International Journal of Geography and Geology
2017 Vol. 6, No. 6, pp. 123-130
ISSN(e): 2305-7041
ISSN(p): 2306-9872
DOI: 10.18488/journal.10.2017.66.123.130

THE IMPACT OF HUMAN ACTIVITIES ON THE NDIVANA FOREST RESERVES, KWAYA KUSAR LOCAL GOVERNMENT AREA, BORNO STATE, NIGERIA.

Anthony Dami[1+]
Balami Huali Daniel[2]
Garba, S.S[3]

[1,2]*Department of Geography, University of Maiduguri, Maiduguri, Nigeria*
[3]*Department of Civil and Water Resources Engineering, University of Maiduguri, Maiduguri, Nigeria*

(+ Corresponding author)

Article History
Received: 6 September 2016
Revised: 14 July 2017
Accepted: 31 July 2017
Published: 20 December 2017

Keywords
GIS
Remote sensing
Ndivana
Satellite imageries
Forest reserve
Landuse
Landcover.

ABSTRACT

The focus of this study is to assess the effects of human activities on the Ndivana forest Reserves in Borno State. The types of data collected for the study involves the satellite imageries of Landsat (MSS) 1976, 1986 (TM) and Enhanced Thematic Mapper plus (ETM+) 1999, 2005, 2009 and 2013 respectively, from Global Lat-sat Cover Facility (GLCF) on Earth Science data interface. The GIS software used for the analysis of the datasets include: ILWIS 3.3a to geo-reference and image classification while, ArcGIS 10.1 was used for area calculation and over lay operations. The study adopted six land use and land cover classification scheme (namely, agriculture, bare surface, shrub/grassland, swamp, settlement and wood land). The major findings reported that the land use and land cove change for the period of 37years showed an increase and declining trends. For example, it was observed that agriculture increases in 1986 and 2009 with 3.84km2(7.21%) and 3.86km2(7.23%) because of the increase in human population that engaged in farming activities in the area and decreases in 2013 with 1.40km2(2.61%) due to increase in bare surface. Settlement also increases sharply in 1999 with 7.81km (14.75%) and decreases to 4.17km (7.79%) in 2013 due to the problems of insecurity in the region as many communities relocated to a safer environment. The implication of this change on the forest ecosystem therefore, could lead to further environmental degradation and biodiversity lost in the area.

Contribution/Originality: This study contributes in the existing literatures and use geo-information techniques. It's one of the very few studies which investigated the effects of human activities in the reserve. The primary contribution revealed landuse/cover change in the area. It documents GIS application for management of the reserve.

1. INTRODUCTION

Forest Reserve is defined as a portion of state lands where commercial harvesting of wood is excluded in order to capture elements of biodiversity that can be missing from sustainable harvested sites. Small (patches) reserves will conserve sensitive, localized resources such as steep slopes fragile soil and habitat for certain rare species that benefit from intact forest canopies. Conservation refers to the protection of natural environment. It is an act of preventing the environment from being damaged or destroyed, in order to encourage the conservation of natural resources and biodiversity. On the other hand, degradation is the diminution of the biological productivity expected in a given forest. The sustainable use of biological resources and ecosystem is essential to the wellbeing of the members of the society. This has made the conservation of biodiversity essential for the survival of mankind.

Nigeria is rich in biodiversity with an array of fauna and flora. This includes about 20,000 species of insects, almost 1,000 species of birds, 247 species of mammals, 123 species of reptiles, about 1,000 species of fish and about 7,895 species of plants.

The Forest reserve in Kwaya-kusar Local Government area was established during the colonial period. The reserves were primarily established to conserve indigenous species of plants and wild animals and prevent them from extinction, as well as environmental conservation of water, soil, air, flora and fauna for effective and sustainable use. There is no evidence that communities adjacent to the reserve have customs that regulate the extraction of forest products. The growing population has led to the intensified use of forest to meet the rising demand for food, fuel wood, fodder, building materials, farmland, grazing land and other forest products. Consequently, the traditional state control and highly centralized forest management practice that restricted or denied access to the forest reserve by the Federal government had collapsed with increasing liberalization of land use and other infrastructural development. As a result of these problems, the state government enacted two edicts in 1986, (felling of trees control and burning of bush amendment), in order to protect forest reserve in the state. However, these edicts did not achieve the desired objectives, since the rate of forest depletion is still on the increase.

