization and industrial development (Enuoh *et al.* 2018).

Several studies revealed that pressure from agricultural activities, increasing population, industrial and other social-economic activities engaged by man have great impacts on forest reserves throughout the world (Shi *et al.* 2002, Lambin *et al.* 2003, Bajpai *et al.* 2018, Atomsa & Dibbisa 2019). Literatures has revealed that anthropogenic activities are human interference in the forest and human beings require a lot of space for farmland and industries which takes up tons of space from the forest. Ruprecht *et al.* (2009) posited that the structures of the forest ecosystem were directly affected by human activities such as farming, excessive logging, illegal logging, building construction, mining and sand excavation. All these activities have led to the

deforestation and degradation of the forest environment. Through these activities, forest reserves have been converted to farmland for arable and cash crops (Adekunle *et al.* 2013). These have tampered with plant communities due to incessant human population increase that later on resulted in environmental degradation. It has been emphasized in the literatures that an increased population results in more clear-cutting of plant communities which resulted in severely damaged ecosystems. Ndalilo *et al.* (2017) reported that poverty resulted in high domestic demands for firewood, building materials, poles and illegal poaching of animals which endanger forest resources and led to the vicious cycle of forest degradation.

FAO (2010) reports have shown that in recent times the rate of deforestation and forest degradation in most developing countries of the world are quite alarming and about 13 million hectares of forest were converted to other uses, mainly agriculture, or lost through natural causes each year. It has also been noted that depletion of forest resources in developing countries causes soil erosion, loss of biodiversity; floods, global warming and loss of income for local people (Bryan *et al.* 2010). Nigeria is one of the countries that has the world's highest rate of deforestation of its primary forests in which more than 50% of such forests were lost in the past decades through unsustainable logging, agriculture and fuel wood collection (FAO 2004). Ayanlade (2016) was of the opinion that severe anthropogenic activities like firewood collection and clearing of the forest for agricultural purposes by rural populace causes environmental problems. This finding was corroborated by Orimoogunje & Asifat (2015) who reported that fuel wood consumption in Nigeria resulted in a delectable and alarming rate of forest degradation thereby causing great environmental damage to natural resources with specific reference to flora and fauna. According to Mligo (2011), pole cutting and fuel wood cutting which had significant influences on the decrease of the biomass, plant diversity and changes in the species distribution pattern in the forest.

Shaheen *et al.* (2001) in a study on the subtropical forests of India revealed that the effects of human exploitation is reflected in the way that, the density, basal area and the number of species in disturbed forests were less than those in similar undisturbed stands. The effects of incessant human activities of man in the forests are sometimes grievous. Mishra *et al.* (2004) posited that the influence of human-based disturbance on forest showed that the more the intensity of disturbance increased, the more the species richness and diversity of trees and shrubs decreased. The soil properties of forest trees, shrubs and herbs species could be affected by human activities (Gomoryova *et al.* 2017) as their growth and production depend on soil fertility (Rad *et al.* 2018). Furthermore, the increased number of people entering into timber logging trade has caused incessant increase in timber harvesting from forest reserves and free areas. Hence, this study examined human activities in the study area and appraised the forest cover change and species distribution with a view to assessing the environmental impacts of the human activities in order to identify proximate factors responsible and suggest viable option to mitigate these environmental impacts.

