STATUS AND DRIVERS OF SPATIAL CHANGE OF FOREST RESERVES AND PROTECTED AREAS IN SELECTED STATES OF SOUTHWEST NIGERIA: A CASE STUDY OF OGUN, OSUN AND OYO STATES, NIGERIA

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Abstract

There is a rapid decline in the ecologically and biologically rich South-west Forest Reserves and Protected Areas coupled with negative implications on environmental, social and economic sustainability. Thus, this study evaluated the status and drivers of spatial change of Forest Reserves (FR) and Protected Areas (PA) in Southwest Nigeria. Stratified random sampling technique was used for the study. Forty-four (FR) and one (PA) in Ogun, Osun and Oyo States were selected as representative samples. Forest users (37), Households (68), Community Leaders (10), Government officials (13) totaling 128 respondents were randomly selected. Geographic Information System (GIS) and Remote Sensing as well as quantitative and qualitative methods of data were used to analyze the data collected. The temporal dynamics of the F.R and P.R shows that about 75% of the forest reserves have been degraded. Analysis also showed that degradation is higher in Oyo state compared to Ogun and Osun states as about 50% of the reserves in state has been converted to human settlement (built-up areas). Findings show the major drivers of this massive environmental degradation of forest estates in South-west Nigeria are deforestation, population growth, urbanization, industrialization, agricultural practices, construction and change in government policies. The study thus recommends that there is a need for strict implementation of the 2006 National Forest Policy and periodic monitoring of the forest estate with the use of GIS and Remote Sensing techniques. This will help in knowing the status of the FR and PA per time; reduce the rate of massive degradation and deforestation in South-west Nigeria and enhance forest landscape restoration (FLR) in South-west Nigeria.

Keywords: Status, drivers, degradation, deforestation, anthropogenic activities, sustainable forest management.

Introduction

Forest Reserves (FR) and Protected Areas (PA) are critical to life as they provide ecosystem services; protect the soil, regulate and stabilize climate, provide fresh water, raw materials, shelter, food, genetic materials, act as a barrier against disasters, a stable source of resources amongst others (Mansourian, et al. 2009; Forest Stewardship Council, 2017).They support about 1.6 billion people's livelihoods and nearly 80% of the world's terrestrial species are supported by forests (WWF, 2017). There is however an increasing global concerns as regards the decline of FR, biodiversity loss and PA which has great consequence on economic, social and environmental sustainability.

In the just released Intergovernmental Panel on Climate Change (IPCC) 2018 report, the importance of forest in fighting against catastrophic climate change based on their ability to store and absorb carbon was reemphasized (Pearce, 2018). That is, reducing deforestation is crucial to slowing global warming. The sharp decline in the forest cover which is majorly due to deforestation and degradation has been attributed majorly to human activities (Adeniyi, 2016; FAO, 2007, Orimoogunje et al. 2009).

According to Food and Agriculture Organization (FAO), forests in Africa are disappearing at an alarming rate; at a rate of more than 4 million (MN) hectares per year which is twice the world's deforestation average. The greatest and most

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destructive cause of deforestation in Africa is the conversion of forest land for agricultural purposes (Fleshman, 2008; Butler, 2012; Swanborough, 2016). Nigeria which was once the heart of the tropical rainforest belt has lost about 95% of her total forest cover and now imports 75% of the timber she requires for her own purpose (Adeniyi, 2016). The loss of forest reserves at present in Nigeria is at a rate of 3.5% annually as a result of land cover modification and conversion which has direct impact on loss of biodiversity and its attendant negative effect on the ecological setting (Orimoogunje et al., 2009). Adeniyi (2016) while quoting FAO statistics stated that the forest size of Nigeria declined to 11,089,000ha in 2005 from 13,517,000ha in 2000 and further reduced to 9,041,000 in 2016. Also, earlier studies on forest reserves and protected areas in Nigeria revealed that deforestation resulting from farmland encroachment, increasing population, pressure from human activities (like hunting, logging, conversion of land use, grazing, cross boundary influence, among others), among others has greatly affected the reserves which has led to loss of biodiversity and genetic resources, increasing carbon dioxide (Orimoogunje et al. 2009; Oduntan et al. 2013; Ayanlade, 2016).

If this high rate of deforestation and environmental degradation in Nigeria is not properly contained, the forest estate will not have the ability to provide its goods and services for human use and would also not be able to meet the never-ending demands of the present and future generations. Thus, this paper determined the status and drivers of spatial change of the forest reserves and protected areas in south west Nigeria. It also determined the current status of the FR and PA with reference to the base year 1960 using Landsat Imageries of 2016 and identified the factors contributing to the change in spatial extent of the forest reserves and protected areas in the study area. This would help in sustainable management of the forest reserves and protected areas and also promote sustainable environment.

Materials and Methods

Study Area

The South West geopolitical zone of Nigeria comprises Lagos, Ogun, Oyo, Osun and Ekiti states. The region lies between Longitude 2°31' and 6°00'E and Latitude 6°21' and 8°37'N with total land mass of approximately 77,815 square kilometers (Faleyimu et al., 2013).
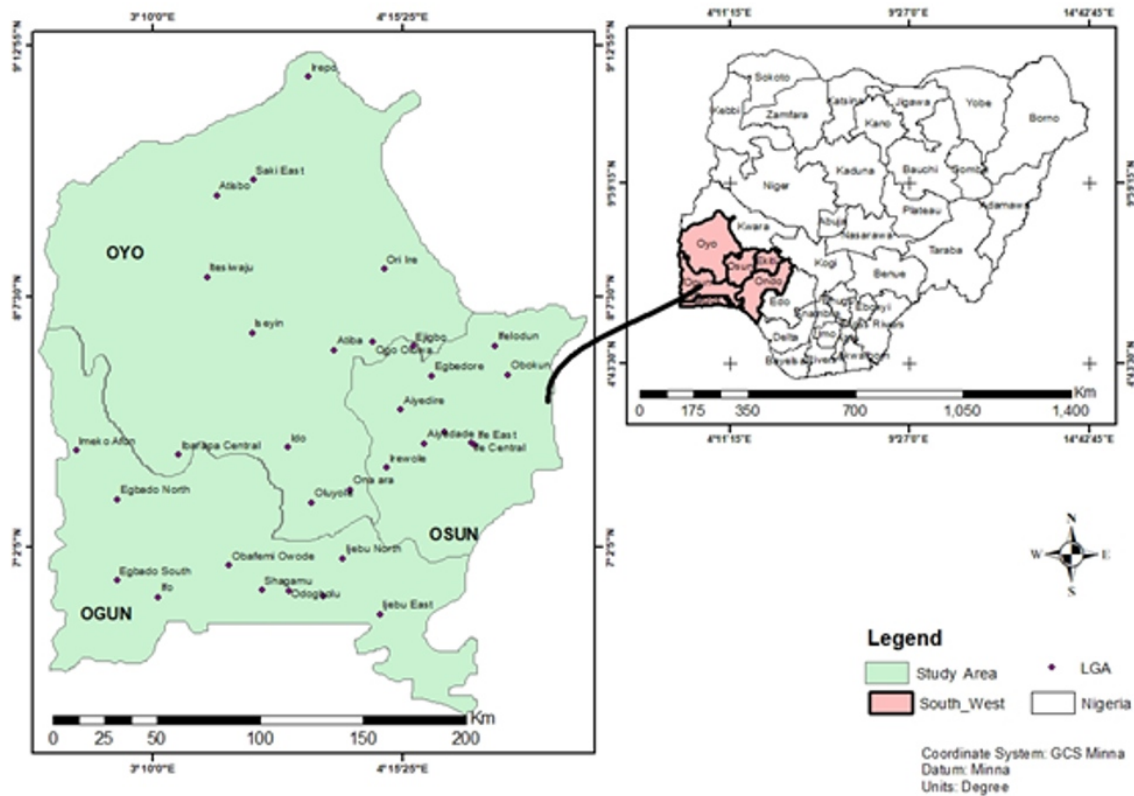