Planning for the intervention against the problems of forest depletion requires information on land use and socio-economic processes responsible for such encroachment Udo (1982) and Rechards (1986). In view of the current situation in Kwaya-kusar Local Government area, the preservation of forest reserves is imperative, hence there is need to highlight the diminishing present status and the extent at which forest reserves have been encroached. Some recent studies carried out on forest reserves in Borno and Yobe includes Dami *et al.* (2011) landuse and land cover change in Pelachiroma, Inuwa (2016) land use and land cover change in Hadejia-Nguru in Nigeria; however there was no similar work carried out in the Ndivana forest reserves. The aim of this study is to assess the effect of human activities on Ndivana forest reserve area of Borno State.

2. THE STUDY AREA

Ndivana forest reserve got its name from the river within the reserve known as river Ndivana which is the major source of water to the Biu dam. The forest reserve has a total land area of 94.9 km square (52miles square), and was gazette on 24th April 1959. The reserve shares boundary with the following villages: Kurbagayi, Safangayi now known as Sabon gari, Maiba, Kwaya- Tera, Gashina, Tawasu, Paman, Teli, Sangayari, Balbaya, Tondi, Kukal, and Kogu. Formerly, all these villages were under Kwaya-kusar Local government area, but currently with the creation of some Local Government Areas, most of the villages fell within Bayo Local government area of the state but share boundary with the reserve. The vegetation of the area can be described as orchard bush on the boundary of the Sudan Savanna grassland and northern Guinea Savanna vegetation of Nigeria (Ayuba, 2005). The Savanna vegetation covers most of the northern part and has a ground cover of grasses often dense and continuous with scattered trees. The grasses are coarse reaching heights of between 1.5 to 2.5 meters tall while some are shorter. The common tree species include Locust bean, Shea-butter, Palm trees found near big rivers, Acacia, Silk-cotton and Baobabs. Among the plants species that survived extinctions are: *pterocarpuserinaceus*, sterculiasetigera, (kuka), *adonsoniadigitata* (Dinya) *vitexdoniana* (Dargaza) *grewiamollis* (Gwandardaji) *Annonasenegalense*, (Magarya), *ziziphusmauritiana* (Taura) *detariumsenegalense* (Kadanya) *butyrospermumparkii* (Tsamiya), *tamarindusindica* (Aduwa) *balanitesaegyptiaca* (Dorowa) *parkiaclappertoniana*.

The annual rainfall of the area ranged between 600-1000 mm with marked two seasons: the wet and dry seasons. The wet season starts from April and ends by October. Rainfall remains very high from June to September. The area is characterized by moderate temperature ranging from 20°C to 36°C with an annual average of about 27°C, whereas, annual temperatures off the Biu plateau are slightly higher. Topographically, the dominant physical features of this region are the Biu Plateau and Plains. The plateau stands at 760 meters above sea level. The plateau

has scarp faces all round it which slope off gradually to the north while the southern part has steep precipitous escarpments.