## MATERIAL AND METHODS

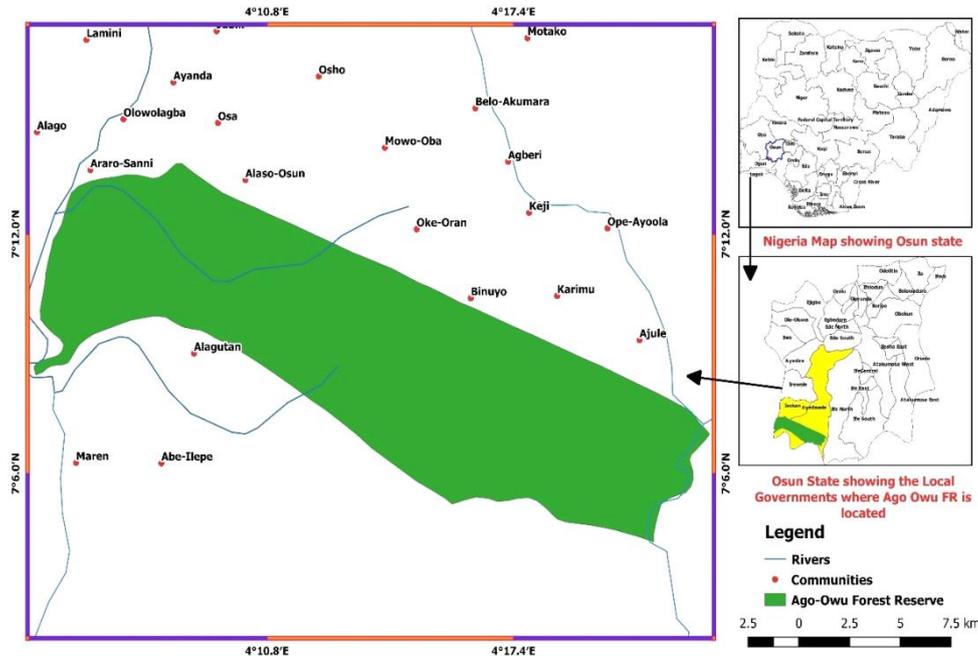
### *Description of the study area*

This research was conducted in Ago-Owu Forest Reserve, Osun State Nigeria. It is located between latitude 7° 9' 37.8144" N – 7° 14' 0.8376" N and longitude 4° 4' 22.7280" E – 4° 10' 6.3264" E. It is found in the rain forest zone and it covers 305.4123 km<sup>2</sup>. The climate of the study area is of humid tropical type with distinct dry and wet seasons. The wet season begins from mid -March to late October. The rainfall pattern is bimodal with peak periods in July and September. The study area is underlain by metamorphic rocks of the Precambrian Basement Complex with great variation in the rocks structure, mineral composition and grain size (Smyth & Montgomery 1962). The soils of the area are also moderately to strongly leach. The soils have low to medium humus content, weakly and to neutral surface layers and moderately to strongly acid sub-soils (Smyth & Montgomery 1962). The vegetation is evergreen with such woody trees like Teak (*Tectona grandis* L.f.), Gmelina (*Gmelina arborea* (Benth.) Staff), Oganwo (*Khaya ivorensis* A.Chev.), Ayunre (*Albezia zygia* (DC.) J.F. Macbr.), Iroko (*Milicia excelsa* (Welw.) C.C.Berg), etc. The climate of the area is humid tropical, with distinct dry and wet season. There are communities that fall within and around Ago-Owu FR such as; Ajegunle, Mokore, Alabameta, Elewe, Alaguntan, Arinkinkin, Okodowo, Alaadura and many others. Major occupation of the people is farming, although some of them have one or two other occupations combined together such as being a farmer and a trader, a farmer and wood contractor etc. They engaged in cash cropping than food cropping. Some of the cash crop planted are; palm fruit, cocoa and cola nut. Other crops found here are plantain, banana, yam, cassava and the like.

### *Data collection*

Quantitative data sources which are primary and secondary sources were employed in this study. The [www.tropicalplantresearch.com](http://www.tropicalplantresearch.com)

primary data include the use of Global Positioning System (GPS) to take the co-ordinate of the Forest Reserves. The study area was demarcated into five (10 m × 10 m) plots where the woody trees species were enumerated. Woody tree variables such as tree height was measured with the use of Hagar Altimeter, girth at diameter breast height (dbh) using a girth tape and volume were measured. The woody trees species were classified into different families according to Carl Linnaeus taxonomy of species classification. Questionnaire was administered to 100 respondents from five communities (20 respondents each) using systematic random sampling. The secondary data included the use of map of the study area on a scale of 1:50,000 and satellite imageries using ARCGIS 10.1 of 1986 to 2016 of the study area. Data were analyzed using descriptive statistics such as tabulations.