Figure 1: Map of the Study Area

It is bounded in the North by Kwara and Kogi States; in the South by the Gulf of Guniea; East by Edo and Delta States and in the West by the Rebublic of Benin. The climate of this region is tropical in nature, and dominated by the influence of the maritime tropical air mass, equitorial easterlies and the continental tropical air mass (Faleyimu et al., 2013; Omogbai, 2010). It is characterized by wet (March to November) and dry (November to February) seasons with a temperature ranging between 21and 34°C and an annual rainfall between 1500 and 3000mm. The wet season is associated with the Southwest monsoon wind from the Atlantic Ocean while the dry season is associated with the northeast trade wind from the Sahara Desert.

The region's vegetation comprises of fresh swamp and magrove forest at the belt. The Nigerian lowland forest region is confined to a narrow band along the coast in the Southwest of Nigeria. The low land in the forest extends inland to Ogun and part of Ondo State, while secondary forest is towards the northern boundary where the derived southern Savannah exists (Faleyimu et al., 2013). The study area measures relatively well on the economic scale as the region boosts of agricultural produce of food and cash crops which includes plantain, cassava, cocoa, maize, kola nut, cocoa, plantain, yam, rice, citrus, timber, millet, cashew, maize, vegetables among others.

Data Sources and Image Pre-processing

Topographical maps, Landsat imageries and questionnaires were used to collect data used for this paper. Topographical maps of Southwestern Nigeria were used as the base map for extracting the forest reserves and protected areas in the study area. Landsat imageries of the year 2016 covering the study area were used in determining the current status of the forest reserves and protected areas while the structured questionnaires and interview were the tools used in carrying out social survey for this research work. Stratified Random Sampling technique was used for the social survey. Stratified Sampling method is a form of random and probability sampling technique in which the population is divided into different strata (groups) based on common characteristics (Dudovskiy, 2015). In the division of the population into strata, each element has the chance of being selected. The sample size used for the study area is two hundred fifty (250). The stakeholders in the population were then divided into four strata namely Households, Forest users, Government Officials and Community Leaders. Each questionnaire was divided into segments. Table 1 shows the spatial data sources and their characteristics.

Table 1: Spatial Data Sources and Characteristics

Parameter	Landsat 8	Topographical map
Date acquired	2016	1960
Identification/Coverage	WRS-2, Path192_Row 054; Path191_Row054; Path190_Row054; Path191_Row055; Path190_Row055; Path191_Row056; Path190_Row056	Ogun, Osun and Oyo States
Spatial resolution (m)	30 (100m – thermal, 15 m pan)	-
Sensor	OLI/TIRS	-
Spectral resolution	11 bands: B 1: Coastal aerosol, Blue, Green, Red, Near-IR, SWIR-1, SWIR-2, Panchromatic, Cirrus, Thermal-IR 1, Thermal-IR 2	
Radiometric Resolution	16-bit pixel values	8
Temporal Resolution	I6 days	3-5 (DMC satellites)
Swath width (km)	185	
Year launched	2013	
Map Projection	Universal Transverse Mercator (UTM)	
UTM Zone	31	
Datum	WGS84	

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The Landsat imageries were extracted and brought into ENVI 5.3 environment. After a careful consideration bands 7,5,3 (Shortwave infrared (SWIR), Green and Red) were layer stacked together in order to generate a composite image of the study area. This was done so as to carry out a land-use land-cover classification to determine the status of forest estate and protected areas in South-western Nigeria. Also, the topographical sheets were scanned and imported to ArcGIS 10.3.1 environment. Thereafter, they were geo-rectified using Universal Transverse Mercator (UTM) projection with Clarke 1880 spheroid for proper projection and to make it registered with the Landsat imageries as plan metrically accurate data source. Similarly, each Questionnaire was given an identification number (ID) which was used to separate each community and states surveyed. Two hundred and fifty (250) questionnaires were distributed and in all, a total of one hundred and twenty-eight (128) questionnaires were filled.

Table 2: Surveyed Communities and their Identification Number

ID	State	LGA	Name of community	Questionnaires Filled				Total
				Forest Users	Households	Community Leaders	Government Officials	
1	Ogun State	Ijebu-Ode, Ijebu-East,Ijebu North, Odogbolu	Atiba, Area J4, Ilese, Adefisan, Ejirin Road, Odogbolu	16	27	4	9	56
3	Oyo	Iseyin, Orire North,	Abaletu Sawmill, Arowosaye, Orimoje	8	15	3	3	29
4	Osun	Ife-East, Obokun,	Ajegunle, Ibokun, Ita-Osa, atagijere	13	26	3	1	43
Total	3	8	13	37	68	10	13	128

Source: Author's fieldwork

Table 3: Classification Schema Used for Land-use Land-cover Classification

SN	Level 1	Code	Level 11	Description of classes
1	Built-up Land	11	Residential	This consist of completed buildings, uncompleted buildings, Foot path, Minor roads and Major road
		12	Commercial and Services	
		13	Industrial	
		14	Transportation, Communications, and Utilities	
		16	Mixed Urban or Built-up Land	
		17	Other Urban or Built-up Land	
2	Forest Land	41	Heavy Forest	These are areas covered by broad leaved evergreen and deciduous forest areas of height between 3-5m. This includes light and heavy, gallery, palm and montane forest.
		42	Light Forest	
3	Water body	41	Rivers	These includes all streams, ponds, lakes, dams and river within the study area.
		42	Lagoon	
4	Outcrop	61	Forested Wetlands	These are areas of marshes, mudflats, and swamps situated on the shallow margins of bays, lakes, ponds, streams, and manmade impoundments such as reservoirs.
5	Wetlands	62	Non-forested Wetlands	
6	Barren Land	61	Open space/Bare surface	This includes open space, sandy areas bare exposed rocks and transitional area

Modified from Anderson et al. (1976)

That is 68 household respondents, 37 forest users and 10 community leaders were engaged in 13 selected communities across 8 Local Government Area (LGAs) in the study area. Also, 13 government officials from the three states (Osun, Ogun and Oyo) were engaged. Table 2 below gives a detailed description of the identification number on each questionnaire.

