EFFECTS OF LAND USE CHANGES ON FLORA DIVERSITY IN OBAN DIVISION OF THE CROSS RIVER NATIONAL PARK, NIGERIA

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ABSTRACT

The Oban Division of the Cross River National Park, Nigeria, is a globally renowned biodiversity hotspot. The area is experiencing rapid land use changes and little efforts have been made to document the effects of the changes on biodiversity. The study investigated the effects of different land use types on flora composition, distribution and diversity in the area with a view to generating data that will support conservation decisions. The area was stratified into four: primary forest (core), secondary forest (buffer), farm fallow and plantation. Ten transects of 2 km length each were systematically located in each land use type. Four sample plots of 50×50 m were located on each transect at an interval of 500 m. Each plot was subdivided into 10×10 m subplots; and nine subplots were randomly selected for the enumeration of trees, shrubs and climbers. A 1×1 m miniplot was then located at the centre of each subplot for herb enumeration. Flora species composition was estimated across the land use types using species diversity indices and Jaccard similarity indices. Composition, species richness and diversity of trees, shrubs and climbers all decreased from the core to plantation. However, herb species composition, richness and diversity increased from core to farm fallow. Significant differences in species composition were obtained across land use types at 5%. The highest tree species similarities were recorded between core and buffer. The highest similarities for shrubs, herbs and climbers were recorded between farm fallow and plantation. The absence of species previously recorded in the core, and in the other land use types makes it imperative that conservation efforts be improved and extended to areas beyond the core in order to save the remaining flora diversity in this forest.

Keywords:* *Flora, species composition, species diversity, conservation

INTRODUCTION

Tropical rainforest is the most diverse terrestrial ecosystem in the world (Richard, 1996; Gillespie *et al*., 2004). Tropical forests of Africa harbour unique biota, much of which is distributed in forest isolates that have been poorly investigated. Hence our current knowledge of species diversity and distribution patterns in such ecosystems is still limited (Norris *et al.,* 2010). The Guinean forests of West Africa are recognised as a biodiversity hot spot (Myer *et al.,* 2000), supporting about a quarter of the African mammal fauna and displaying significant endemism across a range of animal and plant groups.

Understanding how biodiversity responds to human-induced habitat change is pivotal for conservation efforts in the region. Limited scientific work has been conducted on biodiversity in human-modified forest landscapes in West Africa compared with Amazonia or South East

Asia (Gardner *et al.,* 2009). Oban Division of Cross River National Park (CRNP) in Nigeria is located within the Guinean forests of West Africa which is known to be among the top 25 biodiversity hot spots in the world (Myer *et al*., 2000). Oban Division of CRNP is the only area in the sub-region with near intact largest block of contiguous forest and high level of endemism (Oates *et al.,* 2004). Bergl *et al.* (2007) listed some taxa in the area that show high level of species richness and endemism to including primates, amphibians, birds, butterflies, dragonflies, fish and vascular plants.

Despite the biological value of the forest of this area the future of the area is not secured. This is because the Park is surrounded by 39 enclave communities with high population density (Fa *et. al.,* 2006). As a consequence, the remaining forests are becoming increasingly degraded and fragmented. Oates *et al.* (2004) tag the area as "understudied" with little efforts being made to document the biological effects of land use changes going on in the area. Onadeko (2006) concluded that basic data needed to support the management and conservation of Oban Division of CRNP is scarce and certain taxa remain understudied. Therefore, the effects of different land use types on flora species composition, distribution and abundance was investigated with a view to generating data that will support conservation efforts in the area.

The Study Area

The Oban Division of CRNP was carved out of Oban group Forest Reserve in 1991. It is located in Cross River State, Nigeria, within latitudes 05°15' and 05°25'N, and longitudes 08°30' and 08°45'E (Figure 1). The total area (including buffer zones), is about 3,000 km^2. The area of farm fallow and plantation is not specified as they occur in several locations and in varying sizes at the periphery of the park. The park shares a boundary with Korup National Park, Cameroon, in the east. Annual rainfall ranges between 2,500 and 3,000 mm (Oates *et al*., 2004; Bisong and Mfon, 2006; Jimoh *et al*., 2012).