**Figure 1.** Map of Ago-Owu Forest Reserve, Osun State.

## RESULTS AND DISCUSSION

### *Forest Cover using Remotely Sensed Data*

The areal extent of Ago-Owu forest reserve was 305.412 km<sup>2</sup> distributed into the undisturbed forest land, disturbed forest land and developed land. In 1986, the undisturbed forest land was 234.98 km<sup>2</sup> and the disturbed forest land was 53.289 km<sup>2</sup>. The developed area was 17.134 km<sup>2</sup> (Fig. 2). It is evident from Figure 3 that the land use/land cover of the study area in 1996 was undisturbed forest land covered 233.6616 km<sup>2</sup>, disturbed forest land covered 42.129 km<sup>2</sup> and the developed land covered 29.622 km<sup>2</sup>. Figure 4 revealed that the undisturbed forest land in 2006 was covered by 220.765 km<sup>2</sup> while the disturbed forest land was 44.688 km<sup>2</sup>. The developed area in this same year was 39.959 km<sup>2</sup>. Figure 5 showed that the land use/land cover of Ago-Owu FR in 2016 was undisturbed forest land covered 194.861 km<sup>2</sup>, disturbed forest land covered 14.231 km<sup>2</sup> while developed area covered 96.321 km<sup>2</sup>. The implications of these scenario are that the floristic composition of the study area has been seriously altered while the forest cover has been totally degraded. These conditions will be accentuated with different adverse environmental issues such as erosion, species degradation, habitats fragmentation, and climate change problems.

### *Land use/land cover changes between 1986 and 2016 in Ago-Owu forest reserve*

The satellite imageries of 1986 to 2016 showed clearly the land use / land cover changes for the year under study. The comparative changes are shown in (Appendix I). The undisturbed forest land between 1986 and 1996 decreased by (-1.3266 km<sup>2</sup>). This implies that 1.3266 km<sup>2</sup> of the undisturbed forest land has been usurp thereby reducing the initial size of the land. The disturbed forest land in 1996 decreased by (-11.1609 km<sup>2</sup>) to what was obtained in 1986 and the developed area also increased from 17.134 km<sup>2</sup> to 29.622 km<sup>2</sup> (12.487 km<sup>2</sup> increase) (Appendix II). These results showed that part of the disturbed forest land had been taken up by developed area since the undisturbed forest land in this year also decreased. The implication of thus was that more land was converted for development purpose in 1996, which negatively impacted the forest cover. The changes that occurred between 1996 and 2006 from undisturbed forest land was (-12.896 km<sup>2</sup>) and the changes of the disturbed forest land in 1996 was (42.129 km<sup>2</sup>) and in 2006 was (44.687 km<sup>2</sup>) (Appendix II). There was 2.558