Data Processing

In carrying out the Land-use Land-cover (LULC) classification, identification and extraction of classes was carried out on the composite image of the area of which level II classification was done. Nine classes (namely: water body, built-up, bare/Open surface, Light Forest, Outcrop, Heavy forest, Degraded forest, wetland and Savanna woodland) were identified which was modified from Anderson et al

1976 (as shown in Table 3). These classes were identified based on their nucleation, pattern, shape, hue association, texture and tone.

For the topographical sheets, feature extraction (points, Line and Polygon) was done. Rivers were represented as Line, Settlements as points while Forest Reserves and Protected areas were extracted as polygonal features.

Correspondingly, using Statistical Package for Social Sciences (SPSS), response on the questionnaires were coded after which a descriptive analysis was done on each questionnaire. A context analysis was used in identifying the responsibilities of the government agencies, procedures for applying for forest activities, staff strength and drivers of LULC changes in the study area. Also, the results are presented in form of charts and tables.

Table 4: Static Land-Cover for the year 1960

State	Forest Reserve	Area (Ha)	%	State	Forest Reserve	Area (Ha)	%
Oyo State							
1	Aregunte	10,695.61	1.75	Osun State			
2	Ijaiye_	23,919.34	3.91	27	Shasha	28,140.52	31.96
3	Odo Ogun	893.04	0.15	28	Ife	16,694.81	18.96
4	Iseyin Central	123.44	0.02	29	Ago Owu	29,763.11	33.80
5	Iseyin West	120.85	0.02	30	Oni	3,517.70	4.00
6	Iseyin East	33.32	0.01	31	Ikeji	1,695.32	1.93
7	Upper Ogun	254,492.99	41.55	32	Ede	1,345.87	1.53
8	Otuma	32.03	0.01	33	Oba Hill	6,288.70	7.14
9	Otuma2	50.03	0.01	34	Ejigbo	355.64	0.40
10	Eruwa1	43.44	0.01	35	Oshogbo	194.92	0.22
11	Eruwa2	30.23	0.00	36	Ile	49.78	0.06
12	Eruwa3	43.87	0.01		**Total**	88,046.38	
13	Eruwa4	60.46	0.01				
14	Okpara	249,529.81	40.74				
Ogun State							
15	Otumo	13,633.46	2.23				
16	Igangan	37,086.29	6.06	37	Imeko	62,137.53	25.32
17	Osho	3,782.72	0.62	38	Odugbe	14,262.35	5.81
18	Eleyele	969.97	0.16	39	Aworo	23,918.63	9.75
19	Aremo	63.82	0.01	40	Araranga	135.73	0.06
20	Ibadan	513.50	0.08	41	Olokomeji	6,032.22	2.46
21	Ogunna	26.37	0.00	42	Eggua	4,577.12	1.86
22	Gambari	13,730.91	2.24	43	Ohumbe	4,454.35	1.81
23	Oloyan	73.09	0.01	44	Illaro	3,460.12	1.41
24	Olla Hill	1,928.11	0.31	45	Omo	126,463.85	51.52
25	Ogbomosho	197.42	0.03		Total	245,441.91	
26	Ogbmosho Water Works	377.71	0.06				
	Total	612,451.82					

Source: Author's Lab. Work

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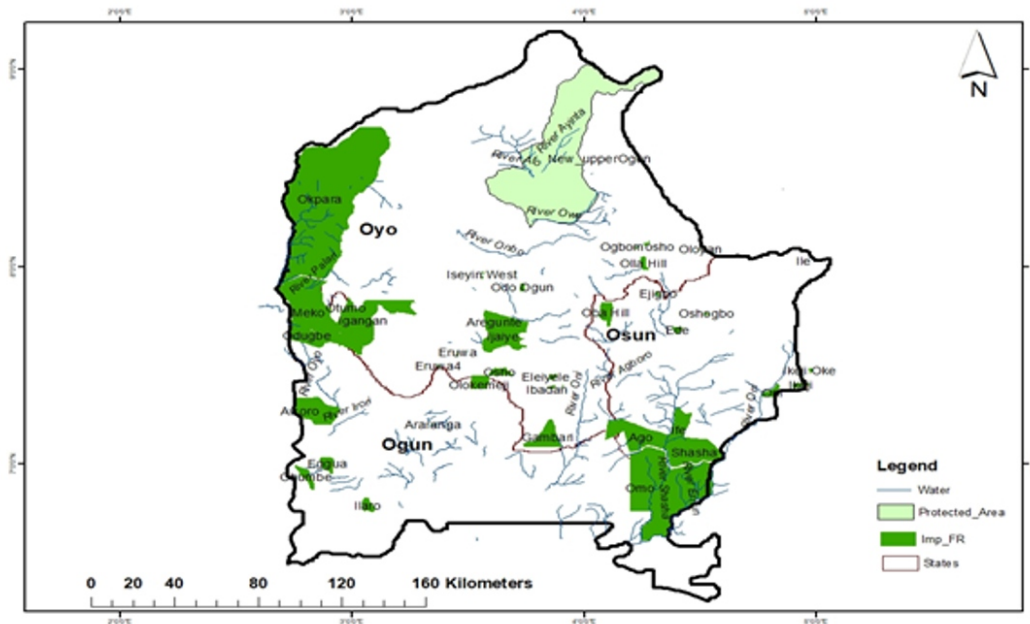*Selected States of Southwest Nigeria: A Case Study of Ogun, Osun and Oyo States, Nigeria*

Figure 2: Status of Forest Reserves and Protected Area in 1960

Table 5: Static Forest Reserve and Protected Areas in South-Western Nigeria in 2016

