

Original Research Article

ASSESSING THE STATUS YANDEV FOREST RESERVE USING REMOTE SENSING AND GEOGRAPHICAL INFORMATION SYSTEM (GIS) TECHNIQUES.

Abstract

The study was conducted to assess and predicts changes in Land use and Land cover of Yandev Forest reserve in Gboko, Benue state Nigeria. Landsat satellite images were acquired for 1986 and 2001, Nigeriansat-x was use for 2012, They were acquired from Centre for Remote Sensing Jos. Images were subjected to various image processing techniques and supervised classification was carried out on the various images. The classification resulted to classes of Built up, Bareland, Cultivated area, Degraded area, forest, Riparian forest and Shrubland. The trend of land use/land cover in the reserve revealed that Bareland increase from 0.01% in 1986 to 0.07% in 2012, built up area increase from 0.75% in 1986 to 1.63% in 2012, Shrubland, increased from 1.10% in 1986 to 6.18% in 2012, degraded forest increase from 2.01% in 1986 to 3.75 % in 2012. Forest area decreased from 34.1% in 1986 to 22.38% in 2012, Riparian Forest decreased from 2.98% in 1986 to 1.54% in 2012, cultivated area decreased from 10.55% to 1.41% in 2012. The magnitude of land use/ land cover change within the 26 years period - 9924.44km² of the forest area were lost to other form of land use, Riparian forest lost -1446.15 km² of the original area. Bareland area lost within the period -1077.35 km² to other land uses. Cultivation area increased by 3582.58 km² within the period, built up area increased by 878.94km,² shrub land increased by 5078.88 km², degraded forest increased within the period of 26 years by 1743.21 km². It was established that tremendous land use and land cover changes are going on in the Yandev forest reserve which could be linked to rapid urbanization of Gboko town. Enrichment planting of reserve was recommended.

Key Words: land use, land cover change, Forest reserve, built up, Riparian forest

Introduction

Information and monitoring systems for the forest sector are instrumental for effective policies and planning, prioritizing interventions, valuation of forest resources, efficient investments, and engendering accountability. This is because they provide the platform through which the past and present human interactions and the impacts of such interactions with the forest resources and the

environment in general can be understood (Mohammed, *et al.*, 2013). The information is also relevant for rational and sustainable allocation of land resources for future development.

In Forestry sector collection of relevant forest information periodically always help in the formulation and effective implementation of policies, inform decision making, and guide management (Akindele, 2012). Current and accurate information on forests also can help raise the profile of the sector and increase awareness of forest resources' potential and promote sustainable management and conservation of forest ecosystems (Akindele, 2012, Akinola and Akindele, 2012). Abundant evidence points to how inadequate information on forests and weak monitoring capacity have resulted in poor forest policies, planning, and management; hampered efforts to reduce illegal and unsustainable extraction of forest resources and improve transparency; and resulted in undervaluation of forest resources. Such conditions, in turn, contribute to continuous decline in area. Studies have demonstrated the potential of combining satellite remote sensing and ground data (Okhimanhe, 1993; Adia *et al.*, 2007; Ikusemoran, 2009; Oyebade, *et al.*, 2012) to effectively determine the extent of land cover change.

Despite the importance of vegetation mapping as one of the basic components of ecological database of any region, Ochege and Okpala-Okaka (2017) noted that vegetation has continued to be inaccurately mapped in Nigeria. Further-more, most decisions about how much land to use were and for what purposes are still poorly understood. Mohammed, *et al.*, (2013) point out that in Nigeria, almost all developmental projects are carry out without reference to land-use and land cover information.

Therefore, there is an urgent need for proper geo-management of land and the concomitant availability of a detailed, accurate and up-to-date geo-information In most of developing countries especially Nigeria availability of relevant and current information about our environment and how it changes over time has been lacking (Ezeomodo, 2006) this problem therefore has consequently been Affecting the achievement of change detection and sustainable

development, and as such requires research for accurate and timely information which is needed for environmental monitoring, planning and forecasting. Although series of works have been done in a conventional system to produce some information on the LULC in some parts of Nigeria especially in forest reserves (Mohammed, *et al.*, 2013, Ikusemoran, and Olokor, 2014), but not much studies have been done using Remote Sensing and GIS technique in its mapping and analysis of forest reserves and other land use and land cover in the Benue state. Therefore, the application of GIS using remote sensed data for land use land cover analysis Yandev Forest Reserve, Gboko Local Government area and its environs would definitely enhance the available data for a sustainable development.

MATERIALS AND METHODS.

StudyArea

Yandev is a populated place in Benue State Nigeria (Africa) with the region font code of Africa/Middle East. It is located at an elevation of 315 meters above sea level and its population amounts to 536,068. Its coordinates are 7°22'0" N and 9°3'0" E in DMS (Degrees Minutes Seconds) or 7.36667 and 9.05 (in decimal degrees). Its UTM position is NP01 and its Joint Operation Graphics reference is NB32-03. Yandev Forest reserve carries a land mass of 331 hectares and consist of exotic tree species such as teak (*Tectona grandis*) and *Gmelina aborea*, which was established as a plantation forest reserve by the Federal and State governments in conjunction with the World Bank to provide raw materials and products in the form of poles, timber, veneer, wood particles, pit props, pulp, fuel wood and for research.

