Journal of Forestry Research and Management. Vol. 15(3).118-136; 2018, ISSN 0189-8418

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CONSEQUENCE OF TIMBER EXPLOITATION ON TREE SPECIES DIVERSITY AND LIVELIHOOD OF COMMUNITIES BORDERING EDA FOREST RESERVE, EKITI STATE, NIGERIA

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ABSTRACT

Eda forest reserve, which has the objective of maintaining biological diversity conservation and environmental protection, has been seriously degraded recently. Unfortunately, information about the extent of the degradation and its impact on rural populace is lacking. Therefore, this study was design to examine the consequence of timber exploitation on tree species diversity and livelihood of communities bordering Eda forest reserve, Ekiti State. In this study, pre-tested and validated semi-structured questionnaire was administered to 80 household heads in four communities bordering the reserve. Inventory data was collected using two transects of 1100m in length with a distance of 500m between the two parallel transects. Four sample plots of 25m x 25m were laid in alternate along each transect at 250m interval. The result revealed that the reserve has undergone various degree of degradation from both illegal and legal loggers. A total of 86 individual per hectare belonging 25 species in 20 general and 16 families were recorded. Comparing these values with what was found in this forest before and what could be obtained from other tropical forests, the deforestation rate is alarming. For instance, in 2014, a total of 500 individuals per hectare belonging to 36 species in 28 general and 16 families were found in this Forest Reserve. The impact of timber exploitation in Eda forest reserve in exacerbating rural poverty is scary as it threatens the livelihood of rural and forest dwelling people. It is therefore recommended that timber exploitation in this forest should stop and the forest should be allowed to recover through enrichment planting.

Keywords: Unsustainable harvesting, forest degradation, diversity loss and rural livelihoods.

Journal of Forestry Research and Management. Vol. 15(3).118-136; 2018, ISSN 0189-8418
www.jfrm.org.ng

INTRODUCTION

The role of forest resources in rural livelihood and income generation in Nigeria cannot be overemphasized. Forests in Nigeria harbour many tree species that produce edible fruits, seeds, vegetables and medicine, which are valuable for livelihood sustainability (Onyekwelu *et al*., 2015). Notable examples are *Afzelia africana, Chrysophyllum albidium, Tetrapleura tetraptera, Irvingia gabonensis* etc. Their contributions to diets as well as their potentials in alleviating poverty and ameliorating food problems are enormous (Okafor 1991, Leaky *et. al*., 2005). They have immense socio-economic, nutritional, medicinal and cultural importance, especially to rural dwellers. The high diversity of forest foods has important nutritional and availability implications. While people may not get a large quantity of any food at a given time, majority often have access to small portions of a wide range of forest foods all year round and this diversity can be incredibly important in terms of micronutrients (Brandon, 2014).

There is emerging evidence that greater forest biodiversity increases the variety of nutrients people receive, thus improving their overall health (Onyekwelu and Lawal, 2018). Plant diversity is indispensible for human well-being and provides a significant number of the remedies required in health care. It is believed that roughly 28% of plants on earth have been used medicinally (Colfer *et. al.,* 2006). Though only about 7% of tropical plants have been screened for plants that may be useful in pharmaceuticals, about 25% of modern drugs are derived from such compounds. Many tree plants such as leaves, barks, roots, seeds and flowers are used for medicinal purposes for humans or livestock to cure a variety of sickness and diseases, thus contributing to health care delivery (Onyekwelu and lawal, 2018).

Nigeria is currently ranked among the nation with the highest number of extremely poor people (Ogwumike, 2002). Tropical forest has potentials to create wealth and thus alleviate poverty. Akintan *et al*., (2013) established significant relationship between NTFPs wealth creation ability and poverty alleviation. This implies that NTFPs can serve as source of wealth creation and consequently aid poverty alleviation in Nigeria. Through collection, processing and sale of NTFPs (e.g fruits, seeds, leaves, roots, mushroom, etc) as well as marketing of their products, the

forest ecosystem provide employment and enhance economic empowerment of the rural dwellers, thus contributing significantly to rural poverty alleviation (Onyekwelu *et. al*., 2014).