	Oyo		Ogun		Osun	
LULC Class	Area (ha)	%	Area (ha)	%	Area (ha)	%
Dense Forest			12,992.97	5.29	22,101.72	25.10
Light Vegetation	56,477.20	9.22	127,620.23	52.00	45,033.03	51.15
Woodland / shrubs	28,2416.7	46.11	28,012.03	11.41		
Degraded Forest	269,307.85	43.97	75,831.94	30.90	19,697.31	22.37
Wetland	219.97	0.04	546.20	0.22		0.00
Bare Surface	686.41	0.11	4.34	0.00	0.62	0.00
Built-up Area	1,656.42	0.27	434.00	0.18	572.21	0.65
Water Body	1,333.78	0.22	0.18	0.00	0.09	0.00
Outcrop	353.49	0.06	0.00	0.00	641.34	0.73
Total	612,451.83	100.00	245,441.90	100.00	88,046.37	100.00

Source: Author's Lab. Work

Results and Discussion

Descriptive Statistics of Landuse Landcover (LULC) of the study area in 1960 and 2016

The statics of Landuse Landcover (LULC) of the study area in 1960 based on the vectorization of the topographical of the study area as shown in Table 4 and Figure 2, reveals that there are forty-four forest reserves and one protected area in Osun, Ogun and Oyo state. It is then assumed that the dominant land-cover for this year is dense forest which is based on their floristic composition.

From the LULC classification carried out from a modified Anderson Classification, it was observed that the current dominant classes are light vegetation/ forest, woodland/ shrubs, degraded forest, built-up and bare surface. Other Land-cover classes are heavy forest, water body, wetland and Outcrop. Table 5 gives a detailed description of the LULC classes in the study area.

Temporal changes of the Forest Reserves

The temporal dynamics of the forest reserves and protected area in the study show significant alteration and encroachment due to anthropogenic activities which has caused a reduction in the forest cover as opposed to the dense forest in 1960. This relates to the findings of (Fasona, et al., 2018; Orimaye et al., 2018) which shows the effect of anthropogenic activities in the study area. In general, of the total area of forested areas for the three states, about 39%
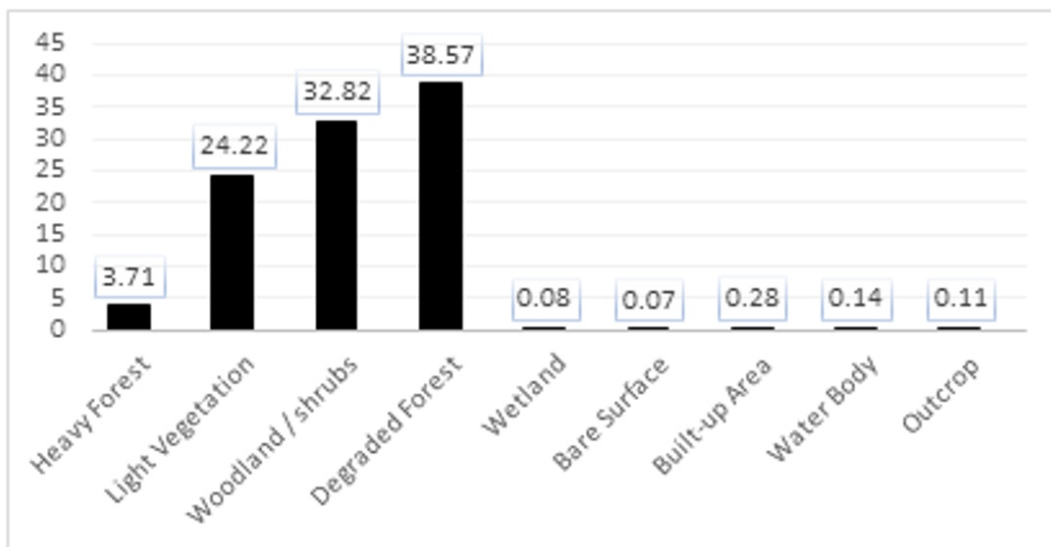
Figure 3: Temporal Characteristics of Forest Reserves and Protected Areas in 2016

have been altered to deforested area while 23% have changed to derived savanna woodland / shrubs. Light forest can only be seen in 24% of the area while total area of dense forest in 1960 (945940 ha) have been decimated to about 35,000ha (a 96% change) as shown in figure 3.

The results show that the level of changes varies across the states and these changes can be related to the significant anthropogenic activities within and around the reserves.

Oyo State

It can be observed that in Oyo state, there is no dense forest but savanna, deforested areas and built-up areas which are as a result of anthropogenic activities (as shown in figure 4) (Akingbogun et al., 2012; Adedeji et al., 2015). Specifically, about 44% of the forest reserve and protected area have been deforested and this is evident in Eleyele Forest Reserve, Ogbomosho Forest Reserve, Iseyin East Forest Reserve, Ogbomosho Water Works Forest Reserve, Ibadan Forest Reserve, Eruwa 3, Ogunna Forest Reserve, Aremo and Iseyin East, which have been converted to human settlements (built-up areas). Furthermore, Oyo national park which is a protected area has been degraded (Omolere et al., 2016) as woodland/ shrubs covers 48.29% while light vegetation and degraded area covers 34.26% and 36.19% respectively.

Ogun State

In this state, the dominant LULC classes are light vegetation, degraded forest and woodland/shrubs. Other than Omo Forest reserve, all other reserves in the state do not have dense forest. This is evident as light vegetation comprises of 52% of the total land area while degraded areas cover 30.90% of the area. For example, as shown in figure 5 Imeko, Odugbe, Eggua and Ohumbe forest have been heavily deforested while Araranga forest reserve no longer exists as it is now a built-up area. These findings are in line with Oduntan et al's., (2013) findings which states that all protected areas in Yewa division of Ogun state are threathened by human activities like logging, harvesting of non-timber forest products, gazing and so on.

Osun State

Unlike Ogun and Oyo states, about 25% of the total area of forest reserves in Osun state are dense forest and this can be found in Shasha forest reserve (76%), Ife forest reserve (15%), Ago-owu forest reserve (1%), Oni forest reserve (7%) and Ikeji forest reserve (1%). Also, as shown in figure 6, about 22% of the total forest cover have been degraded of which Oshogbo forest reserve have been converted to human settlement (Built-up area).