Relative humidity is about 75-95% in January, but towards the end of the year, it reduces gradually to below 70% as a result of the harmattan (Bisong and Mfon, 2006, Jimoh *et al*., 2012). Altitude ranges from 100 to over 1,000 m above sea level (Oates *et al*., 2004). Four vegetation types are distinguishable within the park. These include high forest, ridge forest, secondary forest (buffer zone) and swamp forest. Patches of oil palm and cocoa plantations as well as farm fallows exist in various locations at the periphery of the park. Schmitt (1996) identified 1,303 species of plants, 141 lichens, and 56 mosses within the park. Seventy seven of these are endemic to Nigeria. Fauna diversity includes 134 mammals, 318 birds, 42 snakes, and over 1,266 butterflies (Schmitt, 1996).

Some of the typical tree species found in the area include; *Pericopsis elata* (Harms) Van Meeuwen, *Amphimas pterocarpoides* Harms, *Enantia chlorantha* (A DC) van Setten and Maas, *Entandrophragma spp*, *Hannoa klaineana* Pierre and Engl, *Irvingia spp* (Aubry-Lecomte) Bail, *Khaya grandifoliola* C.DC. *Lophira alata* Banks exGaertn.f. *Milicia excelsa*(Welw.) C.C. Berg, *Piptadeniastrum africanum* (Hook.f) Brenan, *Piptostigma pilosum* Oliv,. *Strombosia schefflei* Engl. *Tabernaemontana spp, Terminalia spp* and *Treculia spp*, (Jimoh *et al*., 2012).

Study Design and Data Collection

Oban Division of CRNP is divided into two corridors, the West and East corridors. The Western corridor is made up of eight villages, while the Eastern Corridor has 31 villages. With the permission of the management of the park, the study was conducted in all the corridors. Five villages: Obung (Erokut), Old Ekuri and Ifumkpa in the West and Aking/ Osomba and Ekang in the East were purposively selected from these corridors based on their proximity to the park as shown in Figure1.