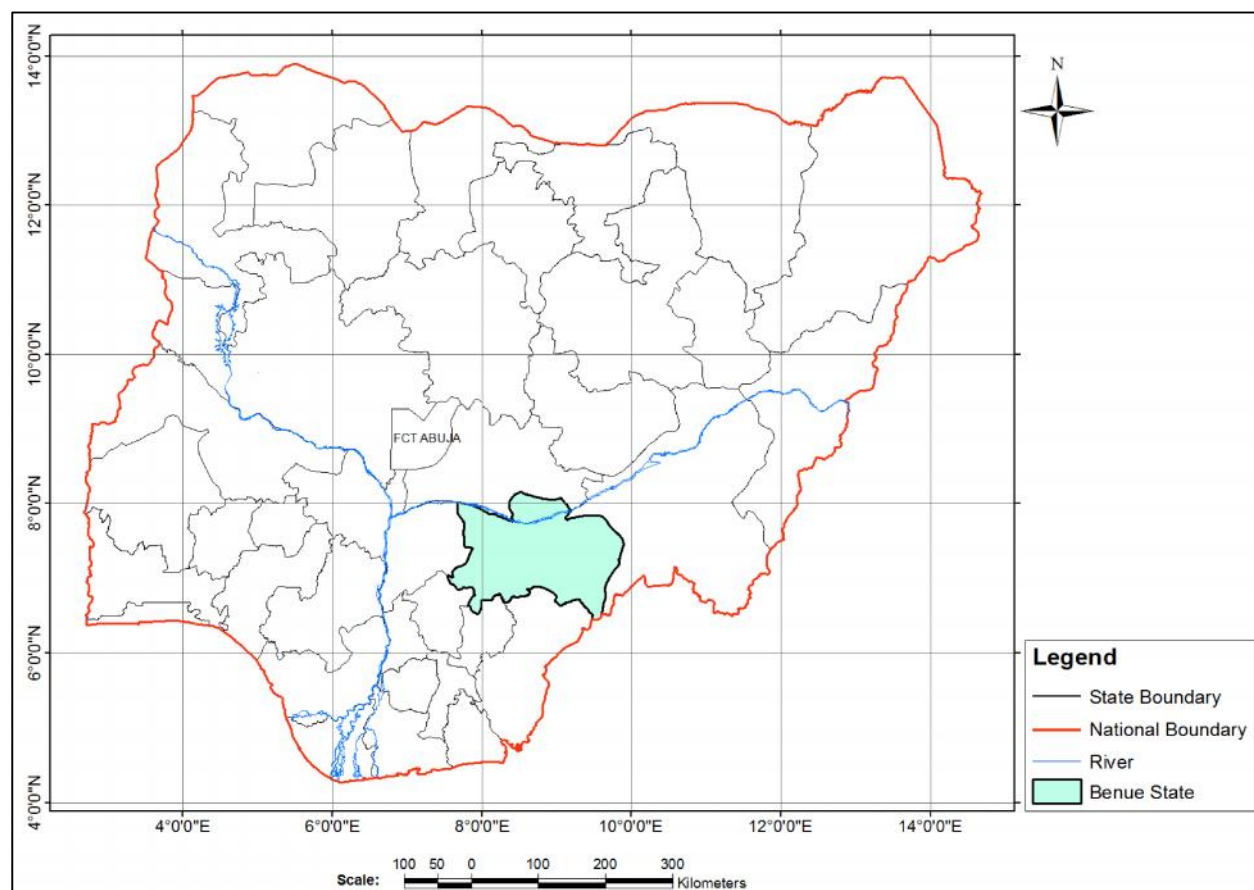


Figure 3.1. Map of Nigeria showing Benue state.