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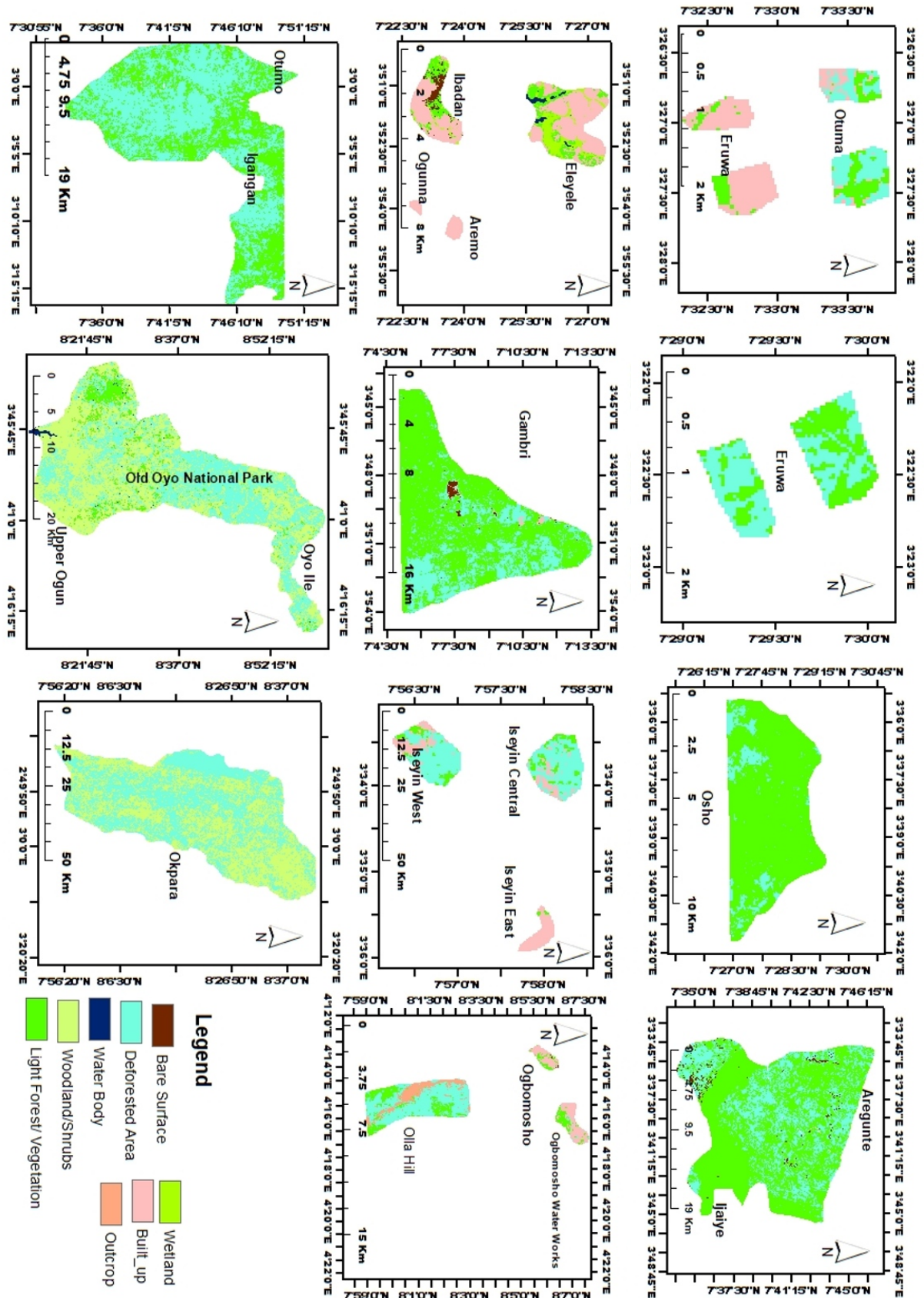Figure 4: Status of Forest Reserves and Protected Area in Oyo State for 2016
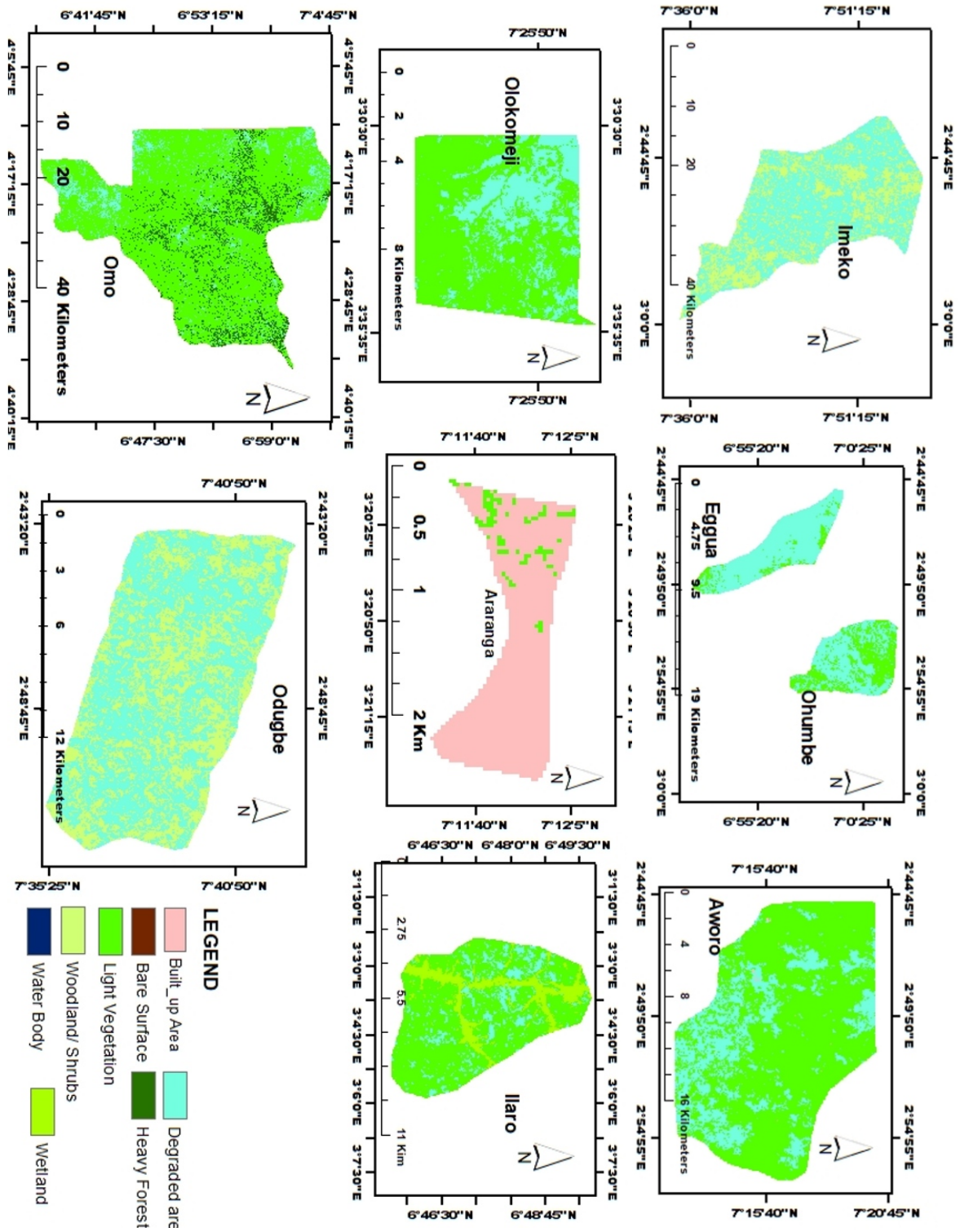
Figure 5: Status of Forest Reserves in Ogun State in 2016

