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ANTHROPOGENIC ACTIVITIES, PRESSURE AND THREAT ON GIREI FOREST RESERVE, ADAMAWA STATE, NIGERIA

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Abstract

In Nigeria, since the last three decades, there has been a tremendous pressure on forest to provide economic resources leading to unabated deforestation. The potential negative effects of such changes on forest quality, quantity and production are wide. The objective of this study is to evaluate the degree of pressure and its threat from anthropogenic activities on protected area of Girei Forest Reserve, Adamawa State, Nigeria, through the application of Remote Sensing and GIS techniques. The images of Landsat TM 1987, ETM+ 2000, Nigeriasat-1 2010 and Spot5 2015 were analyzed to derive information on environmental changes between 1987 and 2015. The results of the analyses revealed that fuel wood extraction and cultivation are the main causes of deforestation in the area, followed by urbanization. It also revealed that forest area has reduced from 177.03 km^2 in 1987 to 125.53 km^2 in 2000 and then further reduced to 112.74 km^2 in 2010 and then dropped to 75.98 km^2 in 2015. This implies that land-use such as built-up areas and cultivated areas were increasing through time i.e. from 3.33 km^2 in 1987 to 5.1 km^2 in 2000, 7.47 km^2 in 2010 and 8.95 km^2 in 2015. This indicated that the rate of deforestation in the area is high at about 33.68 km^2 per year thereby confirming the perception of 58% of the respondents. Decrease in rainfall, increase in temperature and erosion were observed as the most serious effects of deforestation in the area. The study recommends that government and traditional authorities should provide affordable alternative source of energy to cushion and reduce pressure on fuel wood as principal source of domestic energy supply and the need to enforce environmental laws.

Keywords: Anthropogenic, Pressure, Threat, Landsat, Nigeriasat-1, Change detection.

Introduction

In Nigeria, like in many other sub-Saharan African countries, there has been a serious concern on environmental changes since the last three decades. The country is increasingly faced with the challenges of desertification, deforestation, erosion and flooding, which have manifested in multi-faceted problems such as loss of agricultural soil and productivity. Deforestation is one of the major environmental issues not only affecting countries and locations, but also from a global perspective. The degree of international attention to deforestation is commensurate with the role of forests in the global, national and local ecosystems. The rate of deforestation in Nigeria exceeds the rate of regeneration (Aweto, 1990; Iroye, 2010). Tropical forest of all varieties are disappearing rapidly as human clears the natural landscape to make room for farms and pastures, to harvest timber for construction and fuel, and to build roads and urban areas (Robert, 2007).

Many studies showed negative effect of human activities on forest biodiversity. Effects of these activities are manifested at all ecological scales, from short-term changes in the behavior of an individual animal through local extirpations and global extinctions. Abundant fauna and flora resources in Nigeria are being threatened due to the increasing rate of anthropogenic activities across the protected areas in the country (Oladeji et al, 2012). Between 1990 and 2000 Africa lost 52million hectares of forest, this amounts to a decrease of 0.8percent per year and 56 percent of the global total. It is estimated that 60% of the tropical forest areas cleared in Africa

as a whole between these periods were converted to permanent agriculture small holdings (UNEP, 2010). Human activities often referred to as land-use, such as mining, forest exploitation, tourism, hunting, fishing, agriculture, have resulted in the loss of forest resources, such as deforestation and forest degradation which demonstrate the impact of those activities on forest resources by looking at the percentage of forest cover change and meteorological changes (Kiki et al, 2012). Developing countries including Nigeria are saddled with problems emanating from environmental deterioration which has great impact on the forests (Dagba et al, 2017). Clearing of forest reserves and plantations to pave way for farming and urbanization account for over 80% of the factors responsible for the depletion of forest resources in Nigeria. According to (Ogunwale, 2015), in developing communities, social amenities such as roads, hospital, water plants etc. are regularly provided by the government and or the communities themselves, and most times without proper planning whereby primary forests are cleared to site such projects.