Source; created from Nigeria shape file using ArcGis 10.1

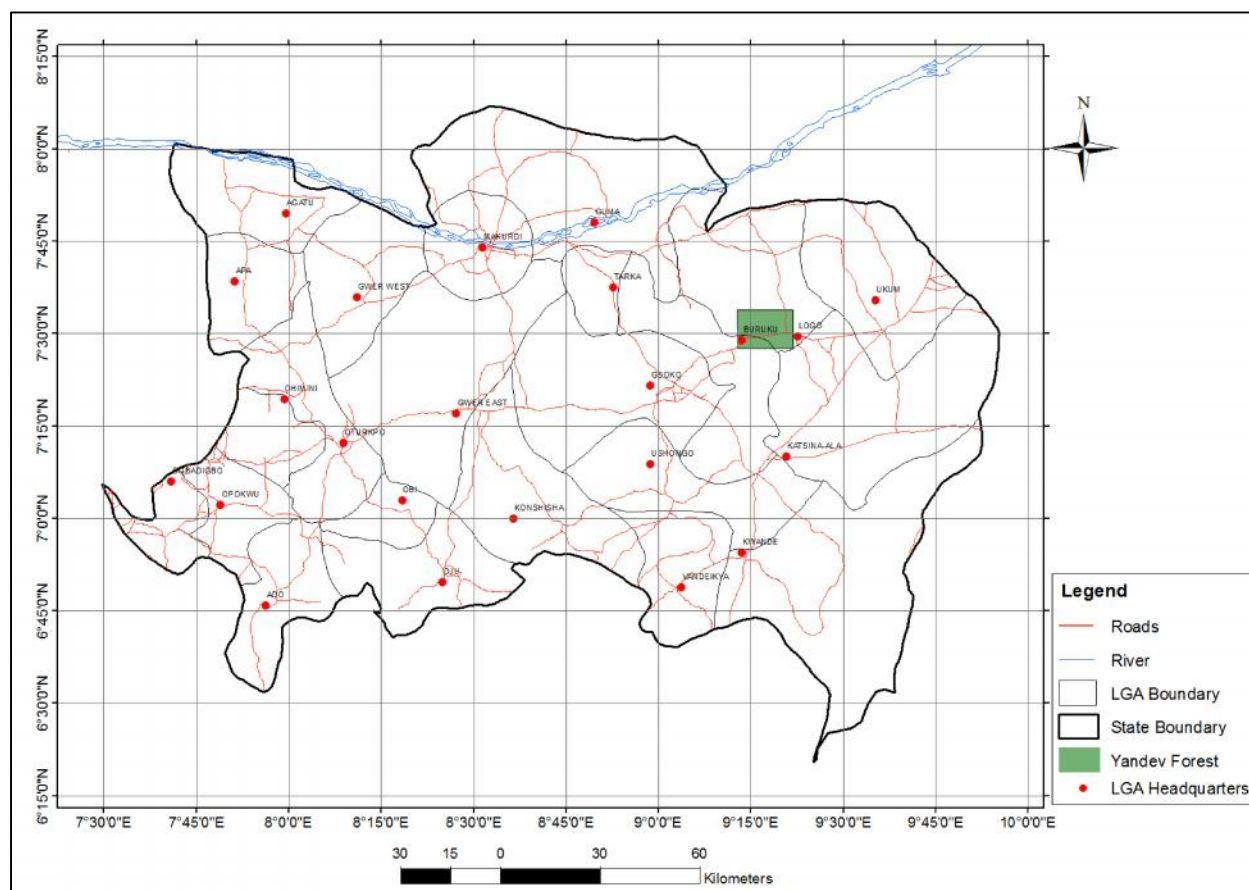


Figure 3.2. Map of Benue state showing the study area.

Source; Created from Nigeria shape file ArcGis 10.1

103 3.2. Climate

104 The area is characterized by two distinct seasons; wet and dry season. The wet season occur
105 between April to October, and dry season between November. Rain fall distribution is bimodal
106 with the areas occurring in June and September. Mean annual rainfall is between 1000mm and
107 1500mm. Mean annual temperature is 30oc relative humidity is between 60% and 80% wet but
108 decreases in the early months of dry season (Jimoh *et al.*, 2009).

109 3.3. Vegetation

110 The vegetation of the Yandev Forest Reserve is open savannah woodland, characterized by
111 predominantly trees, less shrubs and tall grasses up to 2m tall. Forest formations are found in low
112 land areas. Some of the species found in the area are *Tectona grandis*, (Teak) and *Gmelina*
113 *aborea* (Gmelina)

114 3.4 Data source and collection.

115 This study involve primary data collection and secondary data collection. The Landsat TM as for
116 1986, Landsat ETM+ for 2001 and NigeriaSat-X for 2012 images of the study area were
117 obtained from the Archives of the National Centre For Remote Sensing, Jos, Nigeria. Landsat
118 satellite images of Yandev forest Reserve were acquired for the three Epochs; 1986, 2001 and
119 2012 respectively. Landsat TM and ETM+ with Nigeria X satellite images were used for the
120 three epochs. The Landsat TM as for 1986, Landsat ETM+ for 2001 and NigeriaSat-X for 2012.
121 Both 1986 and 2001 were obtained from Global Land Cover Facility (GLCF) and earth science
122 data interface, while that of 2012 as obtained from National Space Research and Development
123 Agency in Abuja (NASRDA) through the National Centre for Remote Sensing Jos.

124 Image Classification

125 Supervised image classification was carried out using the maximum likelihood technique. Prior

to this, a sample set was created to enable the training of class pixels. That is based on the spectral characteristics of the objects on the images. Fixed with similar spectral characteristics were selected and coded with the same class names. Thereafter, the classification process was run to convert the images into different themes or classes. The following LULC classes were developed accordingly, Bare land, Build up areas, Riparian vegetation, Scattered cultivation and Shrub land

Statistical Analysis

Histograms of the classified images were used to provide the information of the total area coverage of each class theme from the different images. Simple percentage tables were used for the statistical analysis. Change analysis was carried out to examine the change in built up area between 1986 – 2012 in order to determine the extent of deforestation