Currently, Eda forest reserve which was gazetted in 1941 (gazette number 37) with the objective of actualizing biological diversity conservation and environmental protection has been seriously degraded owing to unsustainable timber harvesting. However, information about the extent of the degradation and its impact on rural populace is lacking. Hence, this study was design to examine the consequence of timber exploitation on tree species diversity and livelihood of communities bordering Eda forest reserve, Ekiti State.

METHODOLOGY

Study Area

Eda forest reserve is located in Ekiti State between longitudes 4^{o} 5^{1} and 5^{o} 45^{1} East of the Greenwich meridian and latitudes 7^{o} 15^{1} and 8^{o} 5^{1} North of the Equator. The estimate terrain elevation above sea level is 526m. It has total area of 906ha. Eda forest reserve was gazetted in 1941 (gazette number 37) with the objective of actualizing biological diversity conservation and environmental protection (Adekunle *et al.,* 2011). The geology of the area is dominated by crystalline rocks which form part of the South Western Nigeria. The area experiences a tropical climate with distinct wet and dry seasons. The wet seasons are associated with the prevalence of the most maritime south westerly monsoon winds from the Atlantic Ocean and the dry continental north easterly harmattan winds from the Sahara desert respectively.

Method of Data Collection

Inventory Data Collection

Systematic line transect was employed in the laying of the plots. Two transects of 1100m in length with a distance of at least 500m between the two parallel transects was used. Sample plots of 25m X 25m in size were laid in alternate along each transect at 250m interval and thus summing up to 4 sample plots per 1100m transect and a total of 8 sample plots. In each main plot, all living trees with dbh =10cm were identified and their variables were measured with girth tape and relaskop.

Journal of Forestry Research and Management. Vol. 15(3).118-136; 2018, ISSN 0189-8418
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Socio - Economic Survey

Pre-tested and validated semi-structured questionnaire was used to obtain information from twenty randomly selected household heads in each of the four communities selected for this study (Ishinbode, Eda Ile, Omuo Ekiti and Ilasa Ekiti [Fig. 1]). A total of 80 household heads were interview in this study.