Forests are important plant communities that consist of trees and other woody vegetation that performs life supporting functions on earth (Ladan, 2014). Forest reserves are areas of forest designated by the government for the protection of trees growing or planted for the purpose of their ecological benefits among others (Usman and Adefalu, 2010). Forest reserves are areas of land that are protected and managed in order to preserve a particular type of habitat and its flora and fauna which are often considered rare or endangered (Farlex, 2014). Okpiliya (2013) analyzed the flora species abundance in the tropical rain forest ecosystem of Boki, Cross River State which still remains one of the few ecosystems that have been highly valued for its species diversity despite the spate of indiscriminate logging. Ihenyen et al (2009) evaluated the tree composition of Ehor Forest Reserve in Edo state, southern Nigeria, where they observed that several tree species are under threat of extinction from the reserve which is quite alarming and calls for a more resourceful and sustainable management techniques. The study further suggested that the reserves should be protected from further timber and fuel wood exploitation in order to allow it to regenerate itself fully. Akinsoji (2013), carried out a vegetation analysis of Ngel Nyaki Forest Reserve on the Mambilla Plateau, Nigeria. The results indicated that the vegetation of Ngel Nyaki Forest Reserve is stable and self-sustaining. Several studies focus on decline in forest reserves, changes in forest tree species, depletion of forest reserves and forest degradation. Kankara (2010) noted that over the years there is decline in forests in Katsina State, northern Nigeria caused by neglect and human interference which results in the disappearance of wild animals that once roam through the forest across the State. Omale (2011) observed that in Nigeria, there is the depletion of forest reserve through improper wood harvesting methods.

Oduntan et al (2013) evaluate the degree of pressure from human activities on protected areas in Yelwa Division of Ogun State, Nigeria.The findings revealed that all the reserves were severely threatened by logging and grazing while other reserves were severely threatened by conversion of land use. Mmon and Mbee (2014) carry out a study on Gele Gele Forest Reserve, Edo State and the results show that there is a steady growth of the population of the communities around the reserve which leads to rapid decline and depletion of the rich biodiversity and biological resources in the reserve due to over-dependence on the forest resources. Olaniyi et al (2014) determine the intensity of anthropogenic activities that took place within the Chimpanzee's distribution area in Oluwa Forest Reserve, south west Nigeria. The study observed that anthropogenic activities are having significant influences on the occurrence of species and recommended control measures such as encouragement of forest guards to intensify anti-poaching and encroachment patrol.

Anthropogenic influences on the landscape can result in the alteration of habitat, such as the loss and fragmentation of natural vegetation, creation of novel habitat type, alteration of resources flows including reduction in net primary product, increase in regional temperature and degradation of water quality, alteration of disturbance regimes with many habitats experiencing more frequent disturbances, alteration of species composition commonly comprising reduction in the richness of some taxonomic group in areas of intense urbanization (Eniolorunda, 2010). These environmental challenges have no doubt compounded the poverty levels of more than 80 million people that depend on agriculture for their livelihood (Ba et al, 2012). Therefore we need to monitor the quality of our environment as well as to control our developmental processes very closely.

Study area

Girei lies north of the Benue River between Latitude 8^0 N and 11^0 N and Longitude 11.5^0 E and 13.5^0 E (Figure 1). It covers a total land area of 1151.64 square kilometers (Saka *et al*, 2013). The geology of Girei area consists of two strati-graphic units; these are the quaternary river coarse alluvium and feldspar sand-stone. The alluvial deposits occur mainly along the bank of river Benue and its tributaries, consists of sand, clay, silt, silt-clay and pebble sand (Adebayo and Tukur, 1999). The landform type of Girei area is characterized by grouped hills of synclinical folds about 600 meters developed on cretaceous sand stone and lowlands (Adebayo and Tukur, 1999). Climate factor of the area controls the regime and other characteristics of the river. The few rivers in the area are Mayo Pambambi, Maita, Beti-Mayel,Wuro-modi,Toja, river Gede and Wari forming a dendritic drainage pattern that drained in to the Benue River which flows along the Southern part of the area (Adebayo and Tukur, 1999). The area is characterized by two well defined seasons, which are rainy (wet) and dry seasons. The rainy season starts from May through October, while the dry season commences from November and ends in April which is characterized by dry, dusty and hazy wind that bring harmattan dust from the Sahara Desert through the influence of tropical continental air mass, it reduces visibility to less than 100 meters. The average annual rainfall is about 972mm with an average of 62 rainy days. Temperatures are relatively high almost all year round. The temperature of the area ranges from 30^0C to 44^0C (Adebayo, 1999). The vegetation of Girei area is of sub-Sudan Savanna vegetation zone of Nigeria, which is characterized with short grasses, thick vegetation around hills and mountain ranges and inter-sparse by short trees and shrubs (Adebayo and Tukur, 1999). The tree vegetation has over the years been modified by human activities such as farming which involve bush burning, fuel wood exploitation, deforestation and also construction works (Uyanga, 2000). Girei Local Government Area has a population number of 129,955, with 66,906 Male and 62,949 Female, with an annual growth rate of 2.5 percent (NPC, 2007).

