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Assessment of Differential Rate of Deforestation in Reserved Forest and Adjacent Parkland: A Case Study of Mokwa Local Government in Southern Guinea Savanna Area of Niger State, Nigeria

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Abstract: *The loss of tropical forest in many countries means the collapse of major carbon sinks and generation of more carbon dioxide which is serious threat to global climate and atmospheric temperature distribution. The process of deforestation may result in many negative effects with mix implications, but long-term environmental consequences such as global warming, biodiversity loss and soil degradation are often identified. There is an establish relationship between deforestation and global warming because forests, notably tropical forests are major carbon sinks. In view of the foregoing, on-field assessment was undertaken to determine differential rate of deforestation in forest reserve and adjacent parkland in Mokwa LGA of Niger state. Satellite imagery were used to show the extent of forest reserves and adjacent parkland. Descriptive survey design and Geo-information techniques were adopted for the study, and it cover changes between 1985 and 2017 of which 1985, 2000 and 2017 serve as specific date for imagery acquisition. Imageries are the main instrument used, and data were analyse using descriptive statistics. The findings revealed that between 1985 and 2017, various changes in forest cover loss occurred in forest reserve (88.2% to 44.8%) and adjacent parkland vegetation (43.4% to 32.3%), although net loss across years tends to be more in forest reserve area. However, during the same period, there was an increase in non-forested land in forest reserve (11.8% to 55.2%) and in adjacent park land (56.6% to 67.7%) respectively. The results also revealed that rate of deforestation in forest reserve area between 1985 and 2017 increased by 60.70ha/year at the rate of 11.6% as against 16.1ha/year at the rate of 0.6% for the same period in adjacent Parkland. It is recommended that there is needs for rural advocacy to educate farmers and create awareness on the negative consequences of deforestation. Also, local people should be encouraged to practice agroforestry, and be actively involved in institutional participation in forestry management and conservation.*

Keywords: *Forest, Parkland, Geo-information, Imageries, Southern Guinea savanna*

1. INTRODUCTION

The loss of tropical forests in many countries means the collapse of major carbon sinks and generation of more carbon dioxide, a serious threat to global climate and atmospheric temperature distribution. The process of deforestation may result in many negative effects of varied and mixed implications but the long-term environmental consequences such as global warming, biodiversity loss and soil degradation are often identified (Mahapatra and Kant 2005). On part of global warming, it is noted that deforestation and forest degradation in developing countries account for about 18% to 20% of increased emission of greenhouse gases (GHGs) that are responsible for global warming and climate change (Owusu *et al.*, 2011; TEEB, 2010; Insaidoo *et al.*, 2012). There is a relationship between deforestation and global warming because forests, notably tropical forests are major carbon sinks (Gorte and Sheikh 2010). The relationship between the soil beneath selva and vegetation that soil support is so close that there exists a nearly perfect ecological balance between the two, threatened only by people's efforts to earn a living from soil (Gabler *et al.*, 2007). It is thus realized that forest vegetation and biodiversity have become indispensable in soil nutrients maintenance. This is because when the leaves, flowers and branches fall to the ground or the roots die, the numerous soil-dwelling animals and bacteria act on them,

transforming the forest litter into organic matter, which is a reliable supply of soil fertility (Gabler *et al.*, 2007).