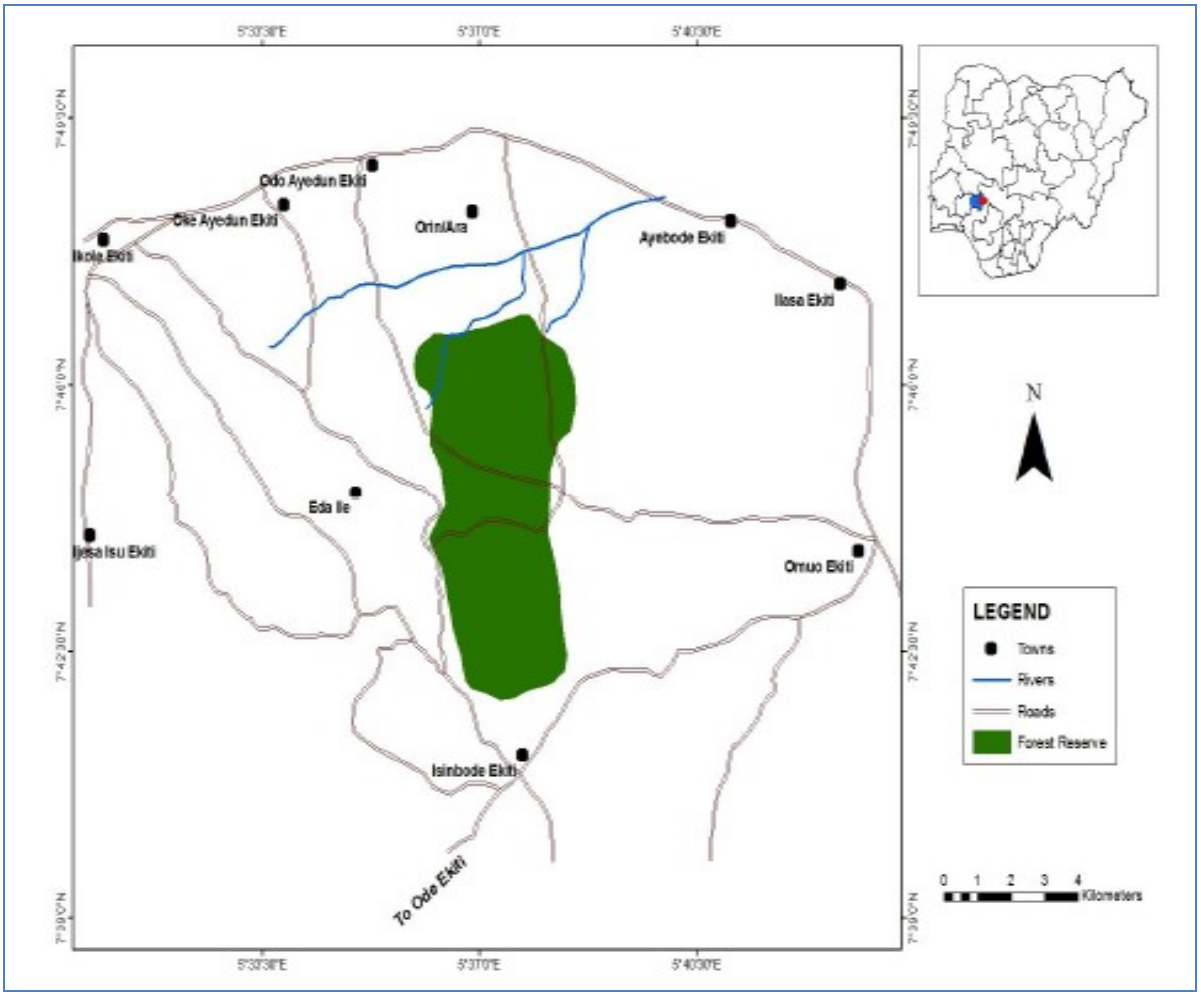

Fig. 1: Map of Eda Forest reserve with the selected communities (Olajuyigbe and Jeminiwa 2018**)**

Data Analysis

Questionnaire Data

The data collected for this study were analyzed using descriptive statistics. This is in form of frequency, percentage distribution and bar charts.

Inventory Data

Basal Area Estimation

The basal area of all trees in the sampled plots were calculated using the formula:

$$BA = \frac{\pi D^2}{4} \quad \text{.....(1)}$$

Where BA = Basal area (m^2)

D = Diameter at breast height (cm)

π = Pie (3.142).

The total basal area for each of the sample plots was obtained by the sum of the BA of all trees in the plot.

Basal area per hectare was obtained by multiplying mean basal area per plot with the number of 25×25m plots in a hectare (16).

$$BA_{ha} = \overline{BA}_P \times 16 \quad \text{.....(2)}$$

Where BA_{ha} = basal area per hectare.

Volume Estimation

The volume of individual trees was estimated using the formula of Newton (Husch *et. al.,* 2003). This equation is expressed as follows:

$$V = \frac{\pi h}{24}\left(D_b^{\,2} + 4D_m^{\,2} + D_t^{\,2}\right) \quad \text{.....(3)}$$

Where:

V = Volume of tree (m^3)

D_b = Diameter at the base (m^3)

D_m = Diameter at the middle (m^3)

D_t = Diameter at the top (m^3)

H = height (m)

Total plot volume was obtained by adding the volume of individual trees encountered in the plots. Mean volume for sample plots was calculated by dividing the total plot volume by the number of sample plots (8 plots). Volume per hectare was obtained by multiplying mean volume per plot $\overline{V}_P$ with the number of 25×25m plots in a hectare (16).

$$V_{ha} = \overline{V}_P \times 16 \quad \text{.....(4)}$$

Tree Species Classification and Biodiversity Indices

(i) The relative density of the species was computed as:

$$RD = \frac{n_i}{N} \times 100 \quad \text{.....(5)}$$

Where:

RD = species relative density

n_i = number of individual of species i

N = total number of all tree species in the entire community.

(ii) Species relative dominance (RD_O (%)) was computed using the equation:

$$RD_O = \frac{\sum Ba_i \times 100}{\sum Ba_n} \quad \text{.....(6)}$$

Where:

Ba_i = basal area of individual tree belonging to species i

Ba_n = stand basal area

(iii) Species diversity index was calculated using the Shannon-Weiner diversity index (Kent and Coker, 1992):

$$H' = -\sum_{i=1}^{S} p_i \ln(p_i) \quad \text{.....(7)}$$

Where:

H' = Shannon-Weiner diversity index

S = Total number of species in the community

P_i = Proportion of S made up of the i^{th} species

ln = natural logarithm

(iv) Shannon's maximum diversity index was calculated using the relationship:

$H_{max} = \ln(S)$ …….…… (8)

Where

H_{max} = Shannon's maximum diversity

(v) Species evenness in each community will be determined using Shannon's equitability (E_H):

$$E_H = \frac{H'}{H_{Max}} = \frac{\sum_{i=1}^{S} P_i \ln(P_i)}{\ln(S)} \quad \text{.....(9)}$$

(vi) Mangalef's index was calculated using the equation below:

$$D = \frac{S-1}{\ln N} \quad \text{.....(10)}$$

Where

S = number of species

N = number of individual

(vii) Simpson's index

$$D' = 1 - \sum \left(\frac{n_i}{N} \right)^2 \quad \text{.....(11)}$$

Where

n_i = number of individual of species i

N = total number of all tree species in the entire community

(viii) Family Importance Value (FIV)

The Family Importance Value (FIV) was used to understand a family's share in the tree community. FIV is defined as the sum of its relative dominance (RDm), its relative density (RD) and its relative frequency (RF), which is

Calculated as follows:

$$RD_m = \frac{\text{Total basal area for a family}}{\text{Total basal area for all families}} \text{X.100} \quad \text{.....(12)}$$

$$RDf = \frac{\text{Number of individual of a family}}{\text{total number of all individual}} \text{X.100} \quad \text{.....(13)}$$

$$RF = \frac{\text{Frequency of a family}}{\text{sum frequencies of all families}} \text{X.100} \quad \text{.....(14)}$$

Thus, Family Importance Value = RDm + RD + RF ……...(15)

RESULT AND DISCUSSION

Result

Current status of tree species diversity and abundance in Eda Forest Reserve

The result of tree species richness and diversity is presented in table 1. *Albizia glaberrima* in the family Mimosaceae had the highest number of individual per hectare (14) and the highest relative density (16.28). This was followed by *Cola acuminata* in the family Malvaceae with the relative density value of 11.64 and *Margaritaria discoidea* in the family Phyllanthaceae (6.98). For relative dominance, *Pseudospongia microcarpa* had the highest value (16.01) followed by *Cola acuminate* (13.44) and *Chrysophyllum albidum* (11.25). The result in Table 2 reveals that the family Malvaceae had the highest family important value (96.66%) while the family Leguminosae had the lowest family important value (9.05%). A total of 86 individual per hectare in 25 species belonging to 20 general and 16 families were found in this study area. The Shannon–Wiener diversity index (H') and Simpson index got for this study was put at 0.93 (Table 5). Shannon's max div. index (Hmax) and Margalef indices were found to be 0.29 and 6.38 respectively. The dominant Dbh and height were put at 27.37 and 12.52 respectively. The Vol/ha and BA/ha were found to be 46.78m^3 and 6.43m^2 as presented in Table 3.

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www.jfrm.org.ng

Table 1: Tree species richness and diversity indices

NAME OF TREES	Family	N	N/ha	RD	RDo	H'
Albizia adianthifolia	Fabaceae	1	2	2.33	2.89	-0.13
Albizia glaberrima	Mimosaceae	7	14	16.28	10.33	-0.36
Antiaris africana	Moraceae	2	4	4.65	2.28	-0.20
Antiaris toxicaria	Moracea	2	4	4.65	5.57	-0.20
Baphia nitida	Fabaceae	1	2	2.33	4.31	-0.13
Ceiba pentandra	Malvaceae	2	4	4.65	2.39	-0.20
Celtis philippensis	Cannabaceae	1	2	2.33	2.72	-0.13
Celtis zenkeri	Ulmaceae	2	4	4.65	8.70	-0.20
Chrysophyllum albidum	Sapotaceae	2	4	4.65	11.25	-0.20
Cola acuminate	Malvaceae	5	10	11.63	13.44	-0.32
Ficus exasperate	Moraceae	1	2	2.33	1.72	-0.13
Hollarhena floribunda	Apocynaceae	1	2	2.33	1.00	-0.13
Holoptelea grandis	Ulmaceae	1	2	2.33	0.33	-0.13
Lonchocarpus sericeus	Leguminosae	1	2	2.33	0.48	-0.13
Margaritaria discoidea	Phyllanthaceae	3	6	6.98	3.89	-0.25
Pseudospongia microcarpa	Anacardiaceae	1	2	2.33	16.01	-0.13
Pterocarpus mildbreadii	Papilionaceae	1	2	2.33	1.05	-0.13
Pterygota macrocarpa	Malvaceae	2	4	4.65	3.65	-0.20
Pycnanthus angolensis	Myristicaceae	1	2	2.33	2.48	-0.13
Spondias mombin	Anacardiaceae	1	2	2.33	2.42	-0.13
Sterculia rhinopetala	Sterculiaceae	1	2	2.33	0.47	-0.13