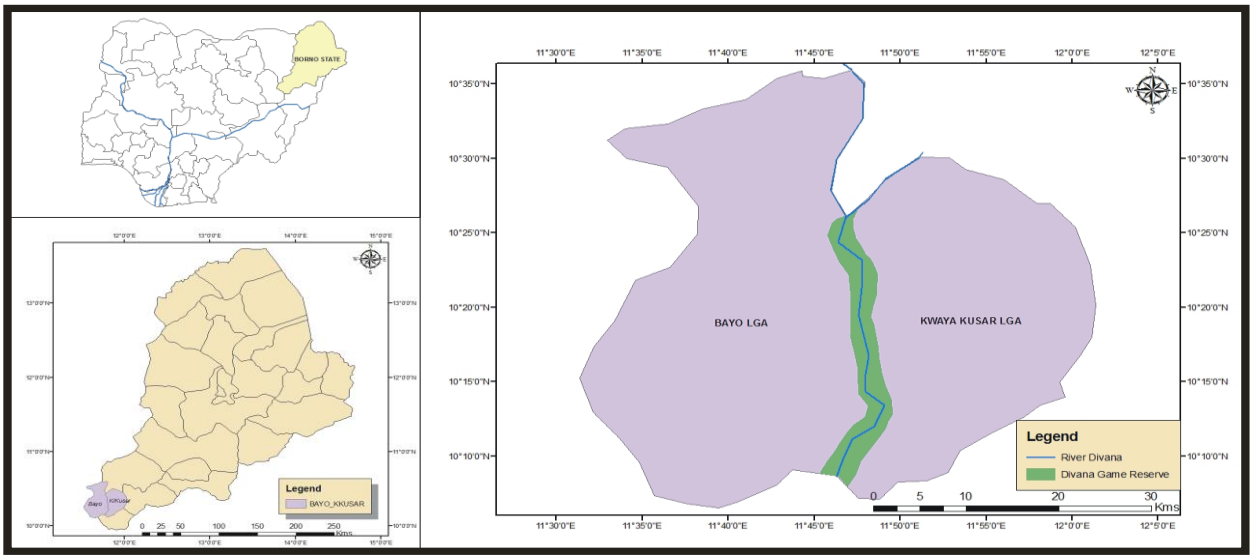

Figure-1. The study area

Sources: Inuwa (2016)

3. METHODOLOGY

3.1. Sources of data

The secondary data (spatial data) source was obtained through the use of satellite imagery of Ndivana forest reserve, Landsat (TM 1976, 1986, and ETM+ (1999, 2005, 2009, and 2013) and topographical maps of Nigeria (1: 250,000). This satellite data was analyzed to detect the land use and land cover changes of Ndivana forest reserve for the period of 37 years. The software used for the processing of this datasets include ILWIS 3.3a, IDRISI and ArcGIS 10.1

3.2. Data Analysis

The Arc GIS 10.1 and ILWIS 3.3a software was used to perform the georeference; submap the image of the study area and also classify the images using the six different land use/cover classification scheme (agriculture, settlement, bare surface, swamp, shrub/grasses and woodland). The classified images was then exported to IDRISI Andes, to perform overlay operation in order to identify the areas that were stable or have changed from one land use or land cover types to another. The area coverage of each of the classes in the overlain images was also automatically calculated using the area calculation modules of IDRISI software.

3.3. Detection of Changes in Land Use and Land Cover from the Satellite Images

When images are classified into land use and land cover classes, each of the classes represents features with distinctive boundaries in such a way that the area coverage of each feature can be calculated in order to determine the land cover changes using change detection by area calculation method through which changes in land use and land cover can be extracted from the images.

3.4. Changes Detection by Area Calculation

Change detection by area calculation is used to identify amount of changes in a specific units, magnitude of changes and annual rate of changes. The three major steps involved in calculating changes detection by area calculation are: -

i). The magnitude of change of a LULC is calculated by subtracting the size of LULC in a particular from its previous size.

ii). The calculation of trends, that is percentage change of each of the land use and land cover obtained by subtracting the percentage change of previous land use from current land use divided by the total magnitude of land use and multiplied by (100) hundred. This can be represented in a mathematical form by assigning variables as follows let the percentages of previous land use be assigned variable A, while current land use be assigned the variable B and total magnitude was assigned the variable TM. This can therefore be represented mathematically as B-A/TM x 100.

iii). The calculation of annual rate of change was achieved by dividing the percentage by 100 and multiplied by the number of study period or years, that is the difference between two periods of study (1976-1986) which is 14 years change detection by nature.

4. The trends of land use and land cover change of Ndivana forest reserve

The Table 4.1 shows the trend of land use and land cover change in Ndivana forest reserve from 1976-2013. The variables such as agriculture, bare surface, settlement, shrub/grassland, swamp and woodland are shown for the period between1976-2013. The table 1 reveals that all the six land use and land covers types for Ndivana forest reserve, had undergone changes from one form to another. The landuse and cover types play a major role in the functioning of the reserve, and changes in them have a major impact. The reserve was known to be a thicker forest with shrubs/grassland which covers 17.70km² in 1976 with 33.21% have decrease to 9.75km² in 1986 with 18.30%, these could be associated to sahelian drought of 1983 Ozah *et al.* (2012) reported that drought has more negative effect on reserves than human activities. However, shrubs had also progressively increased to 20.45% in 1999 (29.70%) in 2005 but decreased in 2013 with 18.89% due to over-grazing, climate change and/or lost to other land cover types. There was a uniform trend of woodland from 1976, 1999 with 21.62% and 2005 with 21.73% and 22.72% in 2009. Woodland increased sharply with 36.16% in 1986 despite the drought of the 1980's, due to the influence of the river (Ndivana) located within the reserve while in 2013 was 33.77%.