Deforestation is the loss or continual degradation of forest habitat due to either natural or human related causes. Agriculture, urban sprawl, unsustainable forestry practices, mining, and petroleum exploration all contributed to human induced deforestation. Natural deforestation and forest degradation can be linked to tsunamis, forest fires, volcanic eruptions, glaciation and desertification (Lanly, 2003). Characterizing deforestation at a given time and place involve as a rule, determining with some certainty what more or less long-term future of deforested area will be (Lanly, 2003). Estimates of forest losses in Africa and Nigeria were observed to be higher (Okonkwo *et al*., 2002; FAO, 2003). For instance, between 1990 and 2000, Africa continent lost about 52million hectares of the forest, accounting for about 56% of the global reduction of forest cover (FAO, 2001). For the period 2000 – 2005, a net loss of about 4 million hectares was reported (FAO, 2007). There is considerable variation of forest cover loss among countries in Africa. For example, three countries in Africa namely Sudan, Zambia and DR Congo alone accounted for almost 44% of forest cover loss, while the entire West Africa, North Africa and East Africa accounted for (43%, 7.2% and 20.8%) forest cover loss respectively. The impact of deforestation on soils, and the release of soil carbon, depends on the magnitude of soil disturbance and the type of soil, and this may be critical, (Gorte and Sheikh 2010). It has also been highlighted that soil erosion is one of the degrading processes likely to arise due to increased deforestation (Karkee, 2004). Its impact cannot be underestimated because it is believed to affect approximately one-third of topsoil and soil nutrients needed to support crops and vegetation growth (Keller, 2005). Deforestation brings about ecological and socio economic problems, which may include wood shortage, food shortage, flooding, erosion, destruction of wildlife habitats and increased poverty, especially in rural areas. All these bring the need for sustainable forest management, which is the maintenance of environmental integrity to meet the present, and leaving enough in quantity and quality to satisfy the needs of the future generation (Gorte and Sheikh 2010). A point of view from this issue is that, anthropogenic induced deforestation contributes to environmental change. For instance, for people to satisfy their wants, interaction occurs between them and their environment. However, without consistent advancement in ensuring sustainable resource management a severe damage will result, and consequences may lead to deforestation and environmental uncertainty (Jimoh, 2001; Fiset, 2008). Besides, man is agent of change and a victim of that change, a builder as well as a destroyer (Olofin, 2008). Since forest play a role in preserving biodiversity of ecosystems and are socio-economically important to mankind, resources cannot just be extracted indiscriminately to ensure environmental sustainability. Rather, certain precautionary measures have to be put in place to regulate human interference. Governments have already designated forest areas permanently for protection of timber and other resources, where harvesting of timber and extraction of other forest resources may be allow under permit or concession to people in surrounding communities. Regardless of this, deforestation is a common phenomenon in forest reserve and adjacent parkland in Nigeria. This study was undertaken due to environmental deforestation from indiscriminate cutting of tree in both reserve forest and adjacent parkland of Mokwa local government area of Niger State. Because of drastic decline in biodiversity and ecological resources of the area which poses environmental challenges and socio-economic problems, there is need to determine the differential rate of deforestation in forest reserve and adjacent parkland.

2. MATERIAL AND METHODS

2.1. Study Area

The study covers vegetation of both reserved forest and adjacent park land in Mokwa Local Government Area (Longitudes 4º37' to 5º31' E and Latitudes 8º57' to 9º36' N). Mokwa Local Government Area (LGA) is one of the 25 LGAs in Niger State, with headquarters at Mokwa town. It shares boundaries with other local government areas; Mashegu to the North, Lavun to the East, Edati to South East and Borgu to the West. The long southern border of is form by River Niger from Jebba Lake in the west beyond the confluence of the Kaduna River in the east with Kwara and Kogi States across the Niger from the LGA respectively (Figure 1). The content of the study covers differential rate of deforestation in forest reserve and adjacent parkland, while the temporal vegetation covers changes between 1985 and 2017.