RESULT ANALYSIS AND DISCUSSION

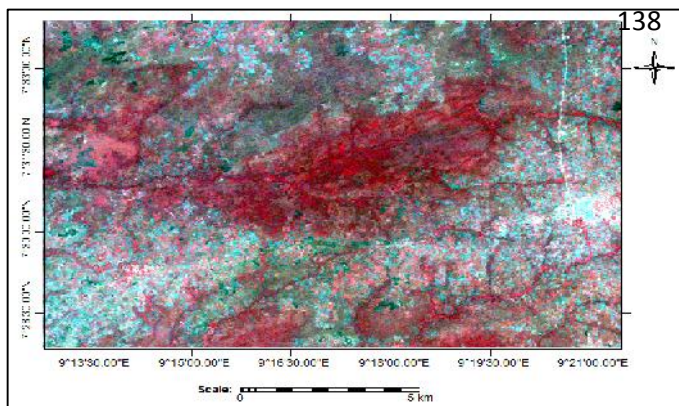
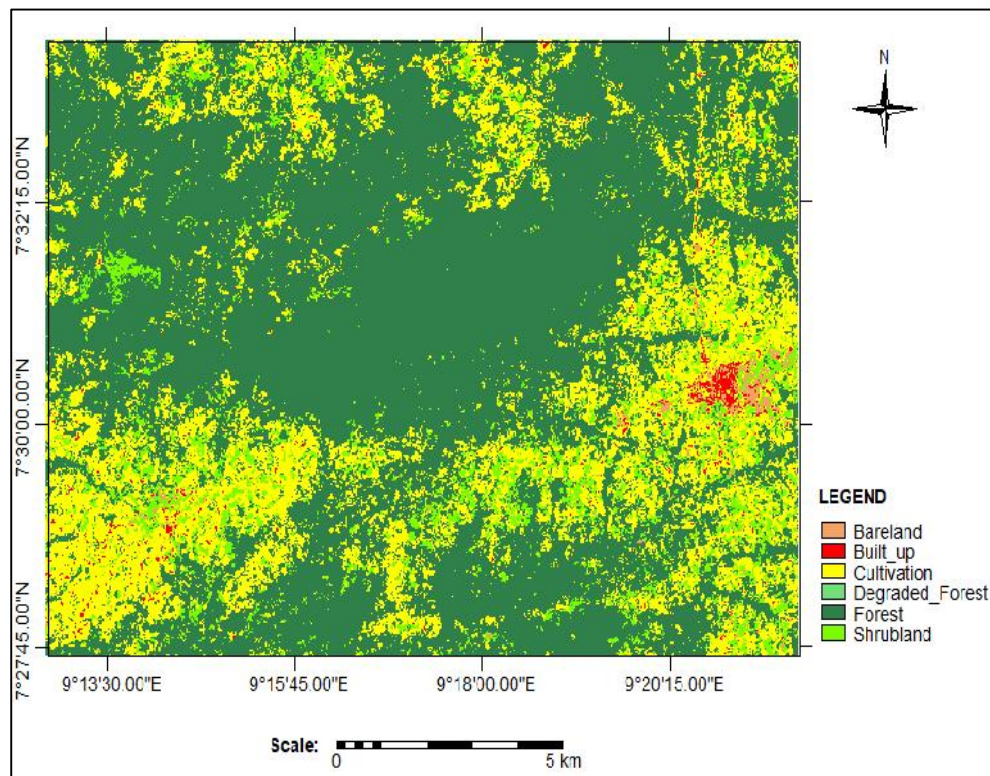
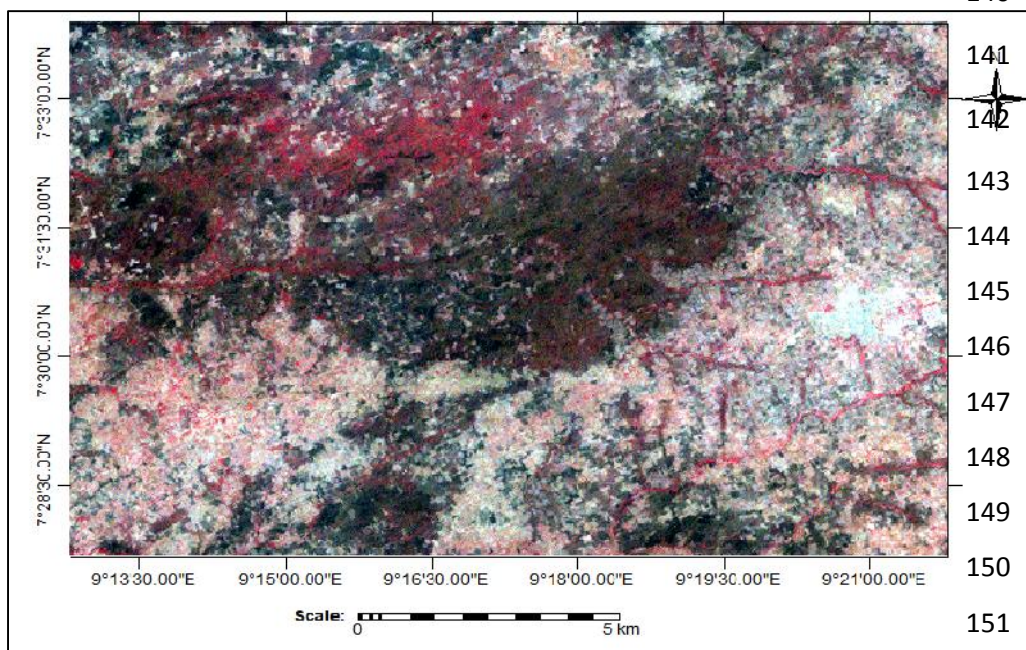


Figure 1. Yandev: LANDSAT TM (1986)