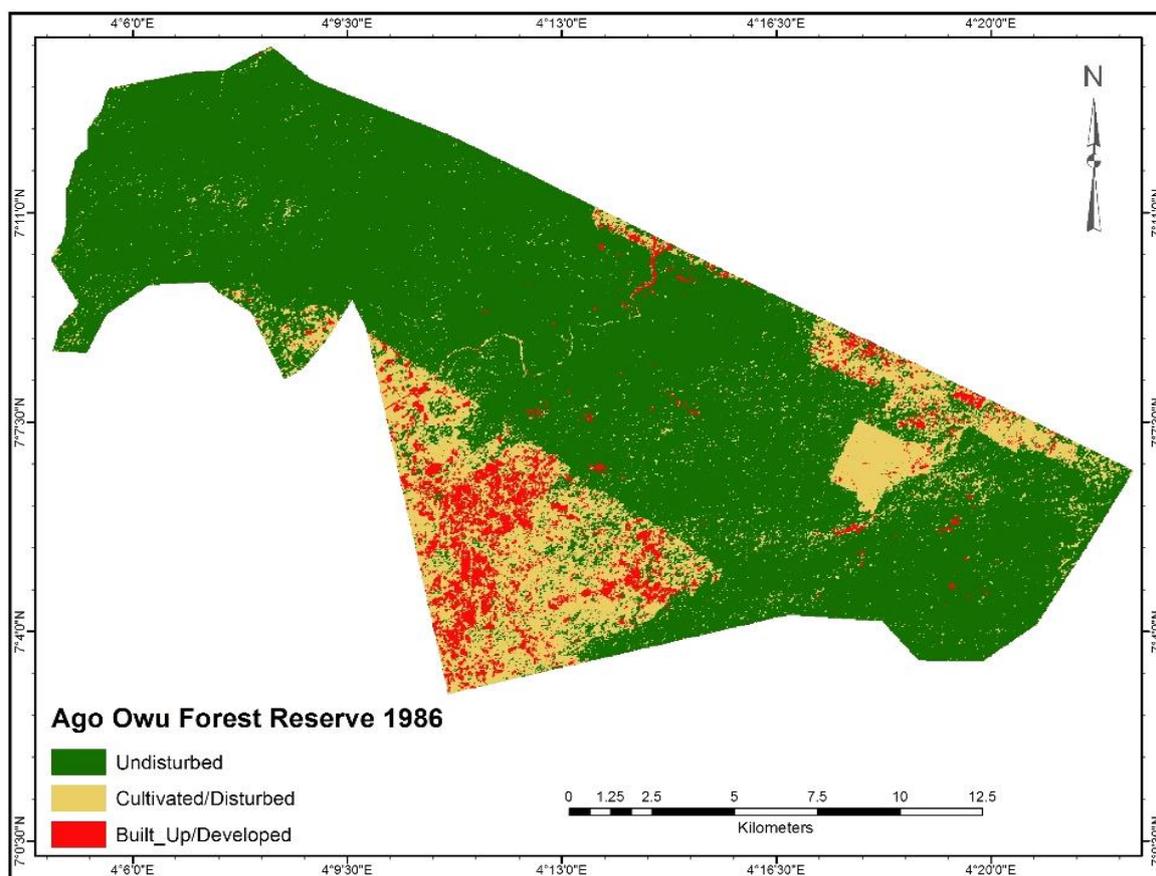


Figure 2. Land use and land cover of Ago-Owu Forest Reserve in 1986.

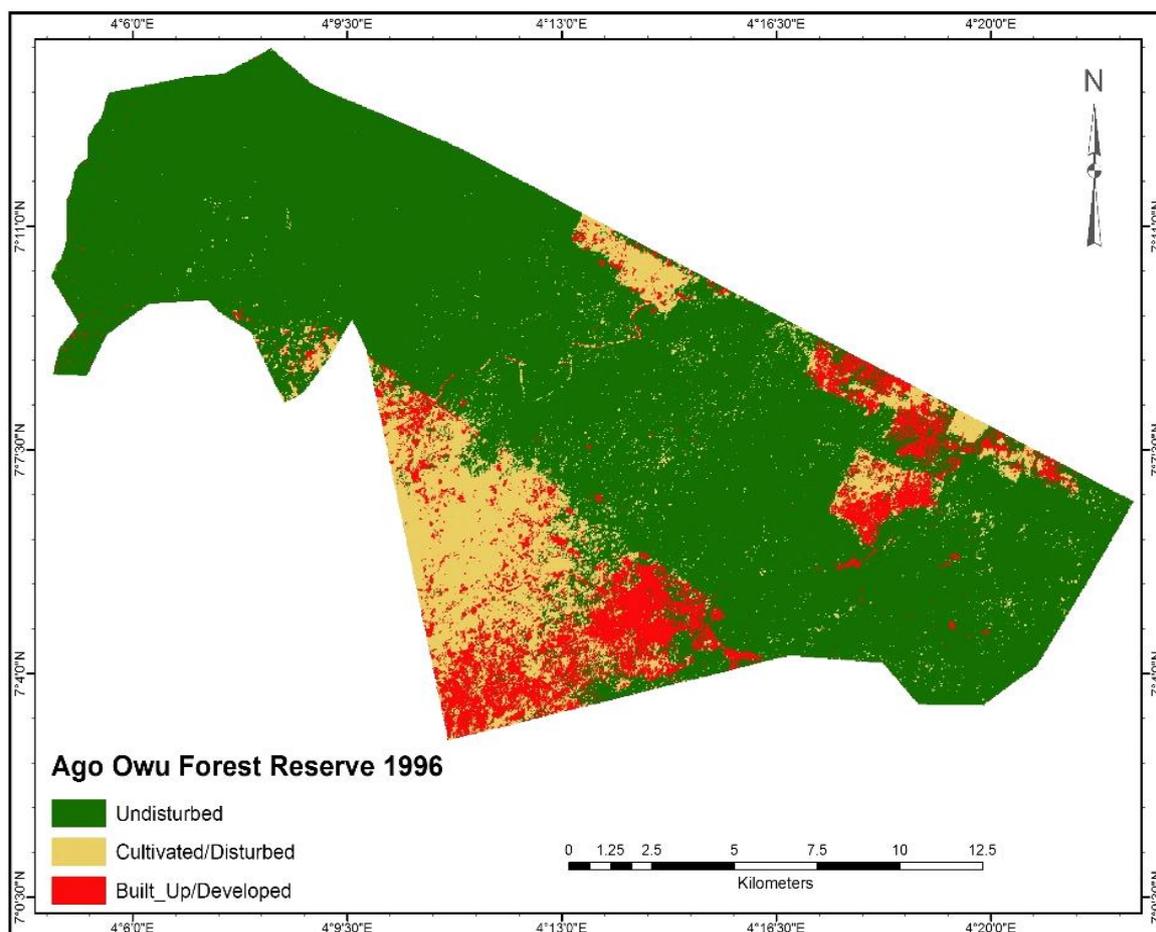


Figure 3. Land use and land cover of Ago-Owu Forest Reserve in 1996.

