

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

Abstract

The study was conducted to assess and predict Land use and Land cover changes of Yandev Forest reserve in Gboko, Benue state Nigeria. The study utilised Landsat images for 1986, 2001 and Nigeriansat-X was used for 2012, The images were obtained from the National Centre for Remote Sensing Jos. A supervised classification was used after the images were subjected to different processing techniques. The land use and land cover was classified into five (5) classes of Built up, Bareland, Cultivated area, Forest and Shrubland. The trend of land use/land cover in the reserve revealed that Bareland increased from 0.60% in 1986 to 0.67% in 2012, built up area increased from 0.73% in 1986 to 1.78% in 2012, Shrubland, increased from 7.63% in 1986 to 12.51% in 2012. Forest area decreased from 66.6% in 1986 to 40.32% in 2012. Cultivated area increased from 24.44% to 44.72% in 2012. Forest area lost 5003.02ha within the 26 years period to other form of land use. All the other land use/landcover classes increased during the period with cultivation area having the highest increase of 3858.99ha and bare land with the least area of change of 13.32ha. The study established that tremendous land use/landcover changes are going on in the Yandev forest reserve which could be linked to rapid urbanization of Gboko town. Enrichment planting of reserve, massive awareness against deforestation and sustainable use of the reserve is recommended.

Key Words: land use, land cover change, Forest reserve, Built up, Shrubland

Introduction

The data generated through monitoring systems in forestry sector are very essential for formulating effective policies and planning for the sustainable management of forest resources. This is because they provide the platform through which the historical and current human interactions and the impacts of such interactions with the forest resources and the environment in general can be appreciated (Mohammed, *et al.*, 2013). The information generated through monitoring systems are also relevant for balanced and sustainable distribution of available land resources for future development.

In Forestry sector, collection of relevant forest information periodically always helps in the formulation and effective execution of policies, inform decision-making, and guide management (Akindele, 2012). Up-to-date and accurate information on forests are capable of advancing the profile of the sector and increase awareness of forest resources' potential and promote sustainable management and preservation of forest ecological systems (Akindele, 2012, Akinola and Akindele, 2012). Ample evidence shows that inadequate information about forests and poor monitoring capacity have led to poor forest policies, planning, and management; hindered efforts to curtail illegal and unsustainable harvesting of forest resources and improve transparency; and resulted in underassessment of forest resources. Such settings, to a large extent, contribute to continuous decline in forest resources. 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.

In spite of the relevance of vegetation mapping as one of the basic components of ecological database of a given area, Ochege and Okpala-Okaka (2017) noted that vegetation has continued to be imprecisely mapped in Nigeria. Again, most decisions about how much land to use, where and for what purposes are still not well understood. Mohammed, *et al.*, (2013) pointed out that in Nigeria, almost all developmental projects are carried out without reference to land-use and land cover information.

As a result, there is an urgent need for proper land management and together with the availability of an accurate, detailed and up-to-date geographic information. In Nigeria and most other developing countries, accessibility of relevant and current information about our environment and how it is changing over time has been deficient (Ezeomodo, 2006). This problem has consequently affected the achievement of change detection and sustainable development, and therefore requires research for accurate and timely information which is required for environmental monitoring, planning and prediction. Even though a lot of researches have been

done using conventional system to produce some information on the land use and landcover change (LULC) in some parts of Nigeria especially in forest reserves (Mohammed, *et al.*, 2013, Ikusemoran, and Olokor, 2014), but little studies have been done employing Remote Sensing and GIS technique to map and analyse forest reserves and other land use and land cover in the Benue State. Therefore, the use of GIS and remote sensed data for land use land cover analysis in Yandev Forest Reserve, Gboko Local Government Area (LGA) and its environs would definitely provide information for the sustainable use of the reserve and development.