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Selected States of Southwest Nigeria: A Case Study of Ogun, Osun and Oyo States, Nigeria
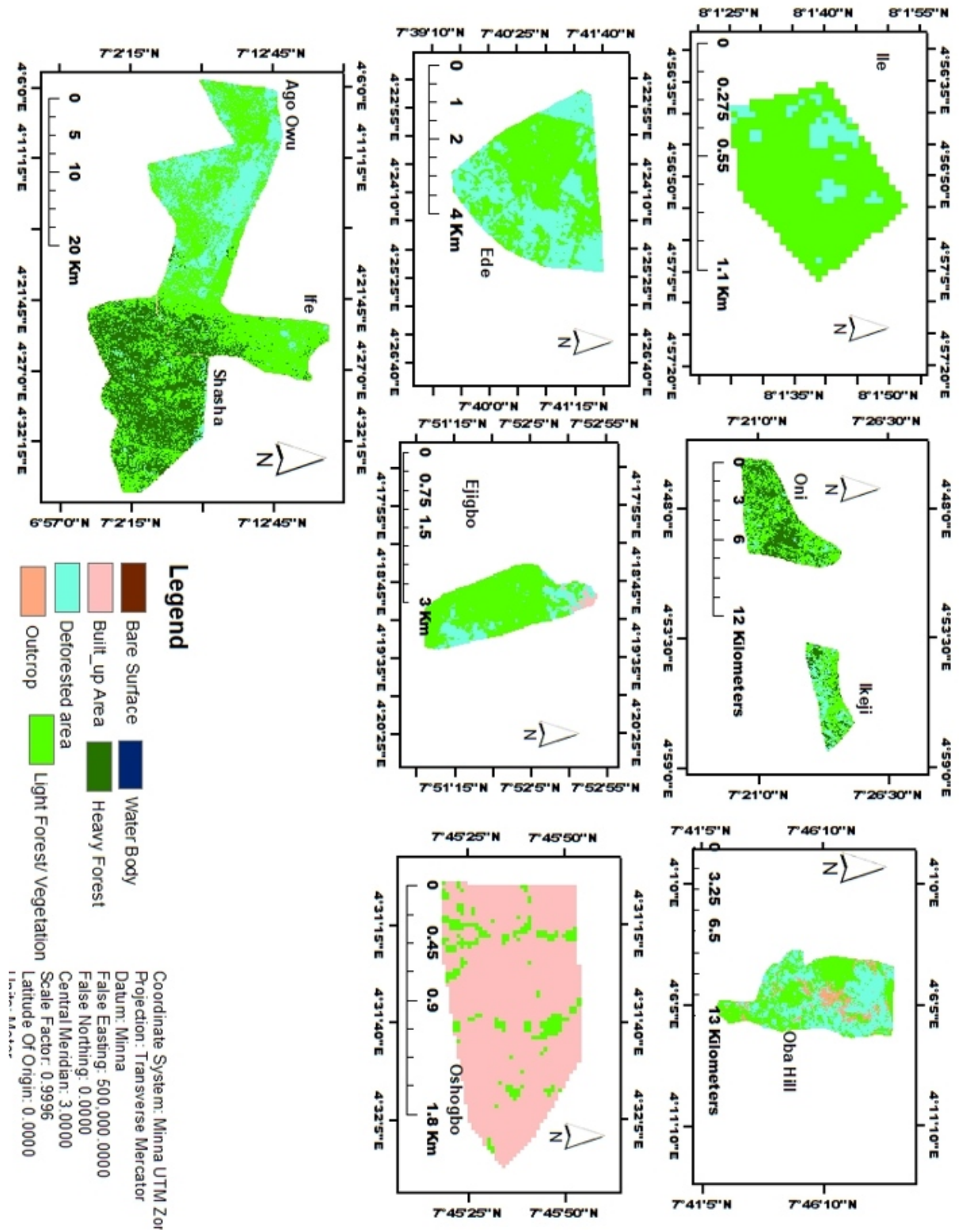
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Figure 6: Status of Forest Reserves in Osun State for the year 2016

Perception of Changes in Vegetation and LULC Categories Compared to the Last 20-30 years

In an attempt to further understand LULC dynamics of the study area, the following sets of people; household, community leaders and agency officials were interviewed for their perception on the subject matter. Their observation correlates with the classification sourced through remotely sensed data. To be more specific, forest lands, forest plantation, woodland, water, wetland and grassland in South Western Nigeria has decreased compared to the last 20-30 years. As shown in Table 6, the decrease in these vegetation and land-cover categories was mainly attributed to human activities which have increased exponentially in the last decade or so, especially activities like urban areas, agriculture/cropland and bare surfaces.

For instance, as shown in Table 6, LULC whose areal extent has reduced in the last 20-30 years in Ogun state are forest land (94%), forest plantation (89%) and woodland (83%). In Oyo state, forest land and woodland (95%), forest plantation (91%), wetland and grassland (67%) has reduced significantly in the last 20-30 years. Similarly, forest land (94%), woodland (91%) and forest plantation (88%) have reduced in the past 20-30 years in Osun state. However, LULC types whose areal extent has increased in the past 20-30 years in Ogun state are urban areas (86%), bare surfaces (50%) and agriculture/cropland. In Oyo state, the LULC categories whose areal extent has increased are agriculture/cropland (76.2%), urban areas (76%) and bare surface (57%) while urban areas (100%), agriculture/cropland (88%) and bare surfaces (53%) have increased Osun state.