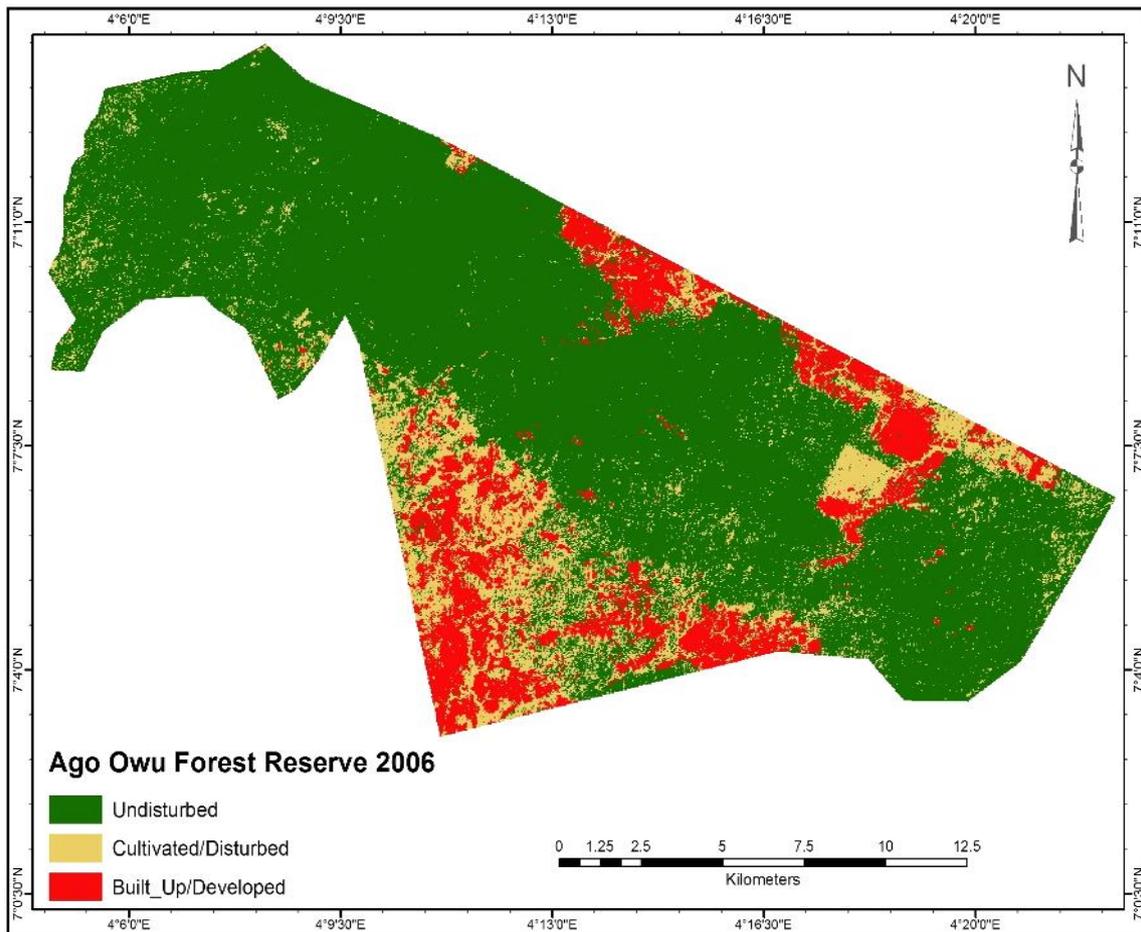


Figure 4. Land use and land cover of Ago-Owu Forest Reserve in 2006.