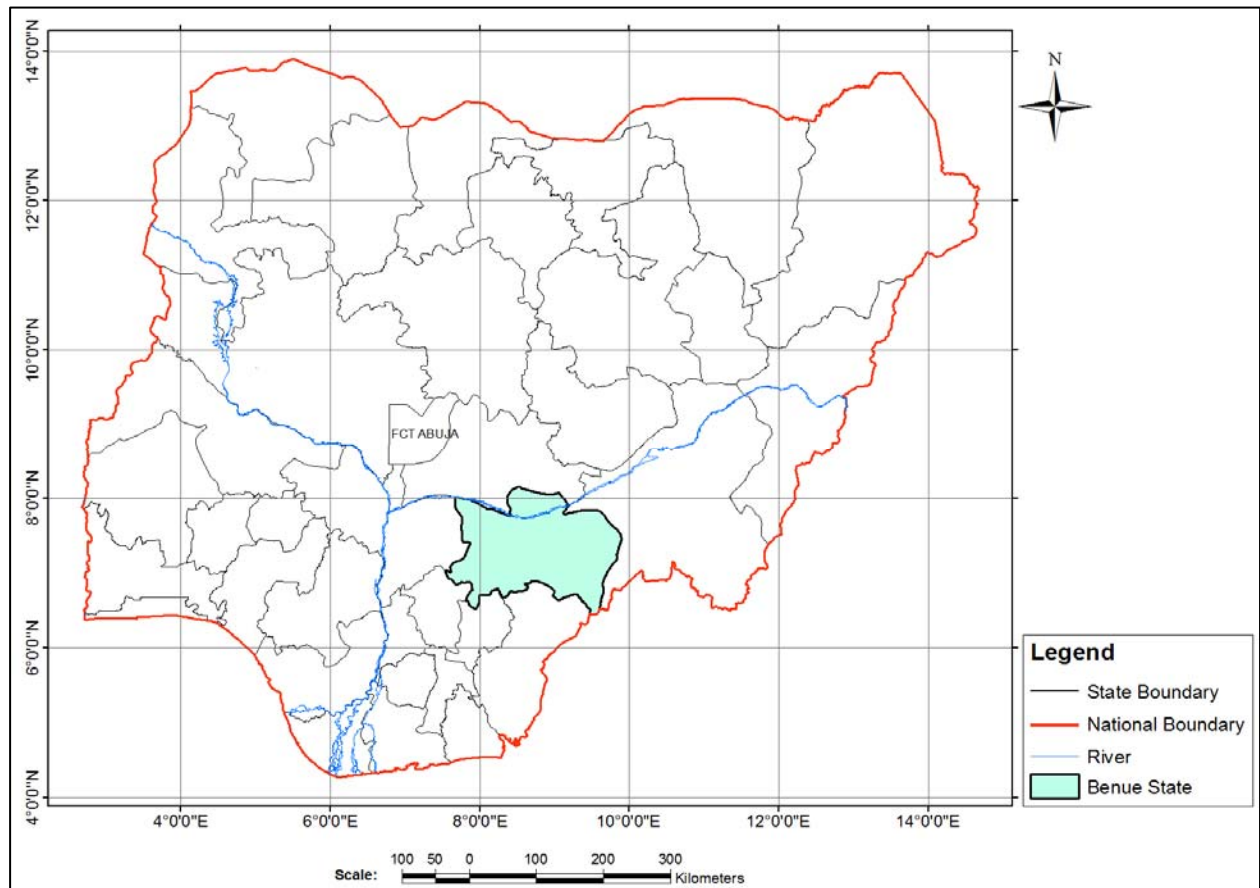
MATERIALS AND METHODS.

Study Area

Yandev is a settlement in Gboko Local Government Area (LGA) of Benue State Nigeria (Africa). It is located at an elevation of 315 meters above sea level and its population amounts to 536,068 as at 2006, National Bureau of Statistics (NBS 2012). It is located between latitude $7^{\circ}22'00''$ N and $7^{\circ}36'00''$ N and longitude $9^{\circ}10'0''$ E and $9^{\circ}25'00''$ E. 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 partnership with the World Bank for the provision of raw materials and products in the form of poles, timber, veneer, wood particles, pit props, pulp, fuel wood and for research purposes (Etim, 2007 and BNSG, 2017).

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82 Figure 1. Map of Nigeria showing Benue state.

83 Source; Produced from GADM Shapefile using ArcGIS 10.1

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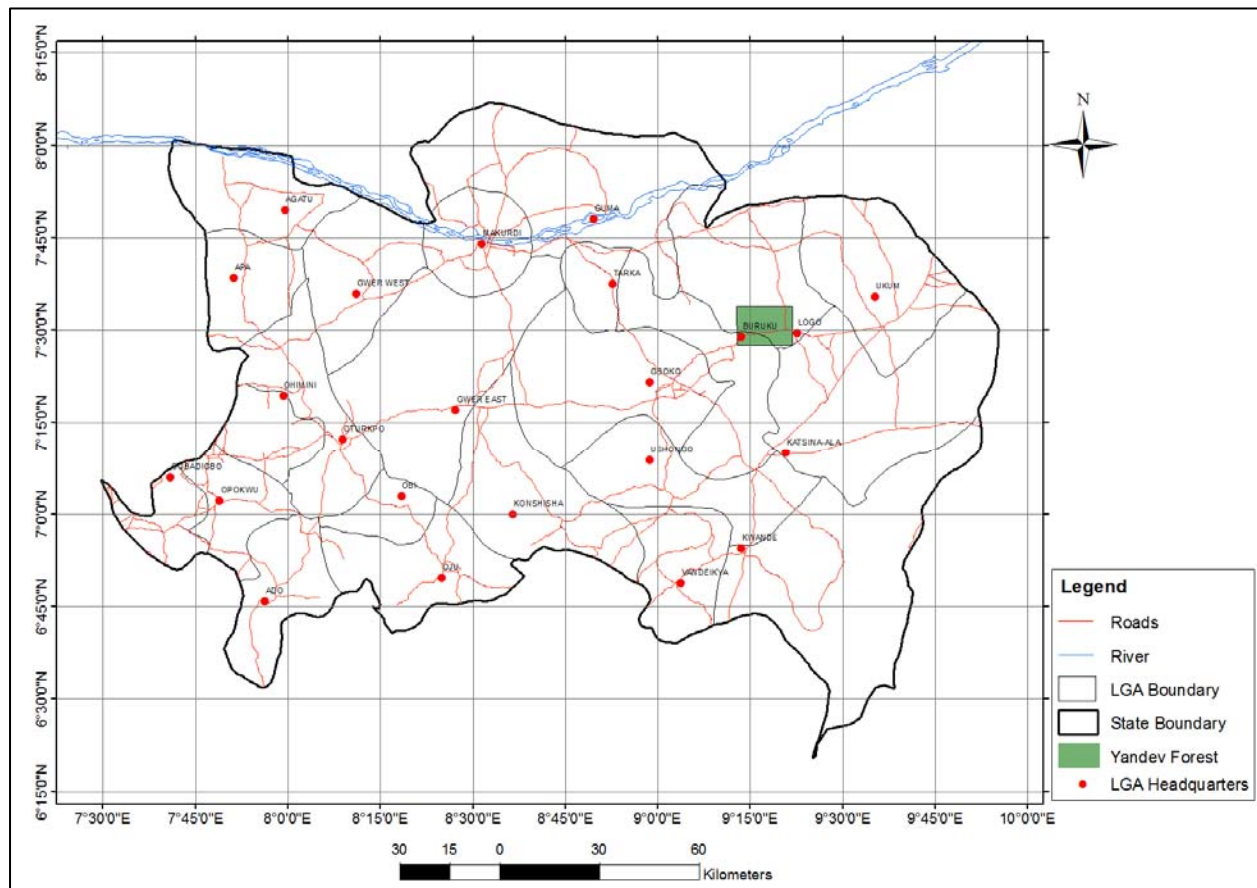