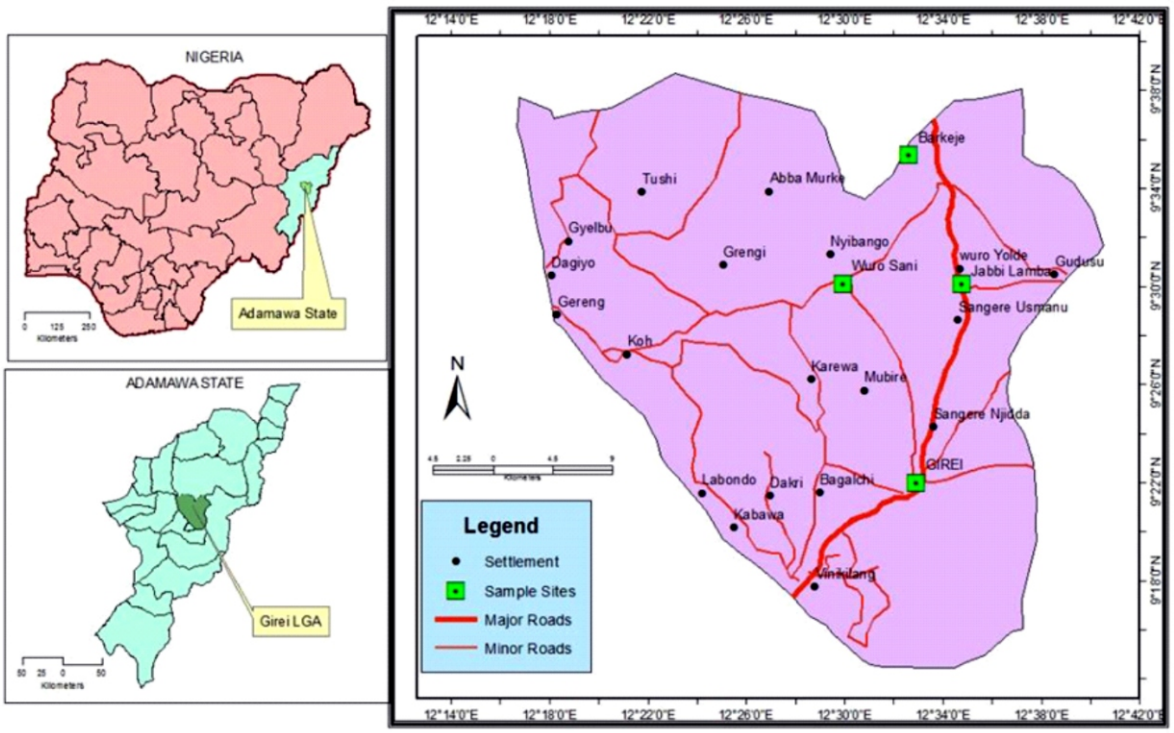

Figure1: Map of the study area

Methods and materials

The data used for this study include satellite imageries of Landsat TM 1987, ETM+ 2000, Nigeriasat-1 2010 and Spot5 2015. Arcgis 10.3 versions, Eradas 9.3 Geographic Information System (GIS) software packages were also used to analyze and perform feature identification, recognition, classification, overlay analysis, accuracy assessment, change detection and prediction for feature scenario.

Data processing and extraction

This involves the reduction of satellite data through cutting out the study area from the selected scenes, geo-referencing and preparation of false color composite (FCC). Analysis of the spectral signatures of individual pixels of the acquired imageries was conducted through different types of band ratios and vegetation indices in order to identify and interprets information from the acquired multi-spectral images. The spectral signatures of the study area capture the characteristic features of land-cover conditions and biotic activity through spectral absorptive properties of features. Vegetation dynamics represented by long-term data series act as a quantitative indicator of vegetation response to both climate and human activities during the period of study.

Classification scheme

This was used to distinguish different features on the landscape such as forests, lakes, build-up areas, farmlands etc. To categorize the image features (pixels in the image) into cover types, training sites were identified and grouped into cover classes. Thus, a six class land cover types were identified and used in a supervised classification procedure. These features could then be identified and recognized by the map user (Congalton and Green, 1999). Specific area covered by the feature classes or cover types identified during the ground truthing were identified on the multi-spectral imageries and their spectral characteristics were then used to train and assign each pixel in the image to one of the classes. The identification of spectral characteristics was done through sampling, which is the assignment of class names to group of pixels, which have similar spectral values to those classes that have been identified on the ground. According to Akinola *et al*. (2012), the only limitation of image classification is that, if classes do not have distinct clusters in the feature space it does not give reliable results.