Bare surface was 4.33km² (8.12%) in 1976, in 1986 was 10.70% gained from agriculture which became fallow and later decreases and lost to settlement, that is areas that were bare surface became settlement with 3.71km² (7.01%) in 1999, while in 2005 it increased to 11.54% as gain from settlement, swamp, and agriculture and in 2009 was 15.41km² with 28.56% which gained from shrub, settlement and swamp. In 2013 was 27.42% gained from agriculture, swamp, woodland, grassland landuse and land cover type.

Table-1. Trends of land use and land cover types in Ndivana forest reserve

Landuse and land cover	1976	1986	1999	2005	2009	2013
Agriculture	3.56 6.68%	3.84 7.21%	3.43 6.48%	3.69 6.92%	3.86 7.23%	1.40 2.61%
Bare surface	4.33 8.12%	5.70 10.70%	3.71 7.01%	6.15 11.54%	15.41 28.86%	14.68 27.42%
Settlement	2.98 5.59%	2.51 4.71%	7.81 14.75%	4.87 9.14%	2.74 5.13%	4.17 7.79%
Shrub/ Grassland	17.70 33.21%	9.75 18.30%	10.83 20.45%	15.83 29.70%	13.62 25.51%	10.11 18.89%
Swamp	13.20 24.77%	12.22 22.93%	15.72 29.69%	11.18 20.98%	5.63 10.54%	5.09 9.51%
Woodland	11.52 21.62%	19.27 36.16%	11.45 21.62%	11.58 21.73%	12.13 22.72%	18.08 33.77%
Total	53.29 100%	53.29 100%	52.95 100%	53.3 100%	53.39 100%	53.53 100%

Source: Balami (2015)

Figure 1 showed more swampland in 1976 with 24.77%, and in 1986 it decreases to 13.20km² with 22.93% as precipitation also decline in the area, while in 1999 indicates a sharp increase of 15.72km² with 29.69%, as there were an increases in rainfall, it gained from bare surface, woodland and grassland. In 2009-2013 indicated a sharp contrast as it decreases to 5.63km²at 10.54% and 5.09km² at 9.51% (table 1). The trend of land use and land cover pattern of change in the area from 1976 to 2013 has been described in the classified images (figure 1-6). It indicated an increase in swamp and shrubs settlement while the other landuse and cover types such as bare surface, agriculture decreases.

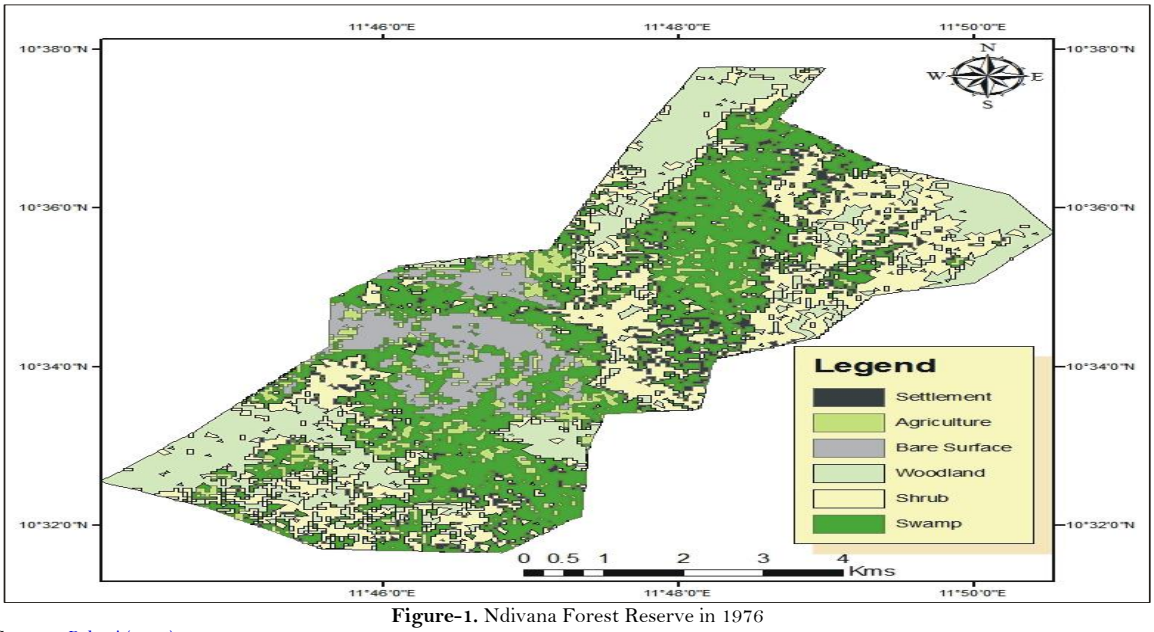

Figure-1. Ndivana Forest Reserve in 1976

Sources: Balami (2015)