Figure 2. Map of Benue state showing the study area.

Source; Produced from GADM Shapefile using ArcGIS 10.1

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102 **Climate**

103 Yandev Forest Reserve is characterized by two distinct seasons; rainy and dry season. The rainy
104 season takes place from April to October while the dry season last from November to March.
105 Rain fall distribution has double maxima occurring in June and September. Mean annual rainfall
106 lies between 100cm and 150cm. Mean annual temperature is 30°C while the relative humidity is
107 between 60% and 80% wet but declines in the early April (Jimoh *et al.*, 2009).

108 **Vegetation**

109 The vegetation of the Yandev Forest Reserve is the sudan savannah woodland which is
110 characterized by mostly trees, less shrubs and tall grasses up to 2m tall. Isolated forest
111 formations are found in lowland areas. Some of the species found in the area are *Tectona*
112 *grandis*, (Teak) and *Gmelina aborea* (Gmelina) (Abah, 2014).

113 **Data source and collection.**

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

123 **Image Classification**

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. Pixels 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, Forest vegetation, Scattered cultivation and Shrub land

Table 1: Specifications of Satellite Imageries Used

No	Image type	Production Date	Spatial Resolution	No of Bands	Spectral Resolution	Path & Raw
1	Landsat TM	12/12/1986	30m	RGB 3,2,1	7	p187r054
2	Landsat ETM	27/01/2001	30m	RGB 3,2,1	8	p187r054
3	Nigeriasat-X	06/10/2012	22m	RGB 3,2,1	3	-

TM= Thematic Mapper, ETM= Enhanced Thematic Mapper

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

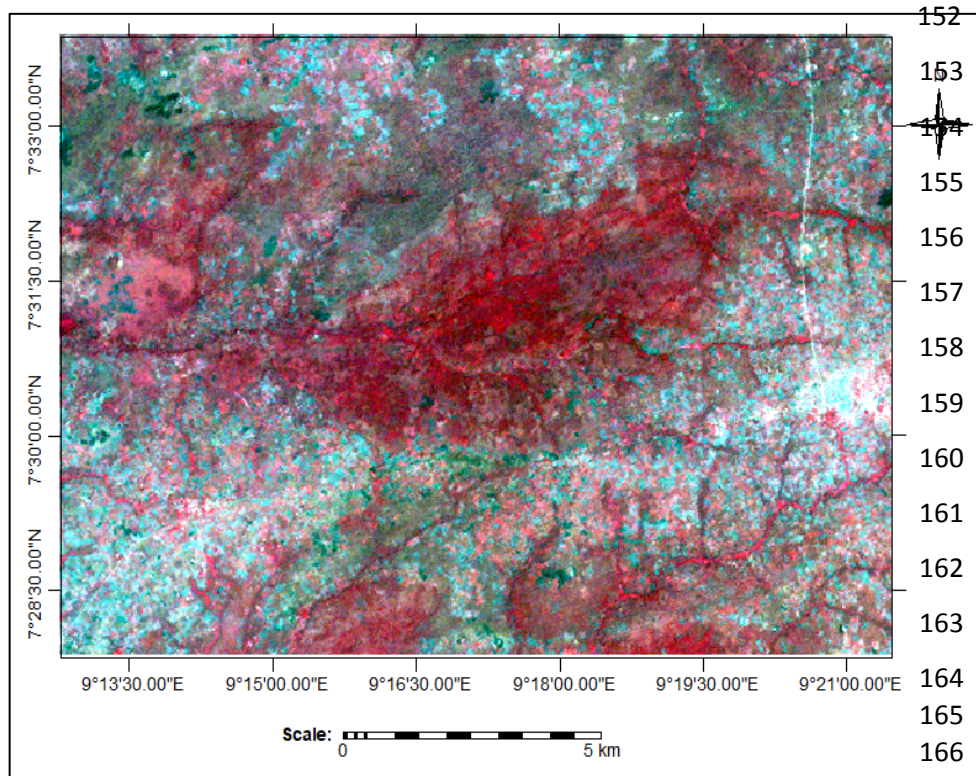


Figure 3. Raw Landsat TM Image of Yandev for 1986
Source: National Centre for Remote Sensing, Jos