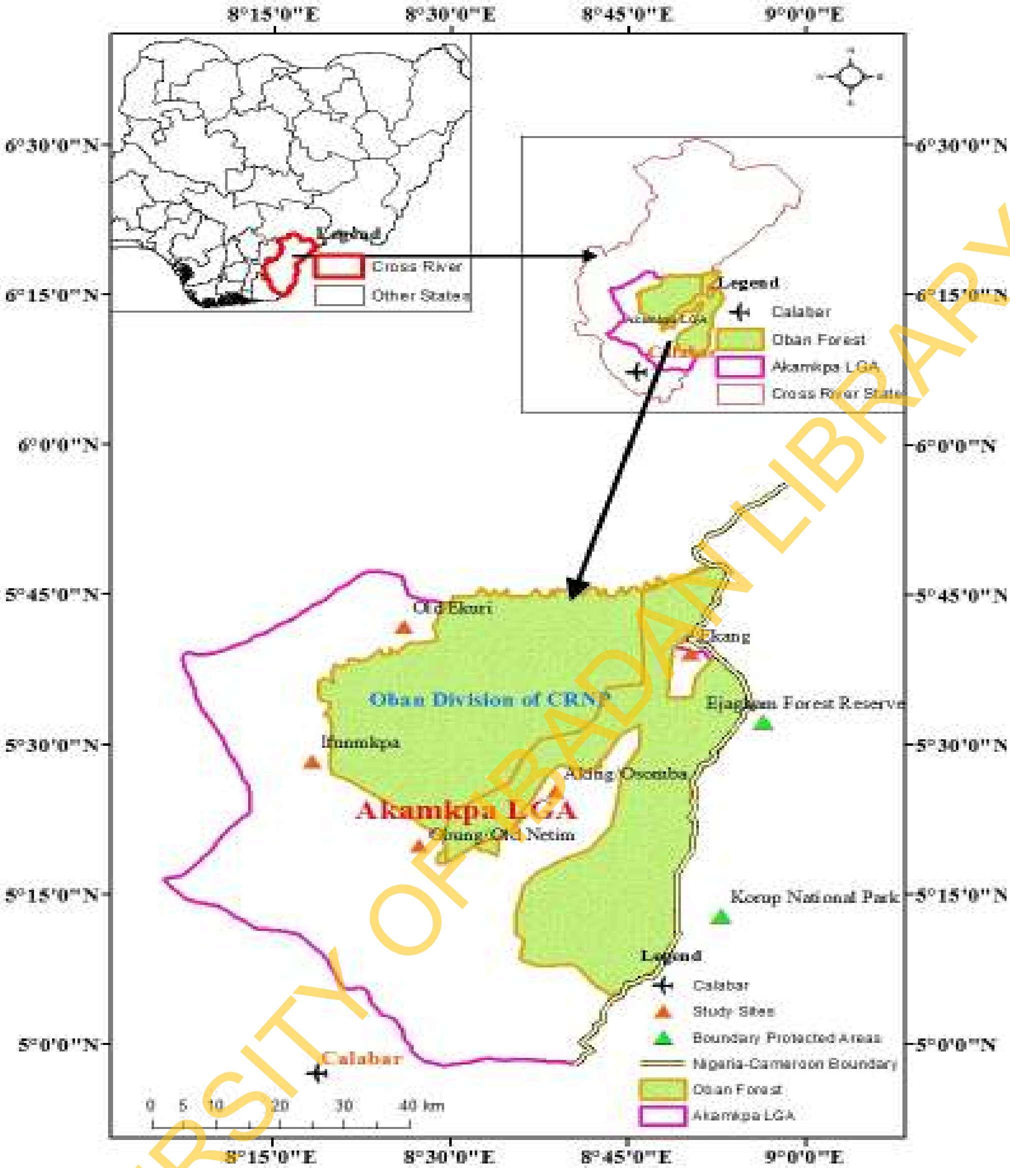

Figure 1: Map of the Cross River National Park showing the study locations.

The study was conducted in the four major land use types in the Oban Division of CRNP namely; primary forest (core), secondary forest (buffer), farm fallow and plantation. Ten transects of 2 km length each were systematically located in each land use type at a regular interval of 2 km apart, this was to cover different gradients present in the study area (Walter *et al*., 2006). Four sample plots of 50 × 50 m were located on each transect at an interval of 500 m. Each plot was sub-divided into 10×10 m subplots and nine subplots were randomly selected for trees, shrubs and climbers enumeration. A 1×1 m miniplot was then located at the centre of each subplot (Sullivan *et al.,* 2005; Turyahabwe and Tweheyo, 2010). Within the 50 x 50 m plots, trees with diameter at breast height (DBH) ≥ 10 cm and climbers were enumerated. Trees with DBH of ≤ 10 cm considered as shrubs and saplings and they were enumerated within the 10 x10 m subplots (Sullivan *et al.,* 2005; Turyahabwe and Tweheyo, 2010). All the herbs and seedlings within the 1 x 1 m sub-plots were also enumerated. Each of the trees encountered was assigned a class based on DBH (Sullivan *et al.,* 2005, Turyahabwe and Tweheyo, 2010). Diameters of trees were measured using a diameter tape. Where there were cases of irregular features such as buttresses, diameters were taken above those features (Turyahabwe and Tweheyo, 2010).

The identification of plant samples was carried out using flora field guides (Keay, 1989; Akobundu and Agyakwa, 1998; Arbonnier, 2004). A taxonomist was engaged for the identification of the plants on the field. Those that could not be identified on the field were preserved in wooden press and taken to the Forestry Research Institute of Nigeria Ibadan Herbarium for proper identification. Identified species were grouped into species, genera and families. Floristic composition in the various land use types were estimated using density, species richness, diversity and evenness.

Density was estimated:

$$\text{Density} = \frac{\text{Number of individuals species}}{\text{Area sampled}}$$

Species richness was computed using Margalef Index Magurran (2004) as follows:

$$D = \frac{(S - 1)}{\ln N} \quad \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where, D = species richness index (Margalef Index), S = number of species and N = the total number of individuals.

Species diversity was estimated using the Shannon-wiener diversity index as cited Turyahabwe and Tweheyo (2010). The Shannon-wiener diversity index equation is stated as:

$$H' = -\sum_{i=1}^{s} p_i \ln p_i \quad \ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Where H′ = species diversity index, pi = the proportion of individuals or the abundance of the i^{th} species expressed as a proportion of the total abundance. The use of natural logs is usual because this gives information in binary digits.