139 Figure 4.3 Yandev LANDSAT TM Classified Image



152
153 Figure . Yandev: LANDSAT ETM 2001

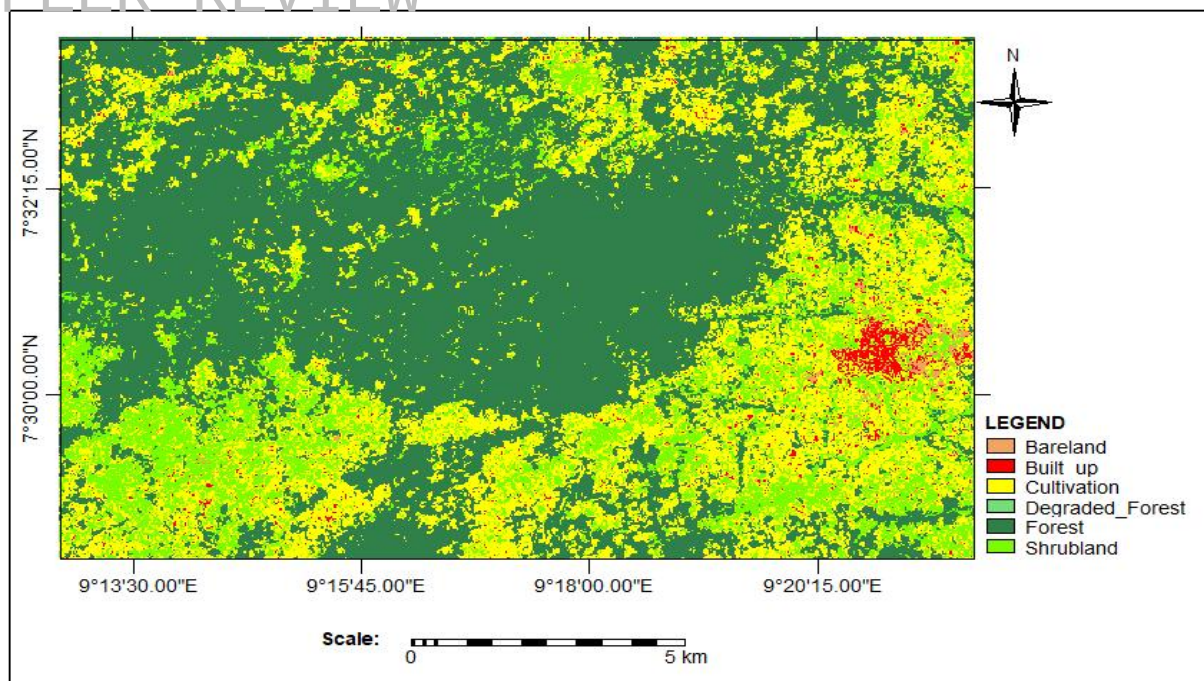
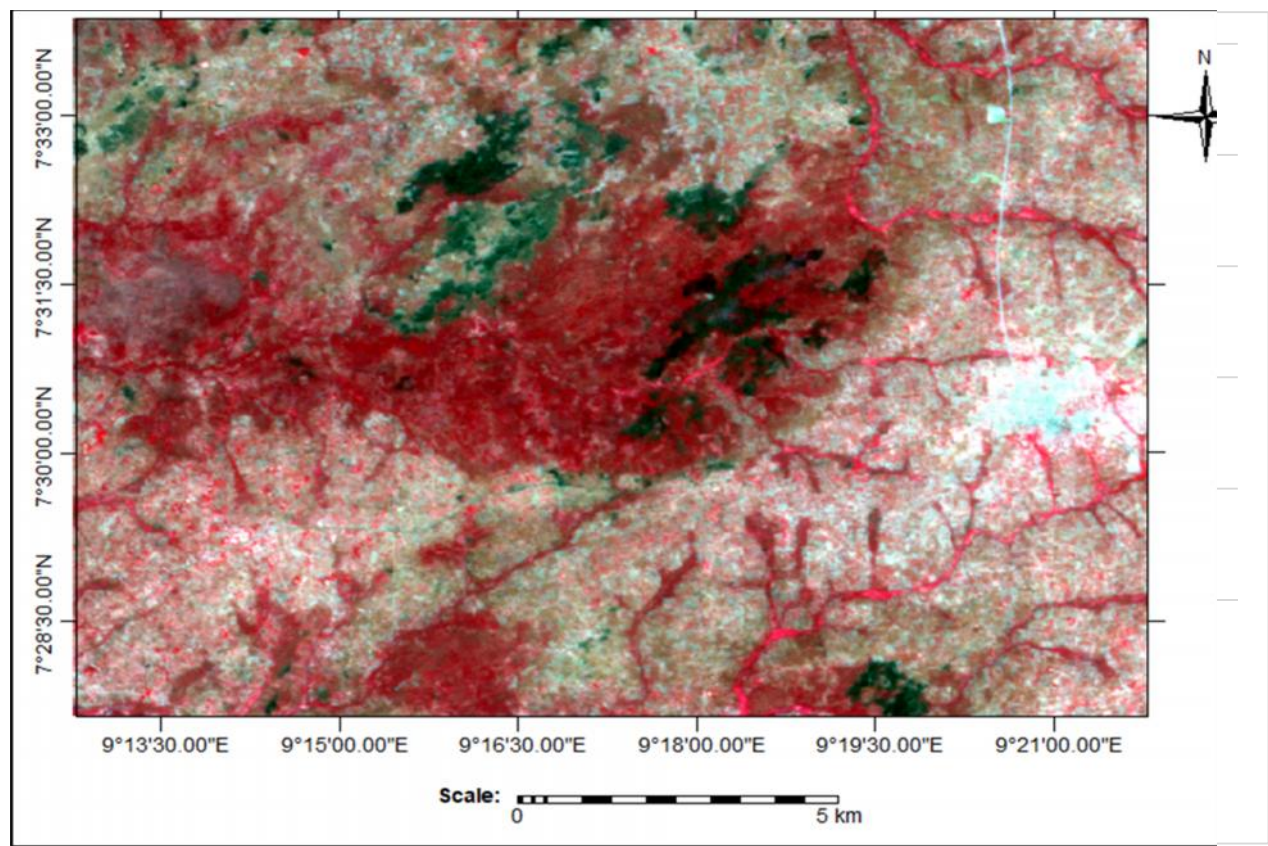