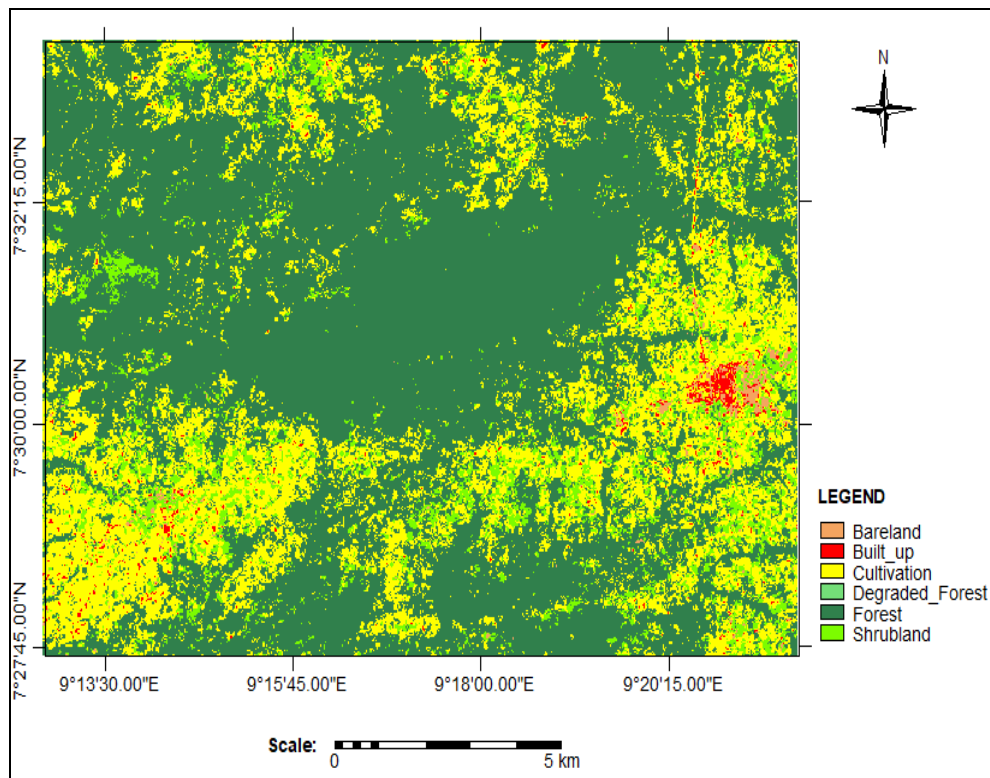


Figure 4 Classified Image of Yandev from Landsat TM for 1986
Source: Author's analysis 2018

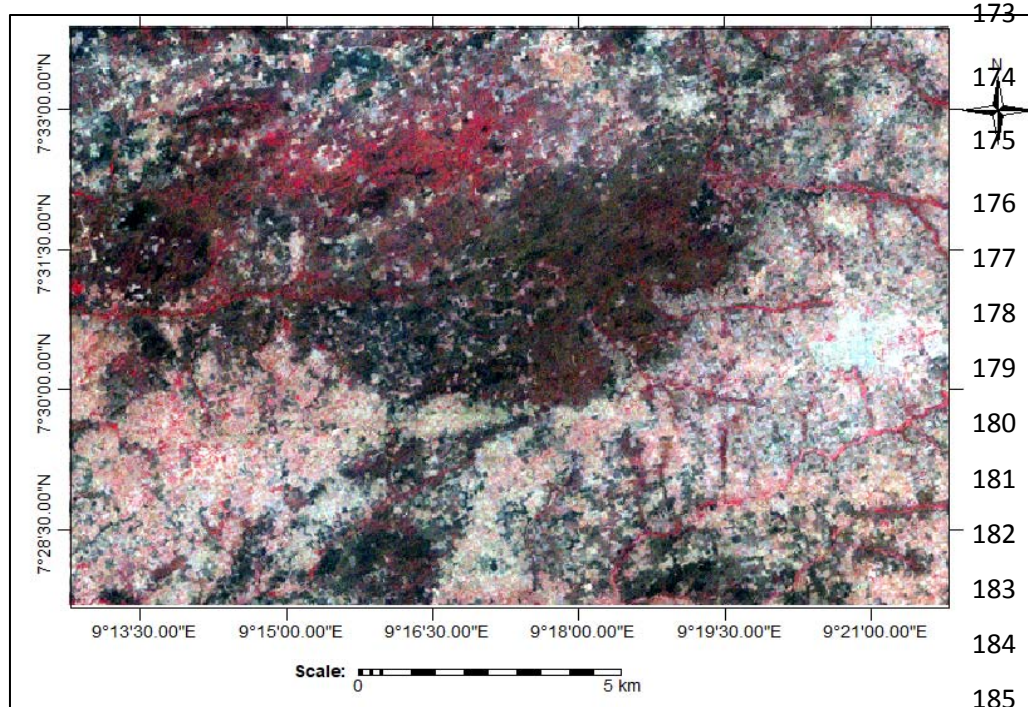


Figure 5 Raw Landsat ETM Image of Yandev for 2001
Source: National Centre for Remote Sensing, Jos