Sterculia tragacantha	Sterculiaceae	1	2	2.33	0.44	-0.13
Tetrat euphorbiaceea	Euphorbieacea	1	2	2.33	1.11	-0.13
Trema orientalis	Cannabaceae	1	2	2.33	0.50	-0.13
Trichilia heudelotii	Meliaceae	1	2	2.33	0.56	-0.13
		43			100.00	0.93

Table 2: Family distribution of species in Eda Forest Reserve

S/N	Family	No of Species	Ni/ha	RDm	RDf	RF	FIV
1	Anacardiaceae	2	4	18.43	4.65	12.50	35.58
2	Apocynaceae	1	2	1.00	2.33	6.25	9.58
3	Cannabaceae	2	4	3.23	4.65	12.50	20.38
4	Euphorbiacea	1	2	1.11	2.33	6.25	9.68
5	Fabaceae	2	4	7.20	4.65	12.50	24.35
6	Leguminosae	1	2	0.48	2.33	6.25	9.05
7	Malvaceae	9	18	19.48	20.93	56.25	96.66
8	Meliaceae	1	2	0.56	2.33	6.25	9.14
9	Mimosaceae	7	14	10.33	16.28	43.75	70.36
10	Moraceae	5	10	9.57	11.63	31.25	52.45
11	Myristicaceae	1	2	2.48	2.33	6.25	11.06
12	papilionaceae	1	2	1.05	2.33	6.25	9.63
13	Phyllanthaceae	3	6	3.89	6.98	18.75	29.62
14	Sapotaceae	2	4	11.25	4.65	12.50	28.40
15	Sterculiaceae	2	4	0.91	4.65	12.50	18.06
16	Ulmaceae	3	6	9.04	6.98	18.75	34.76

Table 3: Summary of phytosociological results and tree growth variables in the forest reserve

Biodiversity Indices	Values	Tree Growth Variables	Values
No of Individual /Ha	86	Mean Dbh (cm)	27.37
No of Species	25	Dominant Dbh (cm)	80.0
No of Families	16	Mean Height (m)	12.52
No of Genera	20	Dominant Height (m)	21.1
Shannon-Weinner Index (H')	0.93	Ba/Ha (m^2)	6.43
Shannon's max div. index (Hmax)	0.29	Vol/Ha (m^3)	46.78
Margalef Index (M)	6.38	Stand Basal Area (m^2)	5822.80
Simpson Index	0.93	Stand Volume (m^3)	42,383.46
		Stand Density	77,916

Socio Economic Characteristics and impact of timber exploitation on the Respondents

The result of the socio economic characteristics of the respondents is presented in Table 4. In this study, it was discovered that majority of the respondents were males (90%). Larger percentage of the respondents was above 60 years (42.5%) and married (78.8%). The highest household size was between 5-6 people. Majority of the respondents in the study area were educated. Only 21.3% had no formal education. Most of the respondents were farmers (71.3%) and practised Christianity (86.3%). On whether the respondents supported the allocation of the reserve to timber contractors (Figure 2), it was discovered that majority of the respondents (63.8%) vehemently opposed the allocation. Since the allocation, only 28.7% of the respondents claimed that the logging activities in this reserve had benefited their household while about 71.3% claimed to have lost all the benefits they usually got from the forest. They (77.5%) complained

that the destruction of the forest had brought about changes in their micro-climate in form of temperature increase. Decrease in the population of the fauna in study area was also pointed out by majority of the respondents (87.5%). Benefits derived from the forest before timber exploitation were much more compared to the current benefits as highlighted by the respondent (Table 5).