Species evenness was estimated using Pielou's evenness (equitability) index (Pielou, 1975) as cited by Turyahabwe and Tweheyo (2010) as follows:
Species evenness was estimated using Pielou's evenness (equitability) index (Pielou, 1966) as cited by Odiwe *et al.* (2012) as follows:

$$J' = \frac{H}{\text{In S}} \quad \ldots\ldots\ldots\ldots\ldots\ldots(3)$$

J′ = Pielou's evenness index Where S is the total species number, H is the diversity index and ln= natural logarithm.

Jaccard similarity coefficient:

$$S_J = \frac{a}{(a + b + c)} \quad \text{...(4)}$$

S_J = Jaccard similarity coefficient,
a = number of species common to (shared by) quadrats,
b = number of species unique to the first quadrat, and
c = number of species unique to the second quadrat

To compare flora species composition between land use types, One-way analysis of variance was used. And where the result was significant Turkey was used to separate the means.

RESULTS

Flora Composition Across Land Use Types

A total of 1,175 plant species with 102,825 individuals in 556 genera and 120 families were recorded in all. Out of this number, 329 (28%) with 14,736 individuals were trees species, 273 (23%) with 20,797 individuals were shrub species; 335 (29%) with 54, 835 individuals were herb species while 238 (20%) with 12,467 individuals were climber species (Tables 1and 2). Table 2 indicates that composition of trees, shrubs and climbers decreased from the core of the park to the plantation.

Tree species decreased from 285 to 128 in the core of the park to plantation, shrubs species decreased from 211 in the core to 92 species in the plantation, while climbers decreased from 155 to 56. Herb species composition increased from 88 in the core to 270 in the farm fallow. The highest numbers of individuals for all the life forms were recorded in the farm fallow; 4, 628, 6,426 28,431 and 4,060 for trees, shrubs, herbs and climbers, respectively. Similarly, the highest density of individuals per hectare for all the life forms were recorded in the farm fallow: 462.8, 1,785, 789,750 and 1,079.7 for trees, shrubs, herbs and climbers, respectively (Table 2). Analysis of variance revealed significant differences in plant species composition across the various land use types. Tukey's pair wise comparisons also revealed that life forms differed in composition between plantation and other land use types (Table 3 and 4).

Table1**:** Flora species distribution according to four life forms in the Oban Division of the Cross River National Park, Nigeria.

Life Form	FI	IG	IF	UD	total	Genus	Families
Tree	309	14	0	6	329	213	59
Shrub	225	26	0	22	273	136	43
Herb	283	24	8	20	335	175	51
Climber	202	13	0	23	238	123	45
Total	1033	76	8	71	1175		

Note: FI = Fully Identified, IG = Identified to only genus, IF = Identified to only family, UD = Unidentified.

Table 2: Distribution of flora life forms and individual species occurrence across land use types in the Oban Division of the Cross River National Park, Nigeria.

Life form		Core	Buffer	Farm fallow	Plantation	Total
Tree	Number of species	285	271	129	128	
	Individuals	3,260	3,012	4,628	3,826	14, 726
	Family	52	50	39	41	
	Density (per hectare)	336	301	462.8	382.6	
Shrub	Number of species	211	172	112	92	
	Individuals	6,240	5410	6426	3,721	20,797
	Family	40	38	27	27	
	Density(No/ha)	1,733.30	1,502.80	1,785	1,033	
Herb	Number of species	88	139	270	190	
	Individual	5141	5901	28431	15362	54,835
	Family	18	30	46	40	
	Density(no/ha)	142,805.6	162,916.70	789, 750	426, 722.2	
Climber	Number of species	155	116	111	56	
	Individual	3604	3269	4060	1534	12, 467
	Family	38	36	32	24	
	Density(no/ha)	1,000.30	888.6	1,079.70	384.2	

Table 3: One-way analyses of variance for floral species composition across land use types in the Oban Division of the Cross River National Park, Nigeria.