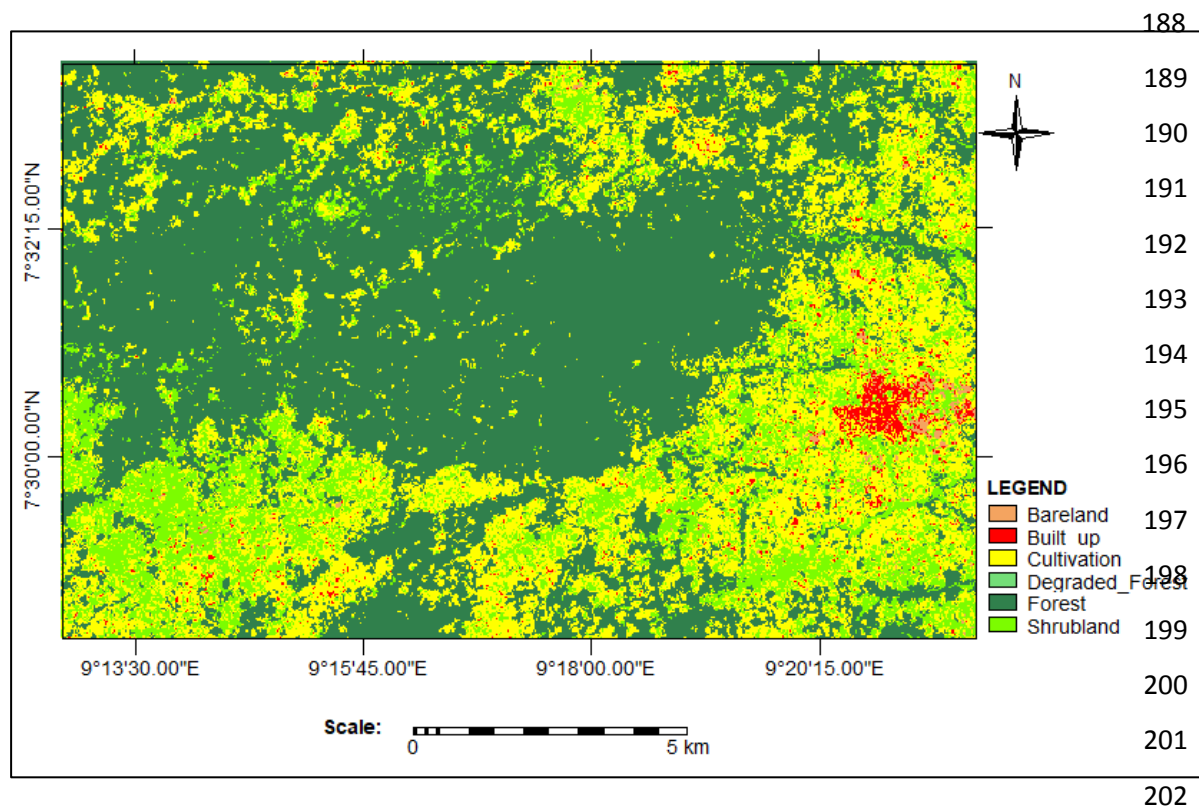


Figure 6. Classified Image of Yandev from Landsat ETM for 2001

Source: Author's analysis 2018

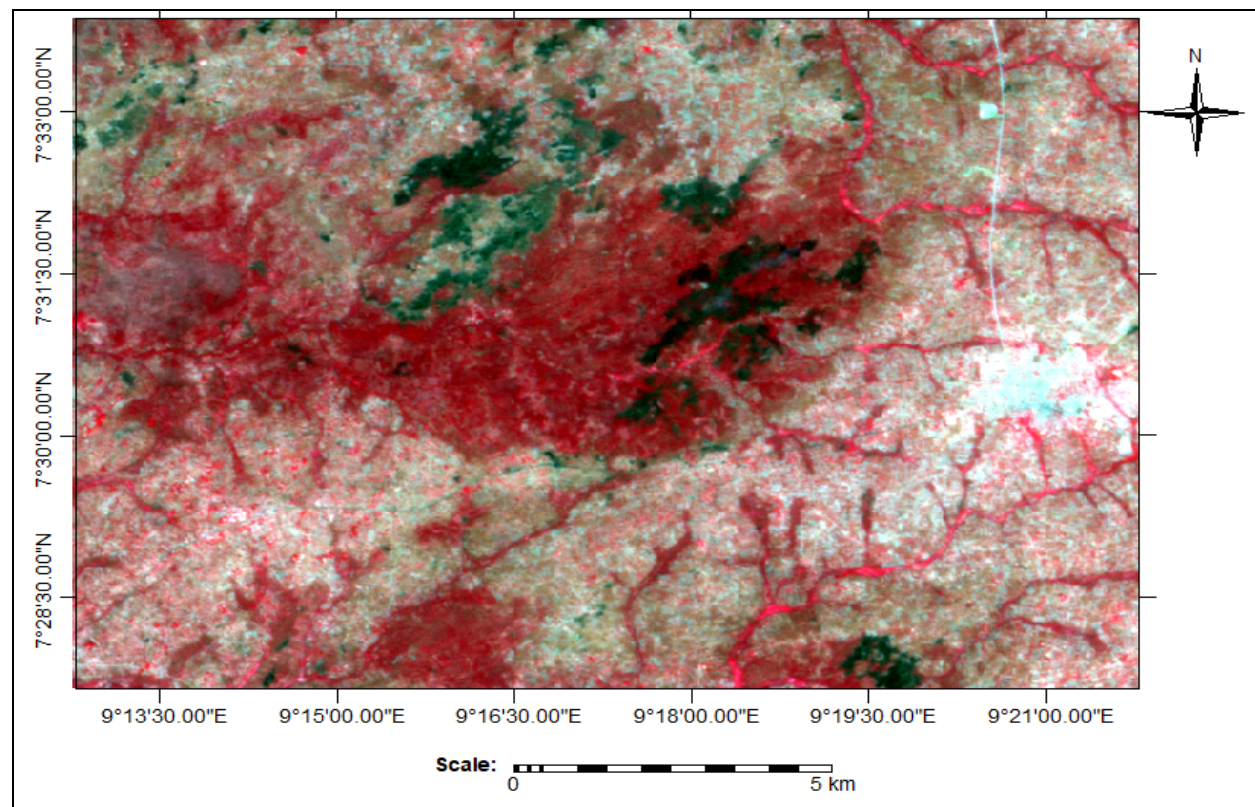


Figure 7 Raw NigeriaSat-X Image of Yandev for 2012

Source: National Centre for Remote Sensing, Jos

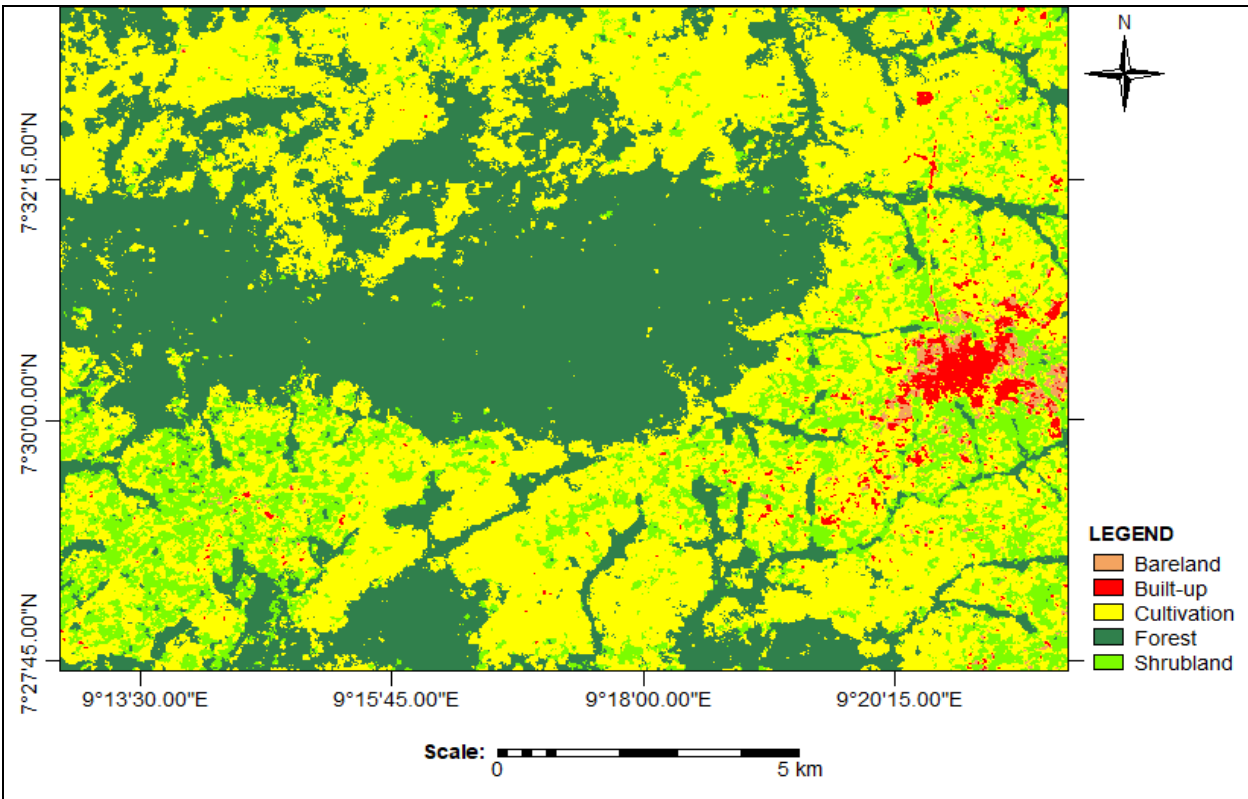


Figure 8. Classified Image of Yandev from NigeriaSat-X for 2012

Source: Author's analysis 2018

Extent of Land use/Landcover change in Yandev Forest Reserve from 1986-2001

The result of land use/landcover change in Yandev Forest Reserve as presented in Table 1 shows that bare land decreased from 114.12ha (0.6%) in 1986 to 83.58ha (0.44%) in 2001 representing a 0.16% decline. Built up area increased from 139.63ha (0.73%) in 1986 to 226.21ha (1.19%) in 2001 accounting for 0.46% increase. Cultivated area also increased from 4653.46ha (24.44%) in 1986 to 5047.97ha (26.52%) in 2001 accounting for 2.08% increase. While forested area decreased from 12677.52ha (66.6%) in 1986 to 10638.12ha (55.88%) in 2001 representing a decrease of 10.72%. Also, Shrubland increased from 1451.65ha (7.63%) in 1986 to 3040.5ha (15.97%) in 2001 accounting for 8.16% increase (See Table 1). Similar experience was reported by Jande and Amonjenu (2018) in Apa local government area of Benue state Nigeria.