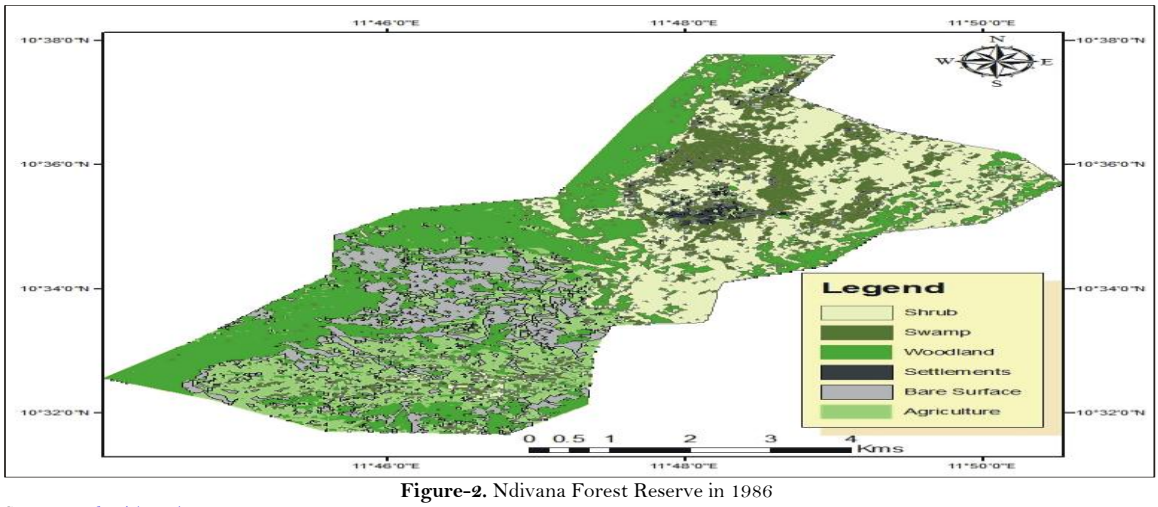

Figure-2. Ndivana Forest Reserve in 1986

Sources: Balami (2015)

Figure 2 1986 shows more of agricultural activities in the reserve due to increased scattered settlement, bare surface increases as swamp, woodland and shrubs decreases due to influence of drought and other land use. From the table1, it can be described that the land area used for agricultural activities increased from 3.56km² in 1976 to 3.84km². In 1986 it decreases to 3.43km² in 2005 to 3.86km² in 2009 and decreases drastically to 1.40km² in 2013 this could be associated with the mass exodus of people moving away from the reserve due to the activities of insurgence in the area (field report). Bare surface decreases only in 1999 with 3.71km² but had a steady trends from 4.33km² in 1976, 1986 (5.70km²) 6.15km² in 2005 with a sharp increase in 2009 to 15.41km² and decreases slightly with 14.68 in 2013.

Settlement in 1999 has increases sharply with 7.81km² shrub/grassland have no steady trends in 1976, (17.70km²) of shrub/grassland and decreases to 9.75km² in 1986, due to the increase in agricultural activities, while swamp in 1999 was 15.72km² and decreases sharply in 2009 and 2013 with 5.63km² and 5.09km² respectively. Wood land increases to 19.22km² in 1986 and 18.08km² in 2013.