Figure 4.7. Yandev: LANDSAT ETM Classified Image



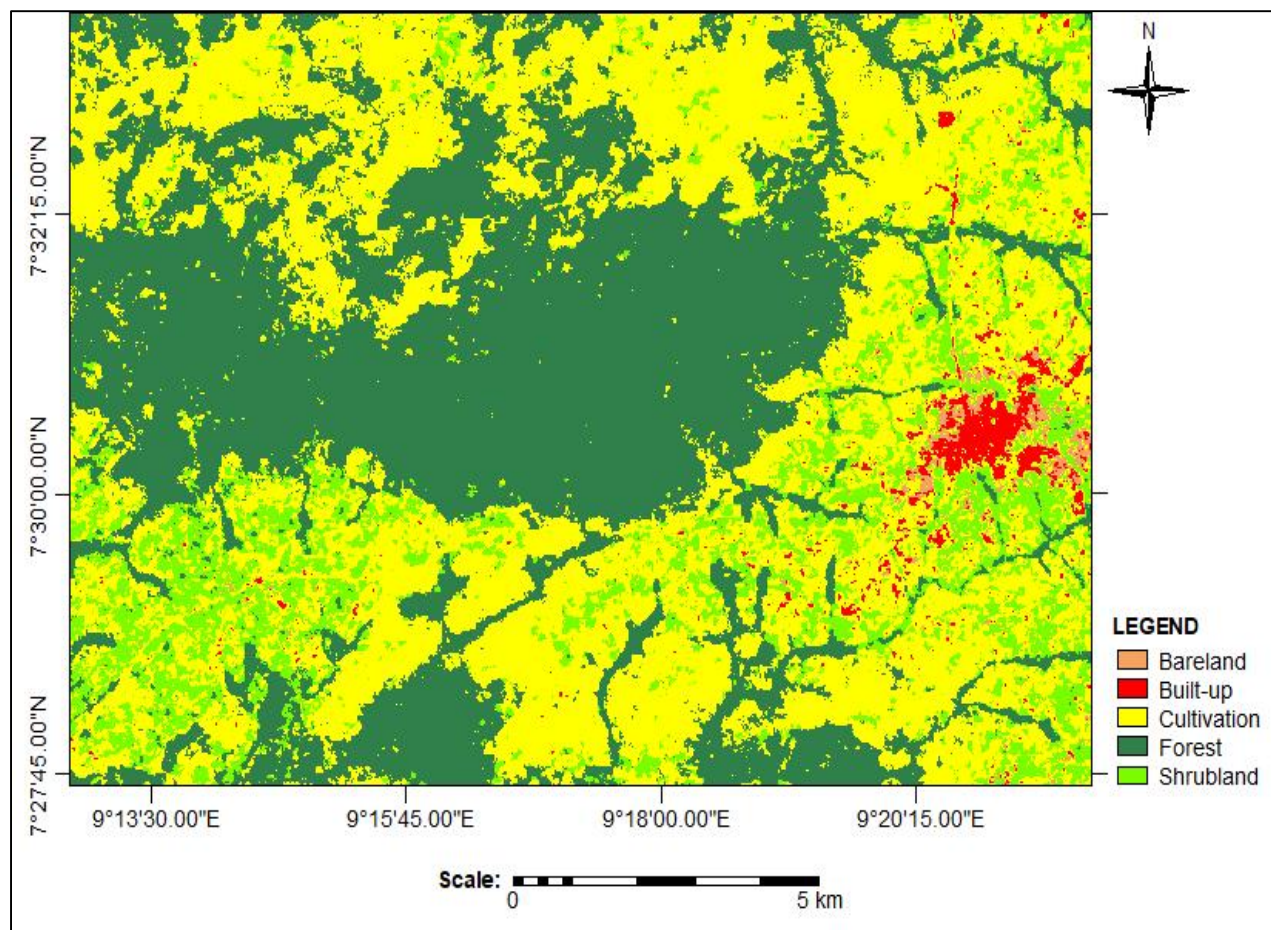


Figure 4.8. YANDEV: NigeriaSat-X Classified Image

Trend of the Land use/Landcover in Yandev Forest Reserve (1986, 2001 and 2012)

The result of percentage vegetation change in Yandev Forest Reserve as presented in Table 1 shows that the bare land increased from 11.53sqkm in 1986 to 75.65sqkm in 2012 accounting for 0.06% increase. Built up area increased from 757.71sqkm in 1986 to 1636.31sqkm in 2012 accounting for 0.88% increase, degraded forest also increased from 2015.25sqkm in 1986 to 3758.46sqkm in 2012 accounting for 1.74% increase. Also, Shrubland increased from 1106.45sqkm in 1986 to 6185.33sqkm in 2012 accounting for 5.08% increase. While Forested area decreased from 34119.45sqkm in 1986 to 22387.4sqkm in 2012 accounting for 11.72% decreased, riparian forest also decreased from 2986.48sqkm in 1986 to 1540.33sqkm in 2012 accounting for 1.44% of the decrease (Table 1).