Extent of Land use/Landcover change in Yandev Forest Reserve from 2001-2012

The result of land use/landcover change in Yandev Forest Reserve from 2001 to 2012 as presented in Table 1 shows that the bare land increased from 83.58ha (0.44%) in 2001 to

127.44ha (0.67%) in 2012 representing a 0,23% increase. Built up area increased from 226.21ha (1.19%) in 2001 to 339.65ha (1.78%) in 2012 accounting for 0.59% increase. Cultivated area also increased from 5047.97ha (26.52%) in 2001 to 8512.45ha (44.72%) in 2012 accounting for 18.2% increase. While Forested area decreased from 10638.12ha (55.88%) in 2001 to 7674.5ha (40.32%) in 2012 representing a decrease of 15.56%. Shrubland also decreased from 3040.5ha (15.97%) in 2001 to 2382.34ha (12.51%) in 2012 representing 3.46% decrease. Ogunmola *et al* (2014) reported similar experience in their study in Plateau State, Nigeria.

Extent of Land use/Landcover change in Yandev Forest Reserve from 1986-2012

Land use/landcover change analysis in Yandev Forest Reserve from 1986 to 2012 as presented in Table 2 shows that the bare land increased from 114.12ha (0.6%) in 1986 to 127.44ha (0.67%) in 2012 representing a 0,07% increase. Built up area increased from 139.63ha (0.73%) in 1986 to 339.65ha (1.78%) in 2012 accounting for 1.05% increase. Cultivated area also increased from 4653.46ha (24.44%) in 1986 to 8512.45ha (44.72%) in 2012 accounting for 20.28% increase. While Forested area decreased from 12677.52ha (66.6%) in 1986 to 7674.5ha (40.32%) in 2012 representing a decrease of 26.28%. Shrubland also increased from 1451.65ha (7.63%) in 2012 to 2382.34ha (12.51%) in 2012 representing 4.88% increase

The last 11years between 2001-2012 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 2.09% between 1986 to 2001, the percentage increase decreased to 1.23% 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) showed 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 is located close to Gboko and Mkar towns, also its proximity to Akperan Orshi College of Agriculture constitutes a major sources of pressure on the reserves.

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261 **Table 2.** Percentage of land use/landcover in Yandev forest Reserve (1986, 2001 and 2012)

Land use	1986		2001		2012	
landcover class	Area (Ha)	%	Area (Ha)	%	Area (Ha)	%
Bareland	114.12	0.60	83.58	0.44	127.44	0.67
Built-up	139.63	0.73	226.21	1.19	339.65	1.78
Cultivation	4653.46	24.44	5047.97	26.52	8512.45	44.72
Forest	12677.52	66.60	10638.12	55.88	7674.5	40.32
Shrub land	1451.65	7.63	3040.5	15.97	2382.34	12.51
Total	19036.38	100	19036.38	100	19036.38	100

262 Source: Author's analysis 2018.

263 **Assessment of classification accuracy of land use/landcover in Yandev Forest Reserve**

264 The classification accuracy for the three periods of 1986, 2001 and 2012 for Yandev Forest

265 Reserve showed an overall accuracy of 80.77%, 85.84% and 86.24% respectively (see Table 2).

266 This was considered a good overall accuracy and therefore usable for the subsequent analysis

267 and change detection. The user's accuracy of individual classes ranged from 74.07% to 100%

268 and producer's accuracy ranged from 64 % to 93.62%. The overall Kappa index was computed

269 for each classified map to measure the accuracy of the results.

270 **Table 2: Accuracy assessment result of LULC classification in Yandev Forest Reserve**

LULC Class	1986 classification		2001 classification		2012 classification	
	Producer's Accuracy (%)	User's Accuracy (%)	Producer's Accuracy (%)	User's Accuracy (%)	Producer's Accuracy (%)	User's Accuracy (%)
Bare land	64	84.21	71.43	83.33	86.36	82.61
Built-up Area	86.49	91.43	88.89	100	74.19	85.19
Cultivation	83.33	74.07	90	80.36	93.62	88
Forest	82.93	79.07	91.67	86.84	82.05	100
Shrubland	80.56	76.32	82.98	81.25	86.89	82.81
Overall Accuracy	80.77%		85.84%		86.24%	

Overall Kappa	0.76	0.83	0.83
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Source: Author's analysis 2018.

The results of the three periods 1986, 2001 and 2012 revealed Kappa statistics of 0.76, 0.83 and 0.83 respectively (Table 2). The Kappa coefficient for the three periods ranges from substantial agreement to almost perfect agreement on the kappa scale, an indication that it can be relied on.

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 showed that forest decreased by -2039.4ha representing a change (49.26%) of the total change for the period as shown in Table 3. Forest had the highest annual rate of change of 7.39% while bare land had the least annual rate of change of 0.11%. These agree with the findings of Ogunmola *et al* (2014) and Jande and Amonjen (2018) who observed that natural vegetated areas in most Nigeria communities have been decreasing in recent years. This is contrary to the findings 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 at the mercy of the communities without proper monitoring.