Life form		SS	Df	MS	F	P
Trees	Between groups:	68.2333	3	22.7444	123	3.165E-70**
	Within groups:	242.511	1312	0.18484		
	Total:	310.744	1315			
Shrubs	Between groups:	32.8599	3	10.9533	49.95	3.033E-30**
	Within groups:	238.601	1088	0.219302		
	Total:	271.461	1091			
Herbs	Between groups:	53.9485	3	17.9828	85.55	1.24E-50**
	Within groups:	280.836	1336	0.210206		
	Total:	334.784	1339			
Climbers	Between groups:	19.0719	3	6.35729	27.88	2.64E-17**
	Within groups:	224.405	984	0.228054		
	Total:	243.477	987			

Note **= significant; ns = not significant

Table 4: Tukey's pair wise comparisons for flora species composition: ($p > 0.05$)

Life form		Core	Buffer	Farm fallow	Plantation
	Core		0.5825 ns	7.721E-06**	7.721E-06**
Trees	Buffer			7.721E-06**	7.721E-06**
	Farm fallow				0.9997ns
	Plantation				
Shrubs	Core		0.002082**	7.721E-06**	7.721E-06**
	Buffer			7.923E-06**	7.721E-06**
	Farm fallow				0.2602ns
	Plantation				
	Core		0.0001073**	7.721E-06**	7.721E-06**
Herbs	Buffer			7.721E-06**	0.0001073**
	Farm fallow				7.721E-06**
	Plantation				
	Core		0.001038**	0.000143**	7.721E-06**
Climbers	Buffer			0.9634ns	7.756E-06**
	Farm fallow				8.359E-06**
	Plantation				

Note **= significant; ns = not significant

Family Composition

Trees were represented by 56 families (44.7%), shrubs 43 families (35.8%), herbs 51 families (42.5%) and climbers represented by 45 families (37.5%) (Tables 1 and 5). The highest number of families for trees, shrubs and climbers were recorded in the core, 52, 40, and 38 respectively. The highest number of families for herbs was recorded in the farm fallow. The core recorded the least number of families for herbs; farm fallow recorded the least number of families for trees. For shrubs both farm fallow and plantation recorded the least number of 27 families each, while the least number of families for climbers were recorded in plantation

The dominant family was Rubiaceae with 140 species representing (11.91%) of the total species recorded. This was followed by Papilionoideae, 50 (4.26%), Orchidaceae 48 (4.09%) and Euphorbiaceae 48 (4.09%). Only seven families (Rubiaceae, Euphorbiaceae, Papilionoideae, Caesalpinioideae, Malvaceae, Melastomataceae and Verbenaceae) were represented across all the life forms (tree, shrub, herb and climber). Caesalpinioideae had the highest number of species of trees, Rubiaceae had the highest number of shrubs, Orchidaceae had the highest number of herbs, while Apocynaceae had the highest number of species of climbers (Table 5). Thirty two families, constituting 26.67% of the families were represented by only one species each.

Flora Species Diversity

Species richness (D) for trees, shrubs and climbers decreased from core to plantation (D = 35.11-15-17), (D = 24.03-11.07), (D = 18.8-7.50) and (D = 4.138-2.583), respectively. Similarly, species diversity (*H'*) for trees, shrubs, and climbers decreased from core to plantation (H '= 4.896-3.013), (H '= 4.659-2.797) and (H'= 3.711-2.606) respectively.

Table 5: Twenty families with the highest number of species for the four life forms in Oban Division of the Cross River National Park, Nigeria.

S/N	Family	Trees	Shrubs	Herbs	Climbers	Total
1	Rubiaceae	14	97	18	11	140
2	Papilionoideae	10	18	9	14	51
3	Euphorbiaceae	24	14	7	0	49
4	Orchidaceae	0	0	48	0	48
5	Apocynaceae	13	1	0	28	42
6	Caesalpinioideae	35	4	1	1	41
7	Acanthaceae	0	6	28	3	37
8	Araceae	0	0	21	10	31
9	Asteraceae	1	2	28	0	31
10	Annonaceae	24	0	0	2	26
11	Moraceae	17	4	5	0	26
12	Sapindaceae	9	7	0	4	20
13	Sterculiaceae	14	4	2	0	20
14	Verbenaceae	7	6	2	3	18
15	Marantaceae	0	0	17	0	17
16	Mimosoideae	12	0	4	0	16
17	Melastomataceae	2	4	9	1	16
18	Amaranthanceae	0	0	15	0	15
19	Icacinaceae	0	7	0	8	15
20	Malvaceae	3	1	10	1	15

For herbs, species richness and diversity increased from core to farm fallow (D=10.18-26.23) and (H'=3.469-4.577).Species evenness (*J*) did not show any definite pattern among the various land use types (Table 6). For trees, shrubs and herbs, the values were high in the buffer zone but lower in the plantation (J′=0.48-0.16), (J′=0.51-0.18), (J′= 0.37-0.32).