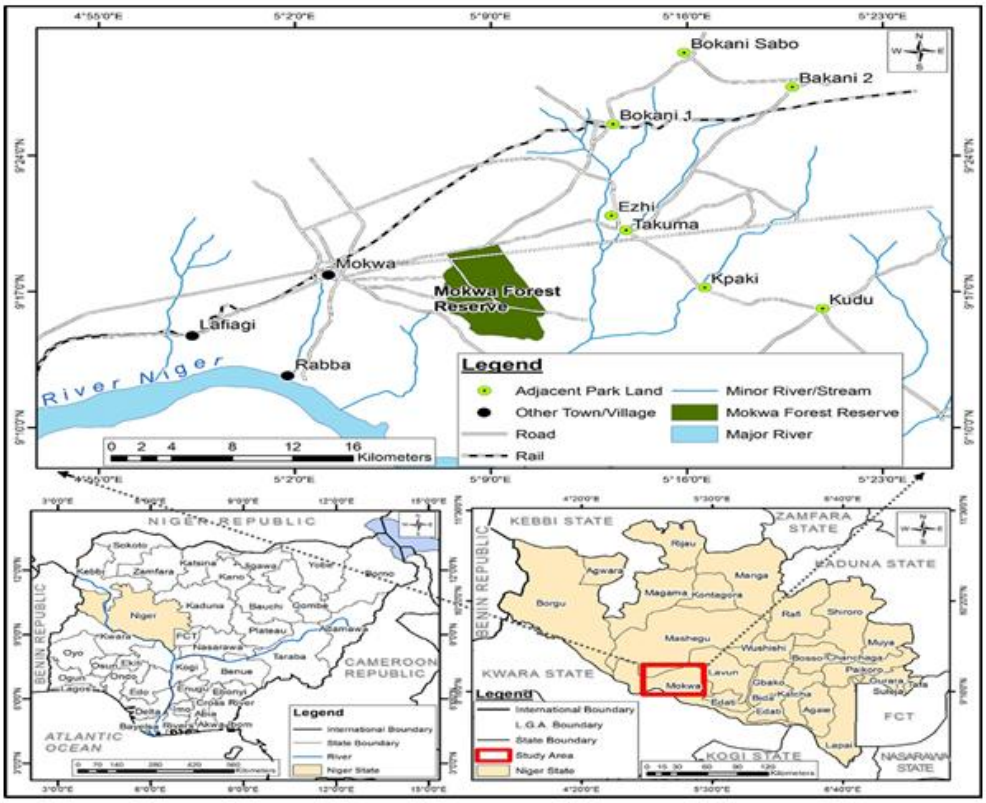

Figure1. *Map of Niger State showing the study area*

2.1.1. Reconnaissance Survey

Seven communities namely; Bokani 1, Bokani 2, Bokani Sabo, Ezhi, Takuma, Kpaki and Kudu around the forest reserve were identified for the purpose of generating primary data source through structured questionnaire.

2.2. Data Collection and Analysis

The study utilized data from both primary and secondary sources. The primary data was structured questionnaire used to obtain information from members of the communities and forest field officers on deforestation and environmental implication in reserve forest and adjacent parkland. While secondary data were obtained from review of literature, relevant books from forest reserve and Federal Ministry and State Ministry of Forestry, published and unpublished.

The data types utilized for this study includes:

- LandSat MSS (Multi-Spectral Scanner) of 9th January 1986 with spatial resolution of 79m.
- LandSat TM (Thematic Mapper) of 12th December, 1996 with spatial resolution of 30m.
- LandSat ETM+ (Thematic Mapper Plus) of 5th December, 2006 with spatial resolution of 30m.
- LandSat 8 of 19th October, 2015 with spatial resolution of 30m.
- Coordinates of sampled sites

2.2.1. Image Geo-Referencing

The satellite images (LandSat TM, LandSat 8 and ETM^{+} with spatial resolution of 30m respectively) were imported into Erdas Imagine 9.2 environment where they were rectified to a common projection (Universal Traverse Mercator). Geo-referencing which involves registering data to the real world was carried out by assigning geographic information like location and position to the images.

2.2.2. Image Classification

Supervised classification technique using maximum likelihood algorithm was used to classify images and sample sites or training pixels were selected based on spectral signatures of features in the image.

Land-use/land-cover types in the study area were classified into five (built-up land, agriculture land, vegetated land, barren/waste land and bare land) (Table 1)

Table1. *Classification scheme*

Code	Land-use/Land cover Categories	Description
1	Non-forested land	i. Lands used for residential and transport/communication purpose (i.e settlements and roads)
		ii. Lands used as crop land and agricultural plantations(i.e farm lands and orchards)
		iii. Lands occupied with strip mines, quarries, mine pits, mine waste and overburden.
		iv. Exposed soils, land devoid of vegetative cover.
2	Forested land	i. Lands cover with natural forest and natural vegetation(i.e predominantly grasses, shrubs and grass-like plants)

All data collected were subjected to statistical analysis using descriptive statistics and Geo-information technique.