Change detection

This allowed identification of difference in the state of the forest reserve. Change that occurred in the study area for the study period of 1987-2015 (28 years) were analyzed by crossing the classified landsat TM 1987 image with the classified landsat ETM+ 2000 image through the OPERATION/RASTER/PROCESSING/CROSS/SHOW subroutine. The same procedure applied on the remaining classified Nigeriasat-1 2010 and Spot5 2015 images. Direct comparison of land use statistic was carried out highlighting the extent and rate of land use changes over the period of study. The results were presented essentially by maps and graphs that have been analyzed to explain the rate and extent of deforestation and implications associated with it. The basis of using remote sensing data for change detection was that, changes in land-cover result in changes in radiance value which can ultimately be remotely sensed. The total forest loss was calculated by using the intervals of 1987-2000, 2000-2010, 2010-2015 and for the total period of 1987-2015.

Future scenario

The future scenario made in this research stretch from 2016-2056 and consists of forest area calculations. The calculation was doned with an assumption that, the annual deforestation rate in the area will be fixed during the time period. The overall annual deforestation rate calculated for the intervals of 1987-2015 was used to create the future scenario.

Results and discussion

With respect to the land-use land-cover of the study area, figure 2 shows the land-use land-cover extent for the study period (1987-2015) with a view to understanding the changes in Girei forest Reserve during the period.

The results show that in 1987, forested areas occupied the highest expanse of land in Girei Forest Reserve with 33.89% (177.03 km^2) of the land mass, shrubs and farm lands occupied 23.83% (124.45 km^2), while built-up environment took only 0.64% of the study area with 3.33 km^2 as shown in Figures 2 and 3.