The last 11 years between 1986-2012 witnessed considerable increase in anthropogenic activities in the study area. The result of the analysis unveils a tremendous change in the land cover of the study area during the 26 years period from 1986 to 2012. It can notice that percentage change in the proportion of some landcover classes increased while other decreased. The high increase and

decrease took place between 2001 to 2012. For instance, while the built-up area increased by 0.13% between 1986 to 2001 it increased by 0.75% between 2011 to 2012. Similarly, riparian forest decreases by 0.33% in 1986 to 2001 it however decreases by 1.11% between 2001 to 2012. Similar trends in land use change and land cover change were reported by Ikusemoran and Olokor (2014) in Kainji lake Basin between 1975 to 2006. *Tudun-Wad et al. (2014)* also show similar change in bare land in their study in Nimbria Forest Reserve, Kaduna State. This explained the threat faced by protected areas in Nigeria as Mohammed, *et al.*, (2013) show a steady decrease in land cover in all the national Park in Nigeria. This could probably be linked to change in population as the population increases so the pressure on the reserves also increases. Yandev Forest Reserve located close to Gboko and Mkar towns also the location of Akperan Orshi college of Agriculture close to reserve constitute the major sources of pressure on the reserves. This explain the reason behind increase in built up area and bare land in the reserve.

Table 1. Percentage of land use/landcover in Yandev forest Reserve (1986, 2001 and 2012)

Land use/landcover Classes.	1986		2001		2012	
	Area (sqkm)	%	Area (sqkm)	%	Area (sqkm)	%
Bare land	11.53	0.01	136.38	0.13	75.65	0.07
Built-up	757.71	0.75	884.7	0.88	1636.31	1.63
Cultivation	10557.63	10.55	7892.96	7.87	4140.21	1.41
Degraded forest	2015.25	2.01	6176.27	0.61	3758.46	3.75
Forest	34119.45	34.1	24195.01	24.19	22387.4	22.38
Riparian forest	2986.48	2.98	2655.57	2.65	1540.33	1.54
Shrubland	1106.45	1.10	11501.22	11.50	6185.33	6.18

Magnitude and percentage of change in land use/landcover between 1986 and 2001

The magnitude of change of forest area for 15 years between 1986 to 2001 was 9924.44km² representing a change (29.087%). These agrees with the findings of Ogunmula *et al* (2014) who observed that natural vegetated areas in most Nigeria communities have been decreasing in

recent years The magnitude of change of riparian forest 15 years between 1986 to 2001 was 330.91km² representing 11.080%. This is contrary to the finding of Ikusemoran (2009) in Kainji Lake Basin where the riparian forest increase by 16.96%, this may be due to better enforcement of protection laws in Kainji which is National Park than Yandev which is a forest reserve which in most cases they are left in the mercy of the communities without proper monitoring. The period witnessed a tremendous increase in bare land and built up area. The Bare land change was 124.85 km² (1082.827%), while Built up was 126.99 km² (16.759%). These changes in reserve could be attributed to the urbanization, increase in commercial activities and increase in population, agricultural activities and infrastructural development amongst others. For instances there is Tarukpe Market located inside the reserves. Similar increase in Bare land was reported by Ikusemoran and Olokor (2014) in Kainji lake Basin between 1975 to 2006. However, Ikusemoran (2009) reported decrease in settlement Kainji lake Basin.

Table 2 Magnitude and percentage of change in land use/landcover between 1986 and 2001

Land use/landcover Class	A 1986	B 2001	C Magnitude of Changes(B-A)	D Annual frequency of change(C/15)	E Percentage of change C/Ax100
Bare land	11.53	136.38	124.85	8.323	1082.827
Built-up	757.71	884.7	126.99	8.466	16.759
Cultivation	10557.63	7892.96	-2664.67	-177.644	-25.239
Degraded forest	2015.25	6176.27	4161.02	277.401	206.476
Forest	34119.45	24195.01	-9924.44	-661.629	-29.087
Riparian	2986.48	2655.57	-330.91	-22.060	-11.080
Shrubland	1106.45	11501.22	-10394.77	-692.984	-936.470

Magnitude and percentage Change in Land use/Landcover between 2001 and 2012

The 11 years period between 2001-2012 witnessed a slowdown in the decrease of the forest reserve as 1807.61 km² representing 7.471% this was less than 29.087% between 1986 to 2001.