Table 3 Magnitude and percentage of change in land use/landcover between 1986 and 2001

LULC Class	1986 Extent (Ha)	2001 Extent (Ha)	Magnitude of Change (Ha)	Percentage of Change	Annual Rate of Change %
Bare land	114.12	83.58	-30.54	0.74	0.11
Built-up	139.63	226.21	86.58	2.09	0.31
Cultivation	4653.46	5047.97	394.51	9.53	1.43
Forest	12677.52	10638.12	-2039.4	49.26	7.39
Shrub land	1451.65	3040.5	1588.85	38.38	5.76
Total	19036.38	19036.38	4139.88	100	

Source: Author's analysis 2018.

The period witnessed a tremendous increase in bare land and built up area. The bare land decreased by -30.54ha representing 0.74% of the total change, while built up increased by 86.58ha representing 2.09%. 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 increased 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.

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 -2963ha representing 32.02% this was less than 49.26% between 1986 to 2001 (Table 4). This may be due to the reduction in the size of the reserve, as most parts of the reserve that were left behind were areas that were closer to the roads where activities going on could easily be noticed. However, this differed with the findings of Ogar *et al.* (2016) in Stubb Creek Reserve in Akwa Ibom state where there was marginal increase in the rate of annual change of forest cover in the last 10 years of their study period. Conversely the built-up area increased by 113.44ha representing 1.23% of the total change. The increment was higher in the last 11 years compared to the first 15 years (between 1986 and 2001) . This could be linked to the increased population of the surrounding areas, such as Gboko, Mkar and yandev. Similar Experience was reported by Jibrin and Liman (2014) in Ilorin, Nigeria, They attributed the increase in the built up areas to city expansion. The magnitude of change of bare land increased to 43.86ha (0.47%) from a negative change of -30.54ha (0.74%) in the preceding period. The magnitude of change in cultivated areas also increased to 5464.48ha (59.12%). The shrubland areas lost 658.16ha (7.12%) to other land use/landcover classes.

Table.4 Magnitude and percentage Change in Land use/Landcover between 2001 and 2012

LULC Class	2001 Extent (Ha)	2012 Extent (Ha)	Magnitude of Change (Ha)	Percentage of Change	Annual Rate of Change %
Bare land	83.58	127.44	43.86	0.47	0.05
Built-up	226.21	339.65	113.44	1.23	0.14
Cultivation	5047.97	8512.45	5464.48	59.12	6.5
Forest	10638.12	7674.5	-2963.63	32.06	3.53
Shrub land	3040.5	2382.34	-658.16	7.12	0.78
Total	19036.38	19036.38	9243.57	100	

Source: Author's analysis 2018.

These findings are consistent with the work of Ogunmola *et al* (2014) who pointed out that forested lands in most of urban settings in Nigeria has been decreasing due to the commercial activities and urbanization. Jande and Amonjenu (2018) also find out that forest area in Apa were on decrease due to expansion in settlement.

Magnitude and percentage of change in landcover between 1986 and 2012

The magnitude of the change of forest for the 26-years period from 1986-2012 reveal that, the forest is on the decline as it lost 5003.02ha (50%) to other landcover classes with annual rate change of 13% (table 5). This implies that 13% of forest land is been lost annually in the reserve for 26 years. This was higher that the annual rate of change reported by Jande and Amonjenu (2018) in Apa local government area of Benue State Nigeria. It was also higher that the rate reported by Oyinloye *et al.* (2010) in some state forest reserves in Southwestern Nigeria. Cultivated land increased by 3858.99ha (38.57%) between 1986 and 2012 at an annual rate of 10.03% which was the second highest. This result indicates that 10.03% of Yandev forest reserve is being converted yearly for farming activities during the study period. This increase in farming activities around protected area was also reported by Ikusemoran and Olokor (2014). More so, built-up areas increased by 200.02ha (2%) at an annual rate of 0.52%. Shrubland increased by 930.69ha (9.3%) at an annual rate of 2.42%. This also implies that shrubland has been increasing by 2.42% annually in the study area during the period.

Table 5. Magnitude and percentage of change in landcover between 1986 and 2012

LULC Class	1986 Extent (Ha)	2012 Extent (Ha)	Magnitude of Change (Ha)	Percentage of Change	Annual Rate of Change %
Bare land	114.12	127.44	13.32	0.13	0.03
Built-up	139.63	339.65	200.02	2.00	0.52
Cultivation	4653.46	8512.45	3858.99	38.57	10.03
Forest	12677.52	7674.5	-5003.02	50.00	13
Shrub land	1451.65	2382.34	930.69	9.30	2.42
Total	19036.38	19036.38	10006.04	100	

Source: Author's analysis 2018.

The lost in forest land (Naturally vegetated areas) in Yandev Forest Reserve is attributed to the urban areas. This research is in line with Ogunmola *et al* (2014) who asserted that rapid population growth, has remained the major factor that has prompted and continued to stimulate environmental resources degradation.

The result is in the agreement with Harrison (1993) who observed that rapid environmental growth has caused 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 7.9% per annum, while that of 2001 and 2012 was -3.53% 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. The implication of this is that Yandev Forest Reserve

will in no distant future be deforested and converted to different land use landcover classes which will lead to increased temperatures, decline in biodiversity and increased soil erosion and degradation. It was recommended that increased monitoring of forest reserves in the state be ensured and key stakeholders should be mobilized towards the sustainable use of the reserve. The use of GIS for prompt detection of land cover change should be encouraged. Also, encouragement of planting of the already degraded areas of the reserves be carried out.

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