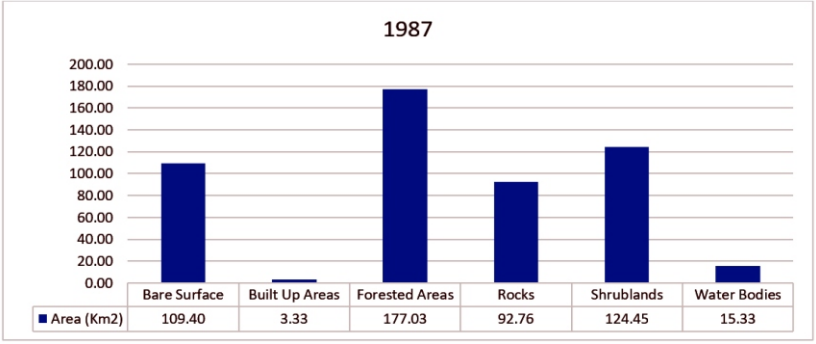

Figure 2: LULC of the study area in 1987

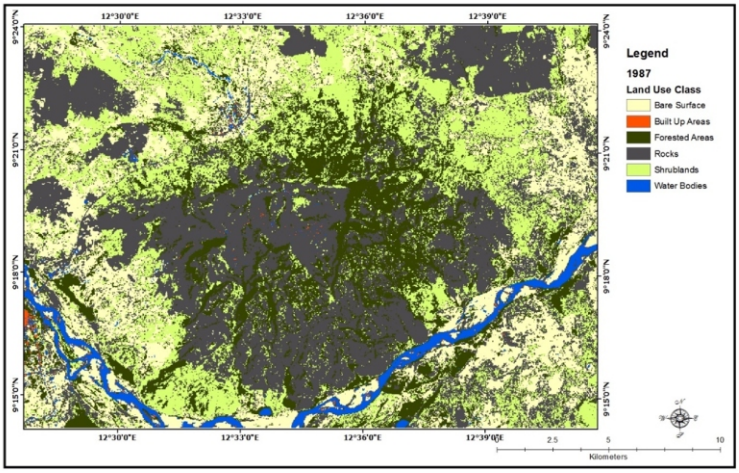

Figure 3: Land use classification of the study area in 1987

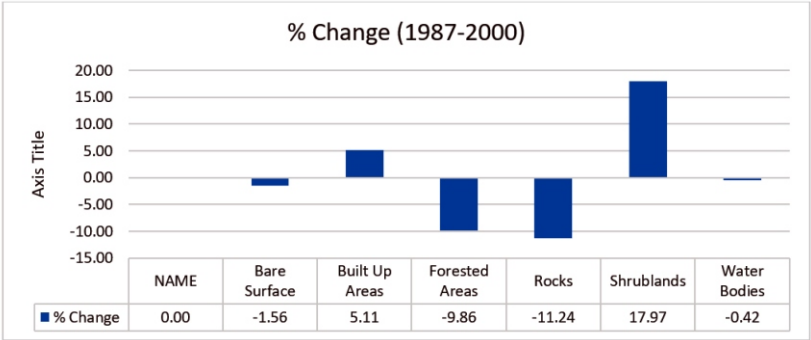

Figure 4: Changes in LULC of the study area between 1987 and 2000

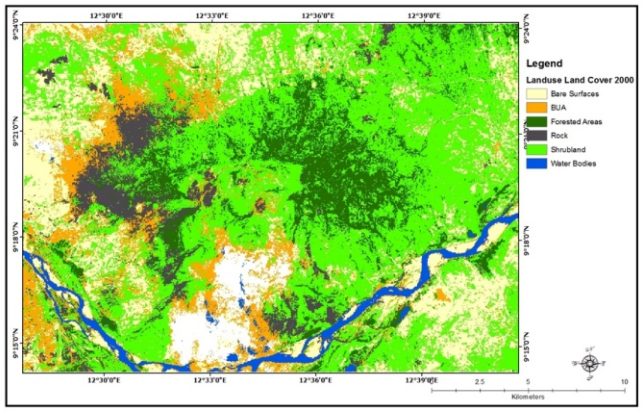

Figure 5: Land-use classification of the study area in 2000

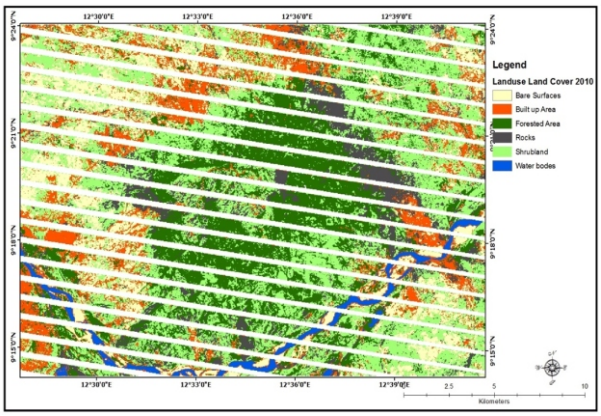

Figure 6: Changes in LULC of the study area from 2000 to 2010

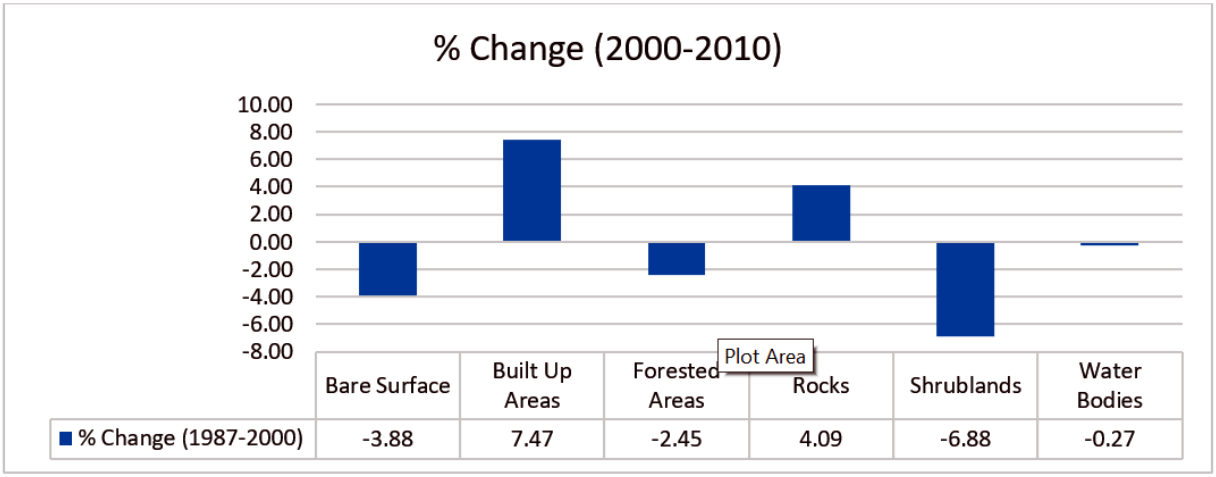

Figure 7: Land-use classification of the study area in 2010

As at year 2000, the forested areas has reduced to 125.53km^2, a reduction of -23.83%, while Built up areas has increased with 10.86% to 30.03km^2, Farmlands increased with 19.9% while bare surfaces and water bodies had very slight increases and decreases respectively as indicated in Fig 4.