Table 4: Socio Economic Characteristics of the Respondents

Gender	**Frequency**	**Percentage**
Male	72	90
Female	8	10
Age		
20-30yrs	2	2.5
31-40yrs	8	10
41-50yrs	13	16.3
51-60yrs	23	28.7
>60yrs	34	42.5
Marital status		
Single	7	8.8
Married	63	78.8
Divorced	1	1.3
Widowed	9	11.3
Household Size		
1-2	4	5.0
2-4	16	20.0

5-6	47	58.8
>6	13	16.3
Level of Education		
No Formal Education	17	21.3
Primary	28	35.0
Secondary	17	21.3
Tertiary	17	21.3
Others	1	1.3
Primary Occupation		
Hunting	6	7.5
Logging	6	7.5
Farming	57	71.3
Trading	10	12.5
Others	1	1.3
Religion		
Christianity	69	86.3
Islamic	8	10.0
Traditional	3	3.8

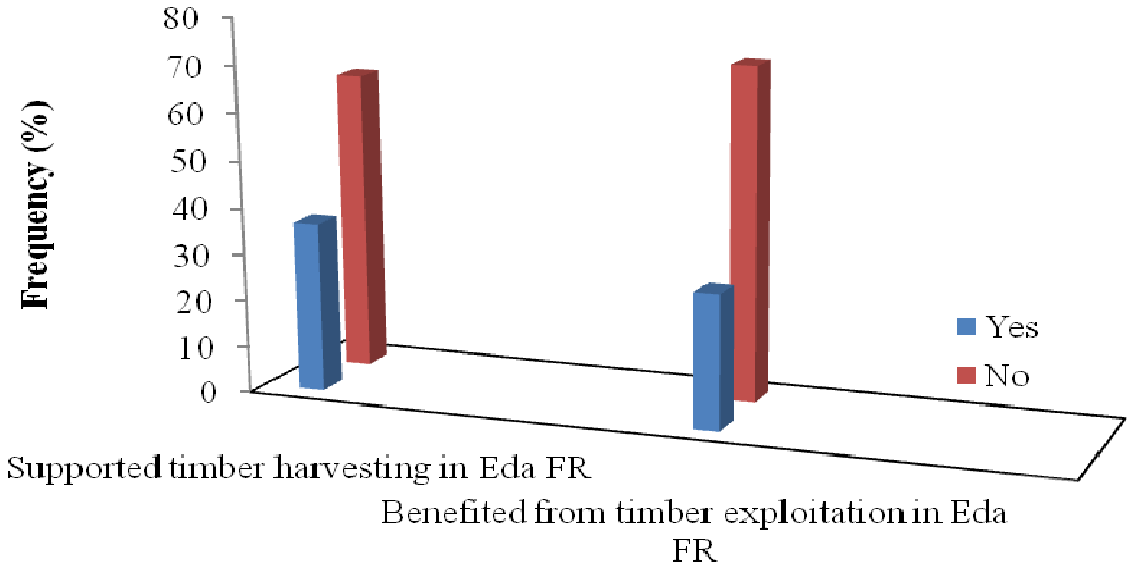

Fig. 2: Percentage of the respondents that supported timber harvesting and benefited from timber exploitation in Eda Forest Reserve, Ekiti State.

Table 5: List of benefits derived by the respondents before and after timber exploitation in Eda Forest Reserve, Ekiti State

Benefits derived before exploitation	Benefits derived after exploitation
Snails	Space for farming
Mushroom	Fuelwood
Leafy vegetables	
Bush meat	
Fruits	
Fuel wood	
Herbs and medicinal trees	
Good climatic condition	

Discussion

Eda forest reserve has undergone various degree of degradation from both illegal and legal loggers. This has led to the reduction in tree species diversity and abundance. The species richness revealed that the ecosystem is seriously disturbed. The forest reserve is now dominated by few tree species and families with little economic values. In this study, a total of 86 individual per hectare belonging 25 species in 20 general and 16 families were found in Eda Forest Reserve. Comparing these values with what was found in this forest before and what could be obtained from other tropical forest, one will be flabbergasted with the rate at which Eda forest reserve was devastated. For instance, a total of 500 individuals per hectare belonging to 36 species in 28 general and 16 families were found in Eda Forest Reserve, Ekiti State (Adekunle *et. al.*, 2014). In another study, Olajuyigbe and Jeminiwa (2018) got 380 trees/ha with *Khaya species* having the highest relative density. In this study, we discovered that *Albizia glaberrima* in the family Mimosaceae had the highest number of individual per hectare (14) and the highest relative density (16.28). This was followed by *Cola acuminata* in the family Malvaceae with the relative density value of 11.64 and *Margaritaria discoidea* in the family Phyllanthaceae (6.98). Adekunle *et al.*, (2014) pointed out that *Celtis zenkeri* in Ulmaceae family had the highest number of individuals per hectare (68). *Chrysophyllum albidum* and *Diospyros monbuttensis* had the second highest number of individuals per hectare (36), followed by *Pterigota macrocarpa* and *Brachystegia eurycoma* with 32 individuals per hectare each. This are highly valued timber species compared to what is currently left in the forest.