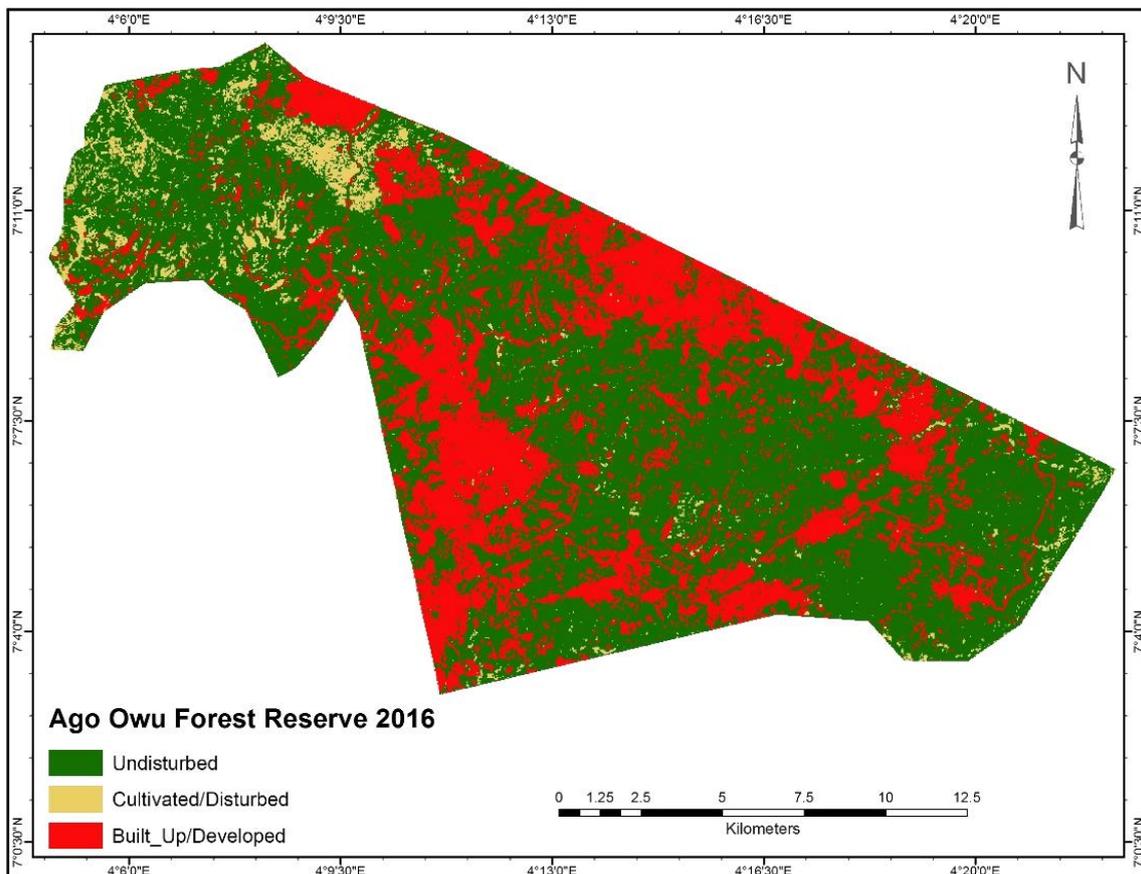


Figure 5. Land use and land cover of Ago-Owu Forest Reserve in 2016.

km<sup>2</sup> increase in the land in 2006. The result suggested that sizeable land area was added to the size in 1996 and indicated that more lands were cultivated in 2006. The developed forest land in 2006 further increased from (29.621 km<sup>2</sup>) to (39.959 km<sup>2</sup>) (Appendix II). This indicated that the areal extent of the developed area is on the increase. It means that more forest land was allocated for more development that engulfed either the undisturbed forest land or the disturbed forest land. The differences between 1996 and 2006 for developed area was (10.3374 km<sup>2</sup>). In 2016, the difference in the undisturbed forest land to that of 2006 was (-25.9047 km<sup>2</sup>) which shows that the undisturbed gradually decreased from (220.7655 km<sup>2</sup>) in 2006 to (194.860 km<sup>2</sup>) in 2016. The disturbed forest land in 2016 difference was (-30.456 km<sup>2</sup>). The land drastically decreased from (44.687 km<sup>2</sup>) in 2006 to (14.230 km<sup>2</sup>) in 2016. This shows that the size of disturbed forest land was small compared to the initial size (53.2899 km<sup>2</sup>) in 1986. The developed area in 2016 increased by (56.361 km<sup>2</sup>) that is the developed area increased from (39.959 km<sup>2</sup>) in 2006 to (96.320 km<sup>2</sup>) in 2016. This implies that the developed area gradually increased from 17.134 km<sup>2</sup> in 1986 to 96.320 km<sup>2</sup> in 2016. This suggested that the land was further occupied for more developmental projects probably farm settlements and building of abode for the farmers.