This implies that conversion of forested areas to farmlands and built-up areas became prevalent during this period with the noticeable rise in built-up areas by 10%. Between 1987 and 2000, the conversion of forested areas to residences and in some cases farmlands is evident by the 19.9% increase recorded within the period under review.

Between year 2000 and 2010, forested areas declined further by -2.45%, while built-up areas picked up by 7.47%, bare surface reduced by -3.88%, and shrub lands reduced by -6.88% (Figure 6). This indicated that the trend of deforestation has continued in the area due to more clearance of forested land for residential areas to meet the pressing demand of more houses for the growing population. This is in line with David (2004) study where he discovered that demographic processes are among the essential drivers of frontiers deforestation. He concluded that population dynamics are but one of several sets of factors determining human impacts on the environment.

Forested areas continued its declining trend by giving way for urban expansion and farm lands, such as Asmau Farm Limited, Andabe Farm Nigeria Limited, Jibirojo Farm Limited, Jibiro Farms Limited and Bakari Agroallied Farm Limited were established. Figures 5 and 6 show the land use land cover extent of the study area in 2000 and 2010 respectively while Figure 6 shows a chart depicting the change.

Between 2010 and 2015, forested area continued its downward trend with a decline of -7.04% in five years, the spate of increase in built-up areas and bare surfaces had small decreases in the region by -0.95 and -0.63 respectively. Shrub lands and farmland were the highest gainers with a high of 13.12% within the five years.

This implies that while the spates of erecting buildings are reduced, the number of farms has increased. The continuous decline of this forestry however is of major concern especially in this era of climate change and its adverse effects of which deforestation is a major contributor. Figure 8 shows the land-use land-cover of the study area in 2015 while Figure 9 depicted the changes that occurred. This is in harmony with Akinola et al (2012), where they identified five land use practices that are heavily depleting forest reserve; these are built-up area i.e. settlement, farmland, fuel wood gathering, farming and logging.

Changes in Forest Estate

An assessment of the changes in forest extent from 1987 shows that forest reserve in the study area has been on decline and this is due in part to the extent of urban expansion as well as increase in farming activities during the period.