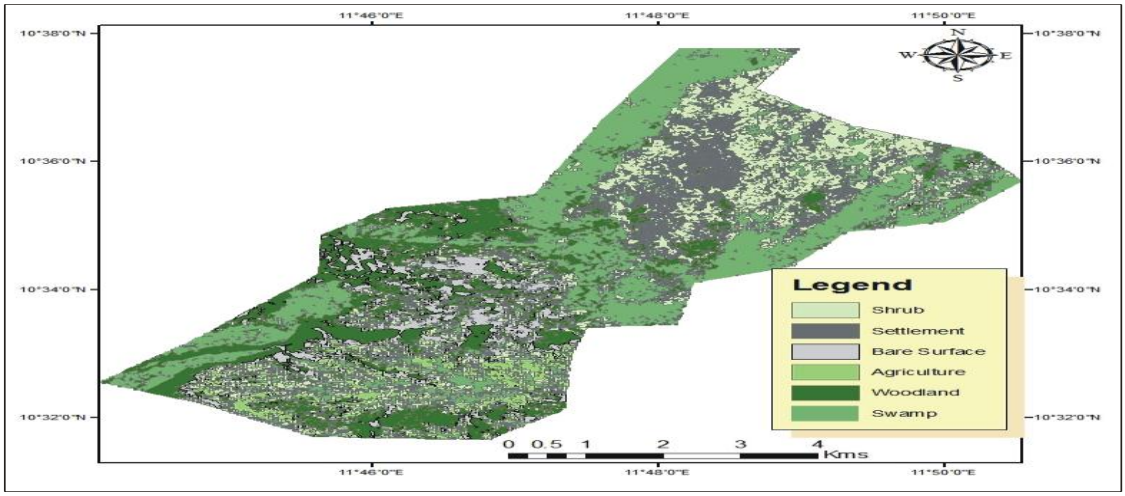

Figure-3. Ndivana Forest Reserve in 1996

Sources: Balami (2015)

Figure 3 shows the changes in land use patterns in 1999, the satellite imagery showed a sharp increase in settlement which suggests possible population increase as observed in the previous years. This posed more pressure on the fragile woodland and shrubs in the area due to increase in deforestation, over-grazing as well as decrease in swampland to increase in bare surfaces while settlement increases could lead to agricultural increase due to over cultivation, as similar trend was also observed in the Lake Chad basin by Ozah *et al.* (2012) and Dami *et al.* (2011).

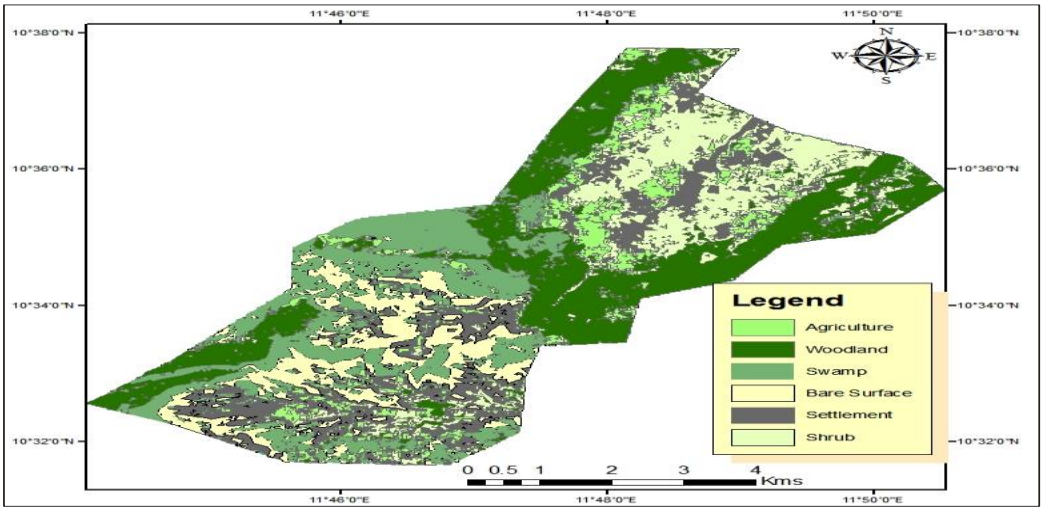

Figure-4. Ndivana Forest Reserve in 2005

Sources: Balami (2015)

Figure 4 described the land use patterns in 2005 which revealed that forest cover are decreasing due to the increase in human settlement (population) that is, woodland decreases through deforestation, while bare surface increases because of the change in other land use/cover type in the area. It was observed that agricultural activities are the key sources of livelihood of the people in the reserve which on the other hand served as one of the major drivers of land use and land cover changes in the region (Inuwa, 2016). Similar examples was also observed in the South Western Nigeria by Adeoye and Dami (2012) stating that farming is the major occupation and land use type

in the forest wetland areas. From the report, Agriculture covers 3.56km² with 6.68% in 1976, and in 2009 it increases to 3.86km² with 7.23%. These increase was believed to be associated to the increase in human population in the area which led to demand for more food and shelters as reported from the field that the population increase in the forest and its surrounding environment are causing more pressure on the forest products and unfortunately, there has been no efforts to replace the destroyed forest cover or to curtail this menace in the region. A similar trend was also observed by Dami *et al.* (2014) in Lake basin of Nigeria.