Appendix I further shows further the changes in the land use of Ago-Owu FR between 1986 and 2016. The undisturbed forest land in 1986 was (234.988 km<sup>2</sup>) and that of 2016 was (194.860 km<sup>2</sup>). This shows (40.127 km<sup>2</sup>) decrease. This indicated that the undisturbed forest land was taken up for other uses such as agricultural purposes, logging and so on. Figure 1 shows that the forest land in 2016 has been taken up by developed area more than what it was in 1986. The disturbed forest land declined from (53.2889 km<sup>2</sup>) to (14.230 km<sup>2</sup>). There was a drastic difference of (-39.059 km<sup>2</sup>) which shows that the disturbed forest land has been lost to other uses which probably may be the establishment of farm settlement in which original forest lands were allocated to people for farming purposes.

#### Human Activities

Table 1 shows various human activities that were found in the study area and forest resources often collected by the respondents during the questionnaire administration. Those respondents (84%) were found in agricultural practices and (16%) were not practicing agriculture. About 57% of the respondents engaged in timber logging while 43% did not engage in timber logging. Quarrying activities are also carried out with (18%) found in this activity and (72%) are not engaging in quarrying. It was observed during the field study that major farming system was cash cropping. This concurred with Thakur (2017) in a study in South Andaman and Fabiyi (2011) in a study in Niger Delta that, anthropogenic activities such as farming purposes and expansion of settlements were most important determinants of vegetation change. The forest resources utilised by the respondents were firewood (85%) which was the highest among other resources collected, followed by fruit gathering (80%) and timber logging was (66%). The collection of leaves for domestic purposes for medicinal and wrapping purposes (56%), Charcoal production (37%) and cutting of woody trees for pole (29%). The proportion of respondents that utilised woody trees from the study area was high (85%) firewood, (66%) timber logging, (37%) charcoal production and poles (29%). This indicated that more woody trees were used by the respondents for various uses. This also implies that valuable woody trees were cut and this exposed the study area to degradation.

**Table 1.** Human Activities in Ago-Owu Forest Reserve.

Occupation/Human Activities	Frequency	
	Yes	No
Farming	84.00	16.00
Timber logging	57.00	43.00
Quarrying	18.00	72.00
<b>Forest Resources Collected</b>		
Firewood	85.00	15.00
Pole	29.00	71.00
Leave for domestic purpose	56.00	34.00
Fruit	80.00	20.00
Timber	66.00	34.00
Charcoal	37.00	63.00

#### Forest structure

Table 2 showed quadrat 3 with the highest volume of wood (31.3 m<sup>3</sup>), quadrat 1 has (23.33 m<sup>3</sup>), followed by (18.05 m<sup>3</sup>) from quadrat 4 and (14.80 m<sup>3</sup>) from quadrat 2. The quadrat 5 has the least volume of wood with (10.77 m<sup>3</sup>). The quadrat 3 has the highest basal area (3.25 m<sup>2</sup>) and the fifth quadrat has the least basal area (1.01 m<sup>2</sup>). Tiny woody tree species were discovered in the study area during the field study. This result showed that matured tree were not available which has resulted from excessive logging and farming activities. The forest

land had been leased out for farming purposes since Ago-Owu Forest Reserve had been de-reserved to make room for farm settlement and woody trees were cut without replacement. Some indigenous trees remaining were shown in table 3, which are, *Celtis integrifolia* Gaertn, *Triplochiton scleroxylon* K.Schum, *Ceiba pentandra* (L.) Harms, *Albizia zygia* (DC.) J.F. Macbr. and some other one.

**Table 2.** Forest Structure of Ago-Owu Forest Reserve.

Quadrat No.	Frequency	Basal Area (m <sup>2</sup> )	Vol. (m <sup>3</sup> )	Av. Vol. of wood (m <sup>3</sup> )
1	09	2.28	23.33	2.91
2	15	2.30	14.80	1.14
3	16	3.25	31.30	1.99
4	19	2.10	18.05	0.95
5	07		10.77	2.15

**Note:** Vol.= Volume; Av. Vol.= Average Volume.

#### Floristic Composition in Ago-Owu Forest Reserve

Table 3 represents different woody species and family distribution according to Carl Linnaeus classification. Eighteen (18) woody species were found in five sampled plots. These woody species were distributed into fourteen families.