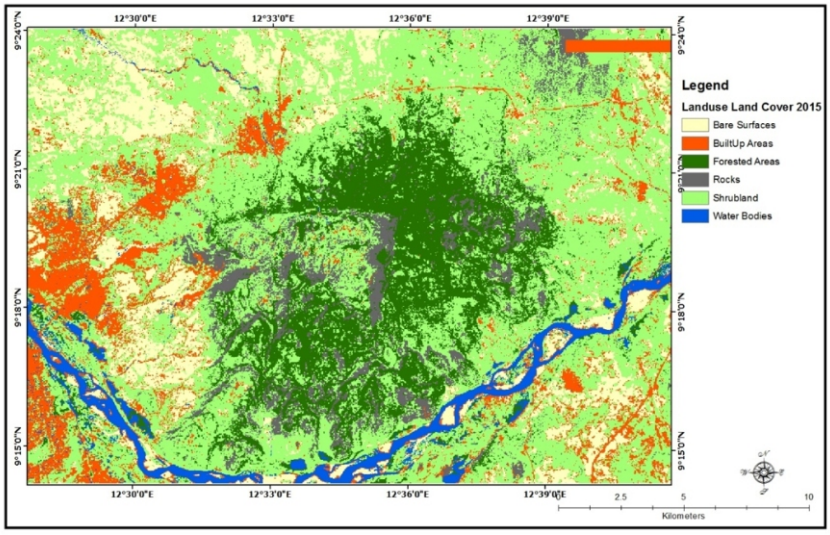

Figure 8: Land-use classification of the study area in 2015

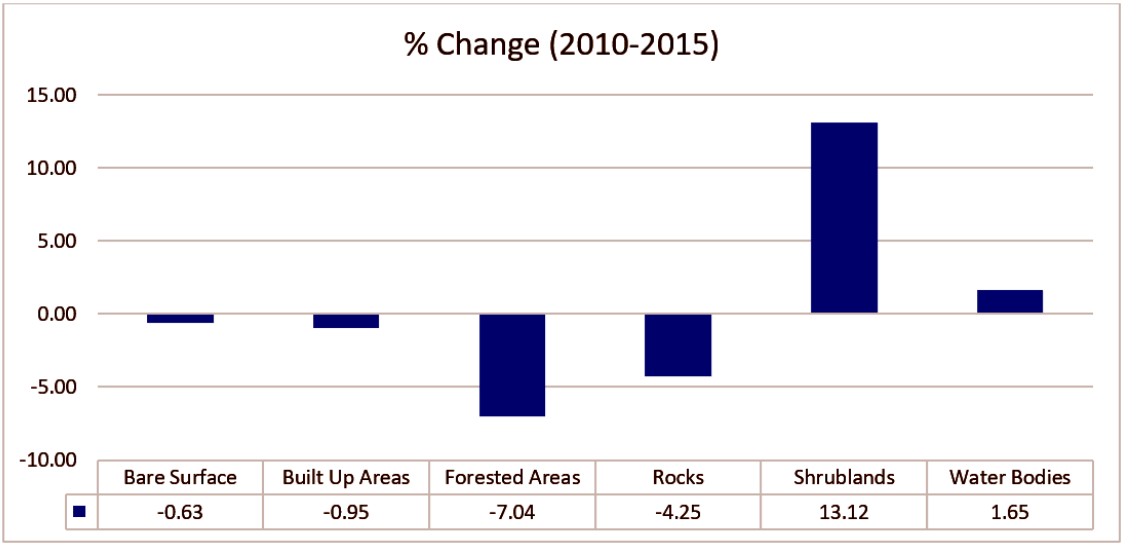

Figure 9: Changes in LULC of the study area between 2010 and 2015

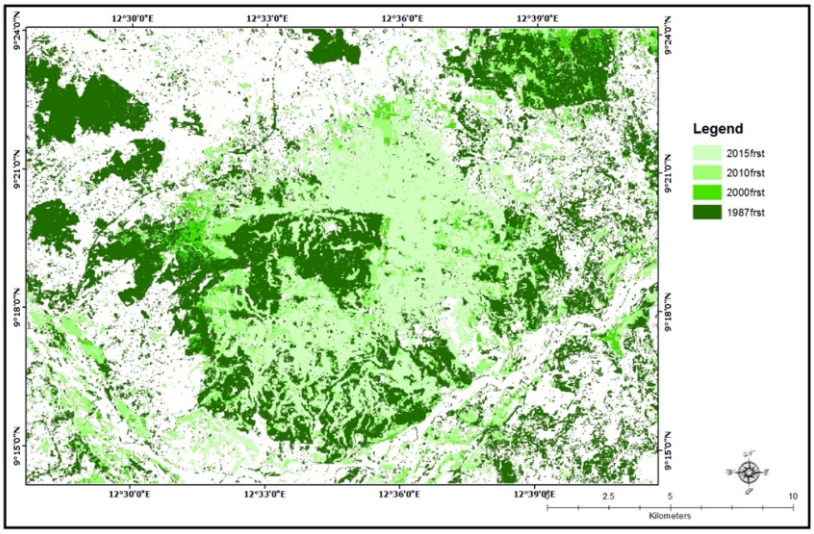

Figure 10: Overlay of Forested Areas of the study area between 1987 and 2015

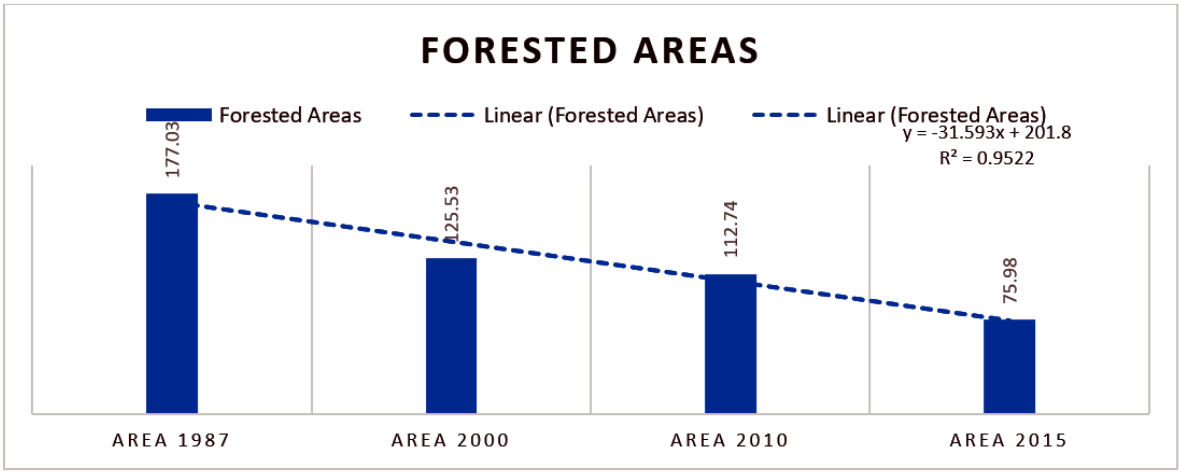

Figure 11: Changes in forested areas of the study area from 1987 to 2015

Table 1: Annual deforestation rates and forest loss between 1987 and 2015.