3. Results and Discussion

3.1. Extent of Forest Cover in Forest Reserve and Adjacent Park Land in Mokwa, Mararaba and Bida across the Years

The extent of forest cover in the reserve forest and adjacent park land in the three year periods are shown in (table 2, fig 2, 3 and 4) below.

Table2. *Extent of forest cover in forest reserve and adjacent park land in Mokwa, Mararaba and Bida*

	Year					
	1985		2000		2017	
Area	Hectare	%	Hectare	%	Hectare	%
Forest Reserve						
Forest land	3943.8	88.2	2912.4	65.2	2001.5	44.8
Non-forest land	525.3	11.8	1556.7	34.8	2467.6	55.2
Total	4469.1	100	4469.1	100	4469.1	100
Adjacent Park Land						
Forest land	2011.2	43.4	1889.9	40.7	1606.2	32.3
Non-forest land	2627.6	56.6	2748.9	59.3	3032.6	67.7
Total	4638.8	100	4638.8	100	4638.8	100

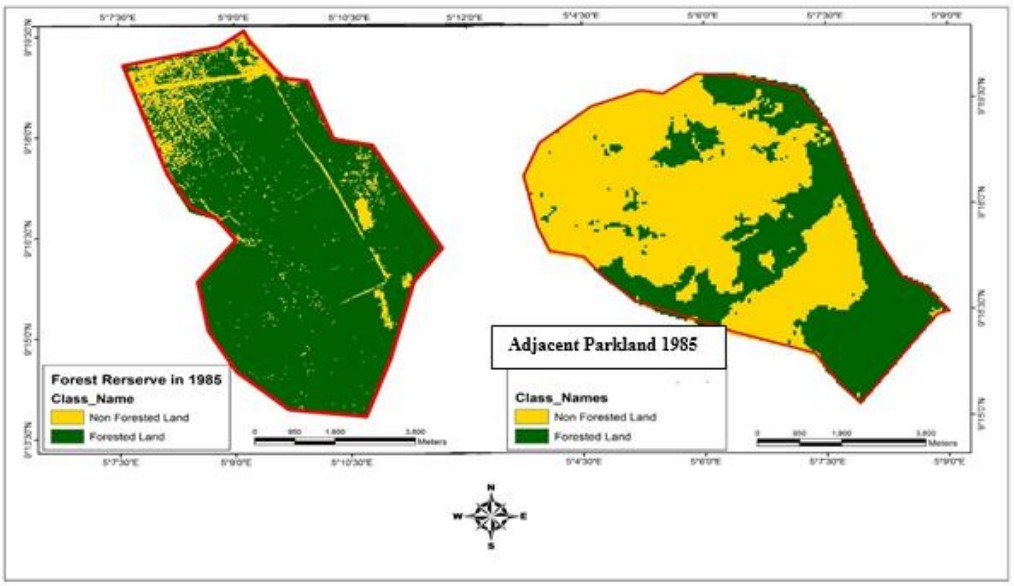

Figure2. *Extent of forest cover in forest reserve and adjacent park land [1985]*