Drivers of change in spatial extent of the forest reserves and protected areas in the study area

Based on the perception of the respondents on the changes in vegetation and land-cover categories in Southwestern Nigeria, it can be observed that the major factors contributing to the change in spatial extent of the forest reserves and protected areas in south western Nigeria are urbanization, construction, deforestation, industrialization, population growth, agricultural practices and change in government/or policies. This is in line with the previous findings (Faleyimu & Agbeja, 2012; Ogundele & Micheal, 2016; Fasona, et al., 2018) on the factors driving forest change in Southwestern

Nigeria. Other drivers include absence of afforestation efforts, unemployment, poverty, civilization, corruption, encroachment, over logging, forest protection laws, technological advancement and Illiteracy. It is evident from the content analysis that the majority of the respondents in Ogun state (61%), Oyo state (68%), Osun state (47%) stated that the key drivers of change in areal extent of the forest reserves in the study area are urbanization, construction, Industrialization, population growth, agricultural practices and change in government or/policies. The result further revealed that 27 % of the respondents in Osun state, 18% in Oyo state and 14% in Ogun states agreed that forest encroachment, over logging, non-compliance to forest protection laws, change in government and deforestation are the major drivers of the change in areal extent of the forest reserves in the study area.

Thus, it can be inferred from the content analysis that these factors are responsible for extreme degradation of the forest reserves and protected areas in South Western Nigeria.

Furthermore, the respondents were asked to rate the extent to which selected proximate factors affect vegetation and land-use change in South-western Nigeria. As shown in Appendix 1, market infrastructure (87%), crop cultivation (74%), afforestation efforts (74%), reforestation efforts (71%), urban growth (68%), private constructions (68%), dams and large water impoundments (68%), industrialization (65%) and opening/closing of forest (55%) are the major proximate land change factors driving significant (high, moderate and extreme) positive impact on the vegetation and land-use change Osun state. Those driving negative impact are flood (61%), animal grazing (58%), Fires (55%) and drought (52%) while mining (42%), temperature (36%) has both negative and positive impact on the on the vegetation and land-use change in the state. In Ogun state the major proximate land change factors driving significant (high, moderate and extreme) positive impact are reforestation efforts (69%), afforestation efforts (66%), urban growth (47%), and market infrastructure (44%). The major proximate factors driving negative impact in the state are charcoal production (53%), animal grazing (50%), flood (50%) and drought (47%). However, some opined that industrialization (44%) and transportation (38%) has both positive and negative impact on the vegetation and land-use change in the state.

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Figure 6: Status of Forest Reserves in Osun state for the year 2016

	Ogun										Oyo								Osun							
	0		1		2		3		Total		1		2		3		Total		1		2		3		Total	
	Fr	%	Fr	%	Fr	%	Fr	%	Fr	%	Fr	%	Fr	%	Fr	%	Fr	%	Fr	%	Fr	%	Fr	%	Fr	%
Agriculture/cropland	2	5.6	15	41.7	17	47.2	2	5.6	36	100	16	76.2	4	19.1	1	4.8	21	100	30	88	4	12			34	100
Forest land	2	5.6	0	0	34	94	0	0	36	100	1	4.8	20	95	0	0	21	100	2	5.9	32	94			34	100
Forest Plantation	2	5.6	2	5.6	32	89	0	0	36	100	2	9.5	19	91	0	0	21	100	3	8.8	30	88	1	3	34	100
Woodland	2	5.6	2	5.6	30	83	2	5.6	36	100	1	4.8	20	95	0	0	21	100	2	5.9	31	91	1	3	34	100
Wetland	2	5.6	3	8.3	20	56	11	31	36	100	1	4.8	14	67	6	29	21	100	6	18	17	50	11	32	34	100
Grassland	2	5.6	8	22	20	56	6	17	36	100	3	14	14	67	4	19	21	100	6	18	24	71	4	12	34	100
Water	5	14	5	14	18	50	8	22	36	100	5	24	12	57	4	19	21	100	13	38	13	38	8	24	34	100
Bare Surfaces	2	5.6	18	50	8	22	8	22	36	100	12	57	7	33	2	9.5	21	100	18	53	14	41	2	6	34	100
Urban Areas	2	5.6	31	86	2	5.6	1	3	36	100	16	76	3	14	2	10	21	100	34	100	0	0			34	100

Where: 0= No response; 1= Increasing; 2= Decreasing; 3= No Change; f = Frequency

Source: Author's Fieldwork.

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Additionally, in Oyo state, the major proximate land change factors driving significant (high, moderate and extreme) positive impact on the vegetation and land-use change are reforestation efforts and afforestation efforts (67%), crop cultivation (61%), industrialization (44%), Fuel/ firewood and Pole wood extraction (44%). Animal grazing (50%), drought (50%) are driving negative impact while terrain (33%) is driving positive and negative impact respectively.

Conclusion

This study analyzed the status and driver of forest reserves and protected areas in the study area. The temporal dynamics of the forest reserves and protected area in the study shows significant alteration and encroachment of the forest estate as a result of anthropogenic activities which has caused a reduction in the forest cover as opposed to the heavy forest in 1960 in the study area. Analysis shows that the forest estate in South-western Nigeria has been enormously decimated as about 75% of the forest reserves have been degraded. It was further discovered that except for Osun state which still has about 25% heavy forest, there are no heavy forest in the study area. It also showed that human activities such as industrialization, urbanization, population growth and deforestation are the major drivers of degradation of forest reserves and protected areas in South-western Nigeria. Thus, there is a need for periodic monitoring of the forest estate with the use of GIS and Remote Sensing techniques as this would help in knowing the status of each reserve and protected area. Also, the 2006 Nigeria forest policy should be strictly implemented as this would help salvage the current rate of degradation in the study area.

The study thus recommends that:

- There is a need for aggressive afforestation and reforestation in all forest reserves in the study areas rather than limitation to natural re-growth.

- The Restoration Diagnostic which was developed as part of The Restoration Opportunities Assessment Methodology (ROAM) for Global Forest Landscape Restoration (FLR) can be incorporated with the 2006 forest policy so as to drive successful regeneration of degraded and depleted forest not only in the study area but in the country.

- There is a need for periodic monitoring of the forest estate with the use of Geographic Information Systems as this would help sustainable forest management.

- Strict Implementation of the 2006 forest policy so as to salvage the current situation of high degradation and depletion of forest reserves and protected areas in South-western Nigeria.