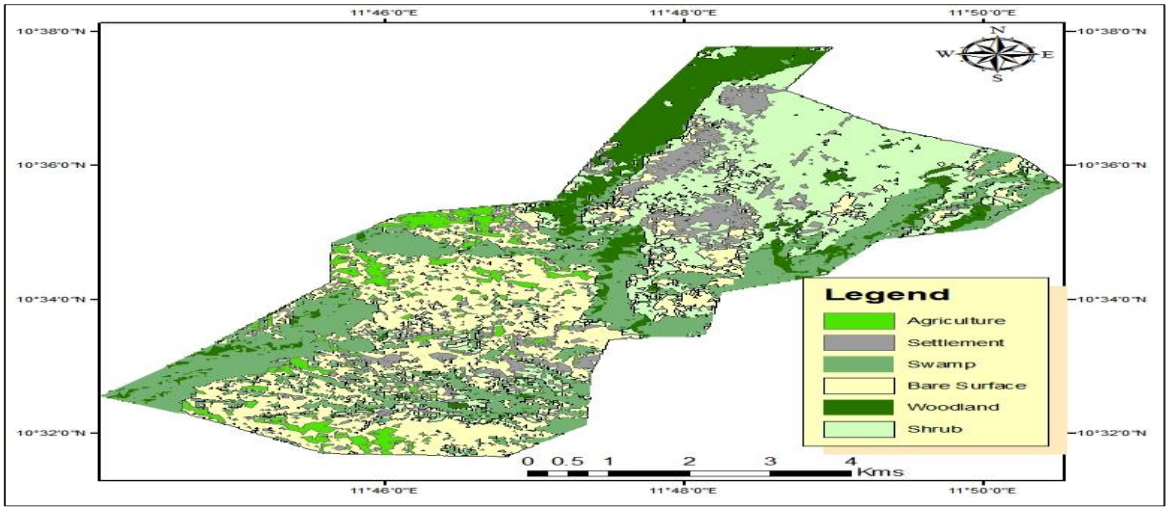

Figure-5. Ndivana Forest Reserve in 2009

Source: Balami (2015)

Figure 5 described similar declining trends in the woodland with increase in settlement causing over-exploitation of the limited and fragile resources through overgrazing and deforestation.

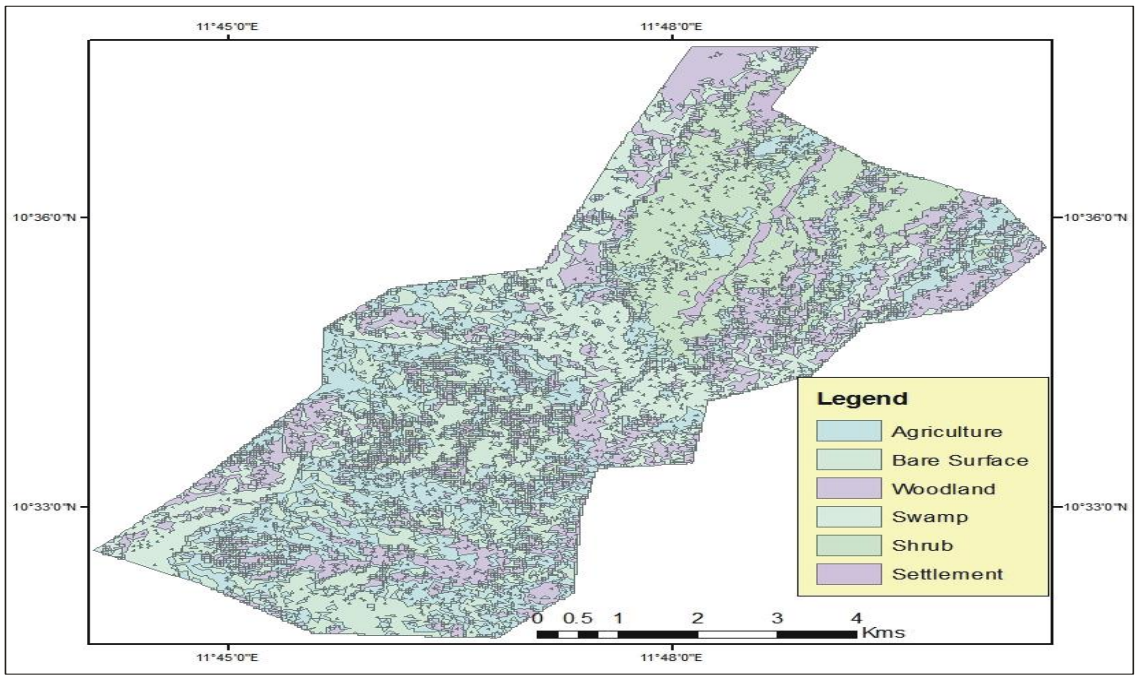

Figure-6. Ndivana Forest Reserve in 2013

Source: Balami (2015)