Generally, the number of tree species (25 species) recorded in this study was found very few compared to the number of species reported by several researchers in other tropical natural forests (Chowdhury *et. al.*, 2000, 85 species; Fox *et. al.*, 1997, 94 species; Kadavul and Parthasarathy 1999, 89 species; Khera *et. al.*, 2001, 92 species). The value of Shannon-Wiener diversity index (0.93) was quite very low compared to 2.20–2.65 for the tropical forests of Kodayar in the Western Ghats of Southern India (Sundaranpandian and Swamy, 2000). The Shannon-Wiener Index (HI) can as well be compare to tree species diversity values in tropical forests of Kalakad Reserved Forests in Western Ghats which were reported as 3.31and 3.69 (Parthasarathy *et. al*, 1992). Before, Eda forest was very rich in tree species diversity that

Adekunle *et. al.*, (2014) put the value of Shannon–Wiener diversity index (HI) obtained for Eda Forest Reserve at 2.123. Also, Olajuyigbe and Jeminiwa (2018) recorded 3.22 for Shannon–Wiener diversity index in the same forest reserve. The values obtained for Shannon's max div. index (0.29), Margalef Index (6.38) and Simpson's Index (0.93) pointed clearly to the severity of devastation in Eda forest reserve.

Compartmentalizing and exploitation of timber in Eda forest reserve had in no great measure impacted the households bordering the reserve. The study revealed that 87.5% of the respondents noticed reduction in the population of the fauna in the forest reserve. This is an indication that the activities of these timber contractors has led to the migration of the fauna. Before this reserve became devastated, people claimed to be deriving huge benefits from collection and sales of NTFPs, enjoy good micro climate and regular precipitation but today the forest has disappear with its benefits. No wonder Dregne (1983) pointed out that deforestation disrupts normal weather patterns creating hotter and drier weather thus increasing droughts and desertification, crop failures and displacement of major vegetation regimes. Forest loss in Africa is particularly troubling, and this due to the fact that two-thirds of the continents population depends on forest resources for income and food supplementation and 90% of Africans use fuel wood and charcoal as sources of energy (FAO, 2010). Hence, the over reliance on forest resources and non-timber forest products (NTFPs) has accounted for the huge change in forest cover and that deforestation in Africa is estimated at around 3.4 million hectares per year (FAO, 2010). Deforestation on lowland plains moves cloud formation and rainfall to higher elevation (Lawton *et. al.*, 2001). Also, timber exploitation affects wind flows, water vapour flows and absorption of solar energy thus clearly influencing local and global climate (Chomitz *et. al.*, 2007). Consequently, the rural people are deprived of forest resources such as wood products, food, medicinal plants through deforestation. The impact of timber exploitation in Eda forest reserve in exacerbating rural poverty is scary as it threatens the livelihood of rural and forest dwelling people.

CONCLUSION AND RECOMMENDATION

This study reveals the impact of timber exploitation in Eda forest reserve on tree species diversity and livelihood of the communities bordering the reserve. It was discovered that timber

exploitation in this forest is threatening the livelihood of rural communities bordering the forest as the benefits derived from this forest depreciates. Since timber harvesting in this forest was not sustainable, the population of important tree species decreased. Even trees with great medicinal values had disappeared. Diversity of tree species in Eda forest reserve has dwindled. The reduction in the number of trees/ha and species richness particularly when compared to previous reports on this forest clearly showed that this ecosystem had been devastated by timber exploitation. Controlling the intensity of tree harvesting, improving logging practice, averting illegal felling and enrichment planting can restore the original structure and biodiversity of this forest. It is therefore recommended that timber exploitation should stop and the forest should be allowed to recover with human intervention (enrichment planting).

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