This period most of parts of the reserve that were left were closer to the roads which activities going on could easily be notice Conversely the built-up area increased from 58.5% in 2001 to 163.7% in 2012. Also, bare land decreases from 13.6% in 2001 to 7.57% in 2012. The cultivated areas also 789.3% in 2001 to 1414.0%. The shrubland areas decreases from 1150.1% in 2001 to 618.5% in 2012. Furthermore, the period between 2001-2012 shoed also the decrease further in the forest from the 24195.05km² in 2001 to 22387.4km² in 2012.

These findings are consistent with the work of Ogunmola *et al* (2014) ho pointed out that forested lands in most of urban settings in Nigeria has been decreasing due to the commercial activities and urbanization.

Table.3 Magnitude and percentage Change in Land use/Landcover between 2001 and 2012

Land use/landcover Class	A 2001	B 2012	C Magnitude changes (B-A)ABS	D Annual frequency of change C/11	E Percentage of change C/Ax100
Bare land	136.38	75.65	-60.73	-5.520	-44.529
Built-up	884.7	1636.31	751.61	68.328	84.956
Cultivation	7892.96	1410.21	-6482.75	-589.340	-82.133
Degraded forest	6176.27	3758.46	-2417.81	-219.800	-30.146
Forest	24195.01	22387.4	-1807.61	-164.328	-7.471
Riparian forest	2655.57	1540.33	-1115.24	-101.385	-41.996
Shrubland	11501.22	6185.33	-5315.89	-483.262	-46.220

Magnitude and percentage of change in landcover between 1986 and 2012

235 **Table4.**Magnitude and percentage of change in landcover between 1986 and 2012

Land use/landcover Classes	A 1986	B 2012	C Magnitude of Change(B-A)ABS	D Annual frequency of change C/26	E percentage of change C/Ax100
Bare land	11.53	75.65	-1077.35	-41.436	-9343.885
Built-up	757.71	1636.65	878.94	33.805	115.999
Cultivation	10557.63	14140.21	3582.58	137.791	33.933
Degraded forest	2015.25	3758.46	1743.21	67.046	86.500
Forest	34119.45	24195.01	-9924.44	-381.709	-29.087
Riparian forest	2986.48	1540.33	-1446.15	-55.621	-48.423
Shrubland	1106.45	6185.33	5078.88	195.341	459.024

236

237 The 26 years period from 1986-2012, experience the magnitude of the change of the forest as

238 9924.44km², with the percentage change of -29.087% and the annual frequency of change is -

239 381.709km². This signifies that 381.709km² of forest land is been lost annually in the reserve for

240 26 years. Also cultivated land had the magnitude of 3582.58km², percentage of change 33.933%

241 and annual frequency of change is 137.791km². Indicating that 137.791km² of the Yandev forest

242 reserve is being converted yearly for farming activities during the study period. This increase in

243 farming activities around protected area was also reported by Ikusemoran and Olokori (2014).

244 More so the magnitude of change of built-up areas is 878.94km², percentage of change is

245 115.999% and the annual frequency of change is 33.805km². This implies that built-up areas

246 increase by 33.805km² annually in the study area for 26 years. Shrubland in the study area also

247 has a magnitude change of 5078.88km², percentage change is 459.024%, and the annual

248 frequency of change is 195.341km², this also implies that shrubland is been increased by

249 195.341km² annually in the study area for 26 years. This research I in line with Ogunmola *et al*

250 (2014) ho asserted that rapid population growth, has remained the principal factor that has

251 triggered and continued to stimulate downward spiral environmental resources degradation.

The lost in forest land (Naturally vegetated areas) in Yandev Forest Reserve is attributed to the in urban areas. As shown in **Table4.** built-up land increase from 757.71km^2 (75.8%) in 1986 to 804.7km^2 (88.5%) in 2001, the magnitude of change is 878.94km^2 , percentage of change is 115.99% and annual frequency of change is 33. 805km².this implies that 33.805km² of natural vegetation is been converted to urban areas for 15 years. From 2001-2012 built-up land further increased from 804.7 (88.5%), in 2001 to 1636.31 (163.7%) in 2012. The magnitude of change 751.61km^2 , percentage of change is 84.956%, and annual frequency is 68.328km^2 . This means that 68.328km^2 of land is been lost to urban area for 11 years (2001-2012) in Yandev Forest Reserve.

The result is in the agreement with Harrison (1993) ho observed that rapid environmental growth has resulted in many environmental problems which has escalated deforestation and loss of vegetation in urban fringes.as population increases, more land is needed for farming, building of houses and other constructions, less is left to forest or fallow.

Conclusion.

The study has established that there was a tremendous change in the land cover and land use of Yandev Forest Reserve during the 26 years period from the 1986-2012. The rate of change of forest area between 1986 and 2001 is -9924.44sqkm per annum, while that of 2001 and 2012 was -1807.6sqkm per annum. Loss of naturally vegetated area in Yandev Forest Reserve is mainly as a result of urban growth and logging, farming and commercial activities. Land cover of the study area during the period between 1986 and 2012 is gradually changing from a forested area to other land uses as a result of increase in population, demand for land for agricultural purposes and increase in the demand fuel wood and logs. It was recommended that increased monitoring of forest reserves in the State be ensured, with the use of GIS for prompt detection of land cover

276 change. Also enrichment planting of the already degradation reserves like Yandev Forest
277 Reserves be carried out.

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