**Table 3.** List of woody Species in Ago-Owu Forest Reserve.

S.N.	Common Name	Scientific Name	Family
1	Ayunre	<i>Albizia zygia</i> (DC.) J.F. Macbr.	Mimozoida
2	Ahun	<i>Alstonia boonei</i> De.Wild	Apocynaceae
3	Isin	<i>Blighia sapinda</i> Konig	Sapindaceae
4	Ako	<i>Brachyestegia</i> sp.	Ceasalpinoidea
5	Araba	<i>Ceiba pentandra</i> (L.) Gaertn.	Bambacaceae
6	Ita	<i>Celtis integrifolia</i> Gaertn	Ulmaceae
7	Omo	<i>Cordia milleni</i> Bak.	Boraginaceae
8	Palm Produce	<i>Elaeis guineensis</i> Jacq.	Areaceae
9	Ire	<i>Funtumia africana</i> (Benth) Staff	Apocynaceae
10	Gmelina	<i>Gmelina arborea</i> Roxb.	Verbanaceae
11	Oro	<i>Irvingia gabonensis</i> (Aubry-Lecomte ex O'Rorke) Bailli	Irvingiaceae
12	Mahogany	<i>Khaya ivorensis</i> A. Chev	Meliaceae
13	Mansonina	<i>Mansonia altissima</i> (A. Chev) A. Chev	Sterciliaceae
14	Iroko	<i>Milicia excelsa</i> (Welw.) C.C. Berg	Moraceae
15	Teak	<i>Tectona grandis</i> L.f.	Verbanaceae
16	Idigbo	<i>Terminalia</i> sp.	Combretaceae
17	Afara	<i>Terminalia superba</i> Engl. & Diels	Combretaceae
18	Arere	<i>Triplochiton scleroxylon</i> K. Schum	Sterciliaceae

#### Environmental Impacts of Human Activities

It is evident from the study that human activities had greatly impacted on the floristic composition of the study area. For instance, the matured woody trees species have disappeared which could probably lead to diverse environmental problems. It should be established that the woody trees species that supposed to serve as carbon sink in order to alleviate the problem of climate change have been cut down for industrial purposes and to make way for farming activities and settlements in the study area. Therefore, climate change scenario with its antecedent problems is looming in the study area. Also, due to the incessant cutting of the woody trees' species, the natural abode of the plants (which may have resulted in permanent extinction of native species such as *Milicia excelsa* and other native species) and animals (which may have resulted in loss of animal's habitats loss and subsequent extinction) have been greatly destroyed. This concurred with Asifat (2012), that fuelwood cutting is causing serious degradation to the forest environment.

#### CONCLUSION

The study investigated human activities in the study area and also assessed the forest cover change and the species distribution. It also assessed the environmental impacts of the human activities. It was revealed that human activities that were prominent in the study area were farming and logging. It was further revealed that forest cover has been greatly tampered with and the changes showed loss of forest tree species and probably animals since forests are homes of diverse animals. Therefore, there is this need of urgent attention by all the stakeholders, be it individual, non-governmental Organisation and Government to be seriously involved in environmental management of this study area to ensure continuous sustainability of this forest reserve.

Governments should embark on afforestation in virgin land and re-afforestation in the existing forest land. The populace needs to be enlightened on the benefits, conservation and sustainability of the forest trees. There is need to educate the people about the adverse effect of incessant cutting of the woody trees that is, climate change and its effects so that all hands will be on desk against this scenario.

#### ACKNOWLEDGEMENT

The authors are grateful to Dr O. J. Oyelowo of the Department of Forest Conservation and Protection, Forestry Research Institute of Nigeria for checking through the scientific names of the woody species listed in this study.

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### Supporting information

**Appendix I:** Differences between 1986 and 2016 land use/Land cover of Ago-Owu.

**Appendix II:** Land use/land cover of Ago-Owu Forest Reserve between 1986 and 2016.

**Appendix I:** Differences between 1986 and 2016 land use/Land cover of Ago-Owu.

Features	1986 & 1996	1996 & 2006	2006 & 2016	1986 & 2016
Undisturbed	-1.33	-12.90	-25.90	-40.13
Disturbed / Cultivated	-11.16	2.56	-30.46	-39.06
Built up / Developed	12.49	10.34	56.36	79.19

**Appendix II:** Land use/land cover of Ago-Owu Forest Reserve between 1986 and 2016.

Features	1986 km <sup>2</sup>	1996 km <sup>2</sup>	2006 km <sup>2</sup>	2016 km <sup>2</sup>
Undisturbed	234.99	233.66	220.77	194.46
Disturbed / Cultivated	53.29	42.13	44.69	14.23
Built up / Developed	17.13	29.62	39.96	96.32
Total	305.41	305.41	305.41	305.41