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APPENDIX

Appendix 1: Proximate Factors Driving Change in Spatial Extent of Forest Reserves and Protected Areas in South Western Nigeria

SN	Proximate Land Change Factors	Osun State					No impact	Very low impact	Low impact	Moderate impact	High impact	Extreme impact	No response	Total
		+ve	-ve	both	No response	TOTAL								
1	Crop Cultivation	74.1	6.5	12.9	6.5	100.0	7	7	16	45	13	10	3	100
2	Animal Grazing	6.5	58.1	29.0	6.5	100.1	13	13	26	29	23	3	7	100
3	Rural agricultural migration	29.0	22.6	29.0	19.4	100.0	3	13	16	36	10	13	10	100
4	Mining	22.6	16.1	41.9	19.4	100.0	7	26	7	29	16	7	10	100
5	Transportation	45.2	6.5	35.5	12.5	99.7	0	7	19	32	26	10	7	100
6	Market Infrastructure	87.1	3.2	6.5	3.2	100.0	0	19	19	29	13	16	3	100
7	Industrialization	64.5	6.5	25.8	3.2	100.0	0	13	16	26	29	13	3	100
8	Dams and large water impoundments	67.7	9.7	12.9	9.7	100.0	29	13	10	23	13	7	7	100
9	Lumbering/commercial logging	51.6	9.7	29.0	9.7	100.0	3	0	23	36	23	13	3	100
10	Pole wood extraction	38.7	19.4	32.3	9.7	100.1		10	16	36	23	13	3	100
11	Fuel/ Firewood extraction	48.4	25.8	19.4	6.7	100.3	10	19	19	26	26	13	7	100
12	Charcoal production	41.9	29.0	22.6	6.7	100.2	3	10	19	26	23	13	7	100
13	opening/closing of forest	54.8	9.7	25.8	9.7	100.0	19	19	10	19	19	3	10	100
14	Afforestation efforts	74.2	3.2	9.7	12.9	100.0	29	23	16	13	19	10	7	100
15	Reforestation efforts	71.0	9.7	6.5	12.9	100.1	29	13	23	13	3	13	3	100
16	Urban growth	67.7	9.7	3.2	9.7	100.0	7	13	19	32	10	13	7	100
17	Private constructions	67.7	16.1	3.2	12.9	99.9	7	19	32	16	16	3	7	100
18	Terrain	32.3	35.5	12.9	19.4	100.1	13	16	23	23	10	7	10	100
19	Fires	16.1	54.8	19.4	9.7	100.0	13	10	26	32	10	7	10	100
20	Drought	19.4	51.6	16.1	12.9	100.0	13	26	19	16	7	13	7	100
21	Flood	9.7	61.3	22.6	6.7	100.3	3	23	26	26	10	10	3	100
22	Rainfall	19.4	45.2	22.6	12.9	100.1	0	23	26	26	13	10	3	100
23	Temperature	16.1	38.7	35.5	9.7	100.0	7	13	16	29	16	16	3	100

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Appendix 2: Proximate Factors Driving Change in Spatial Extent of Forest Reserves and Protected Areas in South Western Nigeria

SN	Proximate Land Change Factors	Ogun State I	II	III	IV	Total	No response	No impact	Very low impact	Low impact	Moderate impact	High impact	Extreme impact	Total	Oyo State I	II	III	IV	No response	No impact	Very low impact	Low impact	Moderate impact	High impact	Extreme impact	Total
1	Crop Cultivation	13	34	28	25	100	19	19	6	13	25	6	31	100	17	61	6	17	6	0	11	33	17	22	17	100
2	Animal Grazing	16	13	50	22	100	0	38	9	9	13	13	16	100	11	11	50	17	22	11	6	11	17	11	22	100
3	Rural agricultural migration	28	34	22	16	100	13	25	3	16	16	6	22	100	50	22	22	6	17	0	17	33	17	17	5	100
4	Mining	25	25	19	31	100	13	41	9	19	19	6	0	100	33	22	22	22	0	11	11	0	33	22	11	100
5	Transportation	19	34	9	38	100	6	19	13	9	22	16	16	100	22	28	22	28	17	0	11	22	28	11	6	100
6	Market Infrastructure	34	44	6	16	100	19	16	19	19	6	16	13	100	28	33	17	22	6	6	17	28	28	11	6	100
7	Industrialization	13	28	44	16	100	19	0	19	19	16	16	44	100	11	44	17	28	11	6	0	11	56	0	22	101
8	Dams and large water impoundments	34	34	6	25		19	34	6	6	6	16	16	100	39	39	11	33	11	17	6	6	6	17	17	100
9	Lumbering/commercial logging	16	25	41	19	100	9	6	0	6	9	28	41	100	33	33	6	44	11	0	11	28	11	33	6	100
10	Pole wood extraction	22	38	22	19	100	16	22	6	9	9	19	22	100	44	44	22	33	11	0	0	17	22	50	0	100
11	Fuel / Firewood extraction	13	34	47	6	100	3	13	9	9	22	28	28	100	17	44	22	17	6	6	0	11	17	61	0	100
12	Charcoal production	19	25	53	3	100	3	9	16	16	22	19	25	100	6	50	22	22	6	6	28	28	22	33	6	100
13	opening/closing of forest	22	28	25	25		13	25	6	6	6	9	34		17	50	11	22	17	11	11	11	11	28	6	100
14	Afforestation efforts	22	66	6	9	100	13	22	16	6	0	13	31	100	17	67	17	11	17	17	0	17	22	17	17	100
15	Reforestation efforts	19	69	3	9	100	9	22	3	6	9	16	34	100	17	67	22	11	11	11	17	28	28	11	6	100
16	Urban growth	16	47	22	16	100	6	6	9	13	9	16	47	100	17	39	22	22	22	6	17	11	28	22	11	100
17	Private constructions	28	41	16	16	100	16	16	6	13	25	16	22	100	17	39	22	22	6	0	17	39	22	17	6	100
18	Terrain	44	25	16	16	100	31	22	6	13	16	9	3	100	17	33	33	11	17	6	17	22	17	22	11	100
19	Fires	34	9	53	3	100	28	25	13	3	16	3	13	100	17	33	28	22	22	6	0	0	39	17	17	100
20	Drought	38	9	47	6	100	22	28	9	3	13	9	16	100	22	17	50	11	17	6	0	11	39	22	6	100
21	Flood	25	16	50	9	100	16	34	3	16	13	6	13	100	28	28	33	11	22	6	0	6	22	39	6	100
22	Rainfall	16	41	25	19	100	6	28	3	13	6	28	16	100	39	39	17	39	6	0	0	11	33	28	17	100
23	Temperature	16	41	19	25	100	9	28	13	0	6	16	28	100	28	28	22	44	6	6	6	28	28	17	17	100

Where: I = No Response; II= Positive; III = Negative; IV= Both