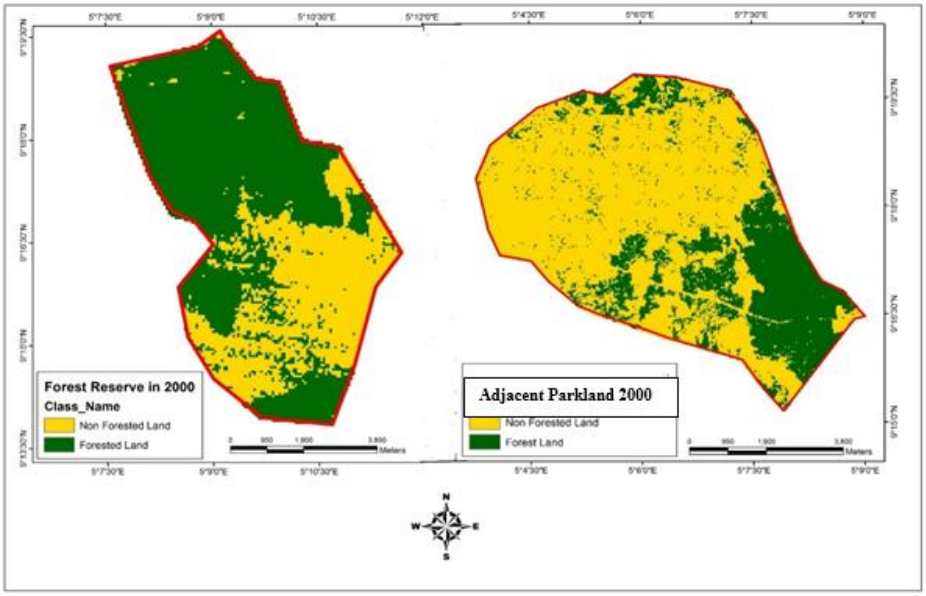

Figure3. *Extent of forest cover in forest reserve and adjacent park land [2000]*

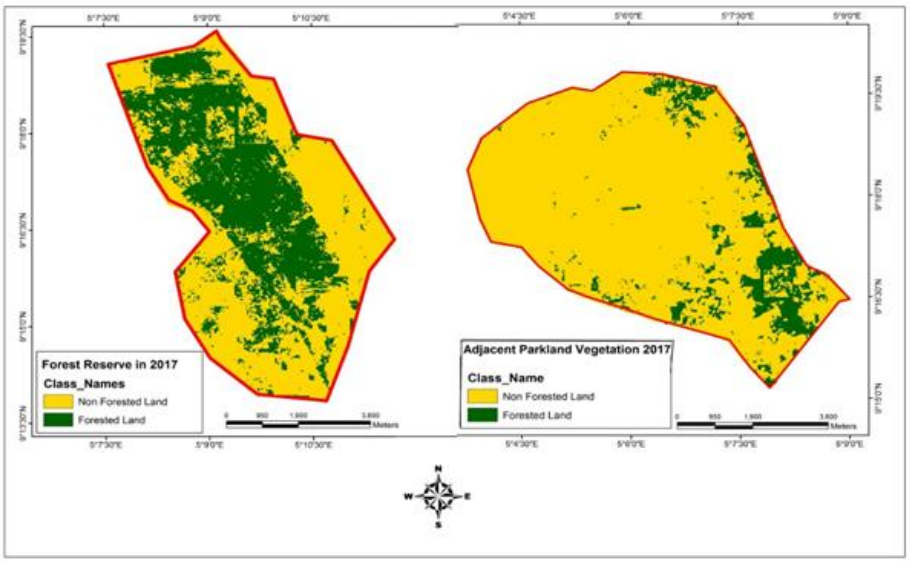

Figure4. *Extent of forest cover in forest reserve and adjacent park land [2017]*

Between 1985 and 2017, various changes in forest cover loss took place. In 1985 as shown in (table 2 and fig. 2) a total of 3943.8 hectares (88.2%) and 2011.2 hectares (43.4%) were recognized as forest cover in the reserve forest and adjacent parkland respectively. These figures decreased to 2912.4 hectares (65.2%) and 1889.9 hectares (40.7%) in the year 2000 (table 2 and fig. 3) in both area. By year 2017 (table 2 and fig. 4), the amount of forest cover further decreased to 2001.5 hectares (44.8%) and 1606.2 hectares (32.3%) in the reserve forest and adjacent parkland. Therefore, a total of 1031.4 hectares (26.2%) and 910.9 hectares (31.3%) of forest cover were lost between year 1985 to 2000 and year 2000 to 2017 from the forest reserve while a total of 121.2 hectares (6.0%) and 283.7 hectares (15.0%) of forest cover were lost from the adjacent parkland during the same periods. This shows a continuous increase of forest cover loss both in the reserved forest and adjacent parkland, though net loss across years tends to be more in reserved forest area where there was a yearly decrease of forest cover than in adjacent parkland. This could be attributed to the presence of much trees and shrubs in the forest reserve which the rural dwellers see as available resource to meet their socio-economic needs than in adjacent parkland. This finding corroborates the view expressed by Gorte and Sheikh (2010) that there is need for sustainable forest management, which is maintenance of environmental integrity to meet the present, and leaving enough in quantity and quality to satisfy the needs of future generation. It has also been estimated that forest losses in Africa and Nigeria are higher (Okonkwo *et al*., 2002; FAO, 2003). For instance, between 1990 and 2000, Africa continent lost about 52 million hectares of