Figure 6 indicated a major increase in woodland with 10.41km² of the reserve area, settlement gained 4.02km² more than the previous years (2005-2009) while the major land use and land cover type that lost to other land use and land cover types was 2.02km² to 1.78km² for bare surface in the same period. Settlement has not shown

significant change from that of the previous period which was 2.72km² and this period was 4.02km² (table 1). There was a decrease in agriculture with 1.32km² over the previous period with 3.81km² due to the problems of insecurity in the area which made the inhabitants to flee to other safer environment.

5. CONCLUSION

In summary, it has been observed that the role of the anthropogenetic activities in the forest reserve has direct impacts on the local and global ecosystems particularly in the Ndivana forest reserve of the semi-arid region of Nigeria. The application of the remote sensing and GIS techniques has clearly demonstrated its capability in assessing the dynamics of the land use and land cover types in the area. The People of the area depend largely on the forest resources for their livelihood (agriculture, hunting, fishing, wood harvesting and grazing). The major findings revealed that the land use and land cove change from 1976-2013 had shown an increase and declining trend. For example, it was observed that agriculture increases in 1986 and 2009 with 3.84km²(7.21%) and 3.86km²(7.23%) because of the increase in human population that engaged in more farming activities in the area and decreases in 2013 with 1.40km²(2.61%) due to increase in bare surface. Settlement increases sharply in 1999 with 7.81km (14.75%) and decreases to 4.17km (7.79%) in 2013 due to the problem of insecurity in the area as many communities relocated to a safer environment. The implication of this change on the forest reserve therefore, could lead to further environmental degradation and biodiversity lost in the area.

Funding: This study received no specific financial support.
Competing Interests: The authors declare that they have no competing interests.
Contributors/Acknowledgement: All authors contributed equally to the conception and design of the study.

REFERENCES

Adeoye, N.O. and A. Dami, 2012. A geospatial analysis of wetland cultivated areas in Ile-Ife, Osun state, Nigeria. Journal of Earth Science and Engineering, 2(2): 97-104. *View at Google Scholar*

Ayuba, H.K., 2005. Environmental science, An Introductory Text. ApaniPublication; A division of Apani business and research consult No.27 Bagaruwa, Road, Costain Kaduna. Nigeria: 1-58.

Balami, H.D., 2015. An assessment of human activities on the Ndivana forest reserves of Kwaya Kusar local government Area, Borno State, Nigeria. M. Sc. Thesis (Unpublished) Department of Geography, Unimaid.

Dami, A., F.A. Adesina and S.S. Garba, 2011. Land use changes in the adjoining rural land of Maiduguri between 1961- 2002: Trend and implication in environmental management in Borno State, Nigeria. Journal of Environmental Issues and Agriculture in Developing Countries, 3(2): 159-168. *View at Google Scholar*

Dami, A., J.O. Odihi and H.K. Ayuba, 2014. Assessment of land use and land cover change in Kwale, Ndokwa-East local government Area, Delta State, Nigeria. Global Journal of Human Social Sciences B, 14(6): 17-23. *View at Google Scholar*

Inuwa, K.B., 2016. Assessment of landuse and landcover change in Nguru Part of Hadejia-Nguru Wetlands, Yobe State, Nigeria. M.Sc Thesis, Department of Geography, Unimaid, Nigeria. pp: 1-98.

Ozah, A.P., A. Dami and F.A. Adesina, 2012. A deterministic cellular automata model for simulating rural land use dynamics: A case study of Lake Chad Basin. Journal of Earth Science and Engineering, 2(1): 22-34. *View at Google Scholar*

Rechards, J.A., 1986. Remote sensing digital analysis: An introduction. Berlin: Springer-Verlag.

Udo, R.K., 1982. Geographical Regions of Nigeria. Ibadan: Heinemann.