Deforestation			
Year	**Rate (%)**	**Annual Forest Loss (ha)**	**Forest Loss in total (ha)**
1987-2000	-9.86	51.50	669.50
2000-2010	-2.45	12.79	127.90
2010-2015	-7.04	36.76	183.80
1987-2015	-6.45	33.68	981.20

The forest estate lost 101.05 km^2 of its extend during the 28 year period under review and Figure 10 shows the overlay of forest covers from 1987 to 2015.

The trend of decline was plotted and the trend line equation shows that the forest estate will continue its decline by about 32 square kilometers for every decade if the current rate of exploitation is not checked. The R Squared shows a 95% certainty that decline in forest estates will continue as shown in Figure 11.

During the time period from 1987 to 2015, the total forest loss was 981.20 hectares, which corresponds to a loss of 14 percent of the total forested area that existed in 1987. The overall annual forest loss for the same time period was 33.68 hectares. This corresponds to a mean annual deforestation rate of -6.45 percent. Between 1987 and 2000 the yearly deforestation rate was -9.86 percent and during this period 669.50 hectares of the former forest was cleared. Between 2000 and 2010 the yearly deforestation rate decreased to -2.45 percent. Hence, the processes of deforestation have slowed down in the area and picked up from 2010 to 2015 where deforestation rate reached -7.04 percent and a total of 183.80 hectares was cleared as indicated in Table 1.

Future scenario

The overall annual deforestation rate from 1987 to 2015 was calculated. This annual deforestation rate (-6.45%) was used to create the future scenario (by calculating the forested area in Girei forest reserve in a possible future). The future scenario stretches from 2016 until 2056 and is based on the fixed deforestation rate of -6.45 per percent Table 1. The annual loss of forest was calculated and the predicted forested areas are shown in Table 2 and by the middle of this century the forested area will consist of only 50.18 hectares compared to 177.03 hectares in 1987.

This means that the area will have lost 45 percent of its forests in the year 2056 compared to 1987 Table 1. Today there is approximately 75.98 hectares. Evidently, there is no existing sustainable forest management in the area. To stop this trend,

investments in forest conservation must be made. It should be mentioned that this is a simplified future scenario, where no other factor than the deforestation rate is taken into account.

Table 2: Predicted Forested Area from 2016 to 2056.

Year	Forested Areas (ha)
2016	75.98
2026	69.53
2036	63.08
2046	56.63
2056	50.18

Conclusion and recommendations

The main objective of this paper has been to assess the anthropogenic activities and their threat on Girei Forest Reserve of Adamawa State, Nigeria using remote sensing and GIS techniques. Based on the datasets obtained and analyzed, the study therefore concluded that

i. There is an alarming increase in the rate of deforestation in the study area 125.53km^2 per year (1987-2000). This loss in natural vegetation results to the increase in bare surface whereas increase in built-up areas and farm lands leads to decrease in vegetation.

ii. Fuel wood gathering and over-cultivation are the most causal factors of deforestation with total average of 45% and 35% respectively. Others are over-grazing, population growth and urbanization and bush burning.

iii. People should find other means of domestic energy other than fuel wood, which is the most popular source of energy in the area. For example, kerosene and gas should be used, as this will relieve the vegetal cover from indiscriminate removal.

iv. Unnecessary cutting down of trees should be stopped. Slash and burn system of farming should be stopped by the farmers, as this will render the lands useless whereby erosion of all types will set in and washed away soil nutrients. It is paramount to encourage vegetation conservation, sustainable use of vegetation resources and wildlife, as the well-being of the people is closely related to the quality of their environment.

v. Legislation: there is a need for stiffer laws concerning cutting down of trees to be made by the government; which should be enforced and the defaulters should be given stiffer penalties. This will go a long way in maintaining the vegetal resources in the area. Hence, there is a need to involve traditional rulers at the grass root level for the enforcement of the laws, as this would in turn mitigate indiscriminate falling of trees for various purposes in the study area.

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