the forest, accounting for about 56% of global reduction of forest cover (FAO, 2001). Similarly, a net loss of about 4 million hectares was reported for the period 2000 to 2005 (FAO, 2007).

3.2. Magnitude of Change and Rate of Deforestation in Forest Reserve and Adjacent Park Land in Mokwa, Mararaba and Bida across the Years

The magnitude of change and rate of deforestation in the reserved forest and adjacent parkland in the study area is resented in table 3 below.

Table3. *Magnitude of change and rate of deforestation in reserved forest and adjacent parkland*

	Extent	Magnitude of change		Rate of change	
Area	**Hectare**	**Hectare**	**%**	**Ha/year**	**%/year**
Forest Reserve					
1985-2000	525.3	1031.4	196.3	68.8	13.1
2000-2017	1556.7	910.9	58.5	53.6	3.4
1985-2017	525.3	1942.3	369.8	60.7	11.6
Adjacent Park Land					
1985-2000	2627.6	121.3	4.6	8.1	0.3
2000-2017	2748.9	393.8	14.3	23.2	0.8
1985-2017	2627.6	515.1	19.6	16.1	0.6

The results from table 3 showed that the magnitude of change of forest cover loss in reserved forest area from 1985 to 2000 was 1031.4 hectares at the rate of 68.8ha/year. This increased to 1942.34 hectares at the rate of 60.7ha/year from 1985 to 2017. The magnitude of change recorded from adjacent parkland during the same periods were 121.3 hectares at the rate of 8.1ha/year and 515.1 hectares at the rate of 16.1ha/year respectively. This imply that high forest cover losses were observed in the reserved forest area than in the adjacent parkland. It also showed that between these two periods (1985 to 2000 and 2000 to 2017), there were higher decrease of forest cover losses in the reserved forest than those recorded in the adjacent parkland. Also recognizable is the annual rate of forest cover change which stood at 13.1% and 11.6% for reserved forest while for adjacent parkland it was 0.3% and 0.6% during the same periods. With these rates, it is pertinent to note that deforestation in the study area especially in reserved forest area is a real challenge given the obtained value which is higher than the normal 3.67% reported annual rate of change of forest in Nigeria from 2000 to 2010 (FAO, 2010). The FAO also reported that Nigeria losses about 350,000 to 400,000 hectares of land per year to deforestation, with a recommended forest cover of 26% for every nation but the reverse is the case in Nigeria with less than 6% with the rate of deforestation of about 3.5% per year (Funmi, 2016).

4. CONCLUSION

Loss of tropical forest in many countries through deforestation means the collapse of major carbon sinks and generation of more carbon dioxide which is serious threat to global climate and atmospheric temperature distribution. This may result in many negative effects with mixed implications, but long-term environmental consequences such as global warming, biodiversity loss and soil degradation are often inimical. Findings from this study showed that between 1985 and 2017, various changes in forest cover and losses occurred in both reserved forest and adjacent parklands, with net losses across years more pronounced in the reserved forest than in adjacent parkland.

RECOMMENDATION

Based on the above results it is recommended that there is needs for rural advocacy to educate farmers and create awareness on the negative consequences of deforestation. Similarly, local people should be encouraged to practice agroforestry, and be actively involved in institutional participation in forestry management and conservation.

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