Similarity Index

Result for similarity index shows high similarity for trees between core and buffer (0.84); the lowest similarity value for trees was recorded between the core and farm fallow (0.29). Shrubs, farm fallow and plantation were more similar, with index value of 0.60. The least value of similarity was recorded between core and plantation (0.24). For herbs, the Jaccard Similarity Index shows farm fallow and plantation to be more similar with index value of 0.57; the least index value of 0.13 was recorded between core and plantation. Farm fallow and plantation were more similar in terms of climbers with index value of 0.40, while the least index value of 0.10 was recorded between core and plantation (Table 7).

Table 6: Flora species diversity indices across land use types in the Oban Division of the Cross River National Park, Nigeria.

Life Form	Core			Buffer			Farm fallow			Plantation		
	H′	J′	D	H′	J′	D	H′	J′	D	H′	J′	D
Trees	4.896	0.47	35.11	4.87	0.48	33.7	3.31	0.22	15.17	3.01	0.16	15.39
Shrubs	4.659	0.5	24.03	4.48	0.51	19.9	3.02	0.18	12.66	2.8	0.18	11.07
Herbs	3.469	0.365	10.18	3.85	0.34	15.9	4.58	0.36	26.23	4.11	0.32	19.61
Climbers	3.991	0.349	18.8	3.71	0.35	14.2	3.84	0.42	13.24	2.61	0.24	7.5

Table 7: Similarity indices for flora species across the various land use types in the Oban Division of the Cross River National Park, Nigeria.

Land Use Types	Trees	Shrubs	Herbs	Climbers
Core versus Buffer	0.84	0.57	0.36	0.37
Core versus Farm Fallow	0.29	0.29	0.17	0.23
Core versus Plantation	0.29	0.24	0.13	0.1
Buffer versus Farm Fallow	0.36	0.35	0.32	0.35
Buffer versus Plantation	0.36	0.3	0.34	0.19
Farm Fallow versus Plantation	0.54	0.6	0.57	0.39

DISCUSSION

Flora Species Composition

One of the most astonishing features of tropical rain forest is its high diversity of plant and animal species. The record of good number of species in other life forms apart from tree is a confirmation that the Oban Division of the Cross River National Park (CRNP) like other tropical rain forests is not just rich in tree species but it is also rich in other plant life forms (Gentry and Dodson, 1987).

It is clear from this study that Oban Division of CRNP still harbours a high number of vascular plants, although the present study recorded lower numbers compared to the work of Schmitt (1996). This may be due to the effects of human activities in the area. However, the present study recorded more climbers and herb species compared to the work of Schmitt (1996). The high number of herbs and climbers could be linked to increased conversion of forest to agricultural land which allows pioneer species of weedy characteristics to invade the area, as a result of opening up of the forest canopy (Fujisaka *et al.,* 1998). For instance, *Chromolaena odorata* which was not recorded in previous studies (Reid, 1989; Schmitt, 1996) was the dominant shrub species in the farm fallow and plantation. A similar observation was made in Korup (Bobo *et al.,* 2006). *Chromolaena odorata* is a light demanding invasive weed species.

The 329 tree species recorded in this study is less than the 444 recorded by Schmitt (1996) in this region. It is, however, higher than the values recorded in other rainforests in different parts of the world. For example, Fujisaka *et al.* (1998) recorded 144 species in an Amazon forest ecosystem Bobo *et al.* (2006) recorded 239 species in Korup, Cameroon; while Duran *et al.* (2006) recorded 148 tree species in a Mexican deciduous forest at Chamela, Mexico. Rajkumar and Parhtasarathy (2008) recorded 105 tree species in Andaman Giant Evergreen forest in India; Ihenyen *et al.* (2009) recorded 99 tree species in Ehor Forest Reserve, Edo State, Nigeria; Lu *et al.* (2010) recorded 207 species in China, and Adekunle *et al.* (2013) recorded 94 tree species in a strict nature reserve in the rainforest of south western Nigeria.

This variation in the number of tree species recorded could be due to sampling intensity which Richards (1996) reported could affect the number of species encountered. However, the fact that the value here is less than the 444 tree species recorded by Schmitt (1996) in this location may reflect the impact of human activities such as logging and oil palm/ cocoa plantation development which are currently very rampant in the area (Oates *et al.,*2004, Bisong and Mfon, 2006; Macdonald *et al.,*2012). This agrees with the submission by Sagar *et al.* (2003) that human disturbance could usually cause an immediate decline in biodiversity. The high number of herbs recorded in the farm fallow and plantation is in agreement with findings from similar studies (Metlen and Fiedler, 2006; Ares *et al*., 2010; Odiwe *et al.,* 2012). This shows that anthropogenic disturbances cause increase in herbaceous layer.

This decrease in flora species composition and diversity in the Oban region is a serious cause for concern about the impact of land use on the forest biodiversity. This is more particularly so when Jimoh *et al*. (2012) had earlier reported a similar depletion in large mammals population in this area.

Tree species composition or richness decreased from core to plantation by 47.72% and to farm fallow by 47.42%. This value is lower than the 62.1% and 79.5% respectively, obtained by Bobo *et al.* (2006) in the Korup National Park, but higher than the 19% obtained by Turner *et al.* (1994) in Singapore.

The observation is a further indication of decrease in tree species diversity with increasing human disturbance. There was a 30.45% increase in the herb species richness from core to plantation and 54.33% increase from core to farm fallow. These figures are lower than the 57% recorded by Bobo *et al.* (2006) between primary forest and farm land around the Korup National Park in Cameroon. The higher herb species richness in the plantation confirms the poor nature of plantation in terms of support for higher plant life forms (Bobo *et al.,* 2006; Fitzherbert *et al.,* 2008; Bruhl and Eltz, 2009; Danielsen *et al*., 2009).

The fewer species of herbs (88) recorded in the core of the park compared to 270 species in farm fallow is typical of a tropical rainforest (Costa and Magnusson, 2002). This is due to the suppression by tree canopy which could only permit shade-loving species to thrive under closed canopy (LaFrankie *et al*., 2006). The number of herb species recorded in the core of the park was similar to what is obtainable in other tropical rainforests. For instance, Poulsen and Balslev (1991) recorded 96 herbs species in Ecuador, Poulsen and Balslev (1996) listed 87 herb species in Borneo.

Family Composition

The dominance of the families such as Rubiaceae, Euphorbiaceae, Fabaceae (Papilionoideae, Caesalpinioideae, Mimosoideae), Apocynaceae, Acanthaceae, Asteraceae and Moraceae in this study is comparable with the results of other studies in other rain forest regions (Kessler *et al.,* 2005; Ihenyen *et al.,* 2009; Mbue *et al.,* 2009; Rasingam and Parathasarathy, 2009; Adekunle *et al.,* 2013). The poor representation of most of the families is typical of the African rain forest (Plana, 2004).

Five out of the nine plant families endemic to the Guineo-Congolian Region are found in Oban Hills Region (Schmitt, 1996). Four of the families (Lepidobotryaceae, Octoknemaceae, Pandaceae, and Scytopetalaceae) were recorded in this study. All of them were recorded in the core and buffer zones of the park. This implies that one of them, Medusandraceae, might have become locally extinct as it was with Yellow-backed and Bay duikers in the area (Jimoh *et al.,* 2012). Also most of the families recorded in this study, especially those in the herbaceous and shrubby life forms, like Acanthaceae, Amaranthaceae, Aracaceae, Asteraceae, Commelinaceae are strongly associated with land use pressures (Houlahan *et al.,* 2006).

Species Diversity

The H' index range of 3.02-4.66 in shrub layer and 3.47-4.58 in the herb layer, suggests less variation in species diversity in the herb layer than in the shrub layer in the four land use types. As suggested by Lu *et al.* (2011), high H' index and low J′ index of the understory in the four land use types indicate that the species diversity of the understory in this the area may be constituted by rare species or dominated by few species. In all the four land use types, the evenness of shrubs was relatively low (0.18-0.51) indicating that only few species like; *Olax gambecola* and *Chromolaena odorata*, clearly dominate core and buffer; farm fallow and plantation respectively. For instance, the evenness index was lower in farm fallow (0.18) which was dominated by *Chromolaena odorata*.

A Similar pattern was observed for herbs. The evenness index was higher in the core (0.3648) with 88 species compared with the plantation (0.32) with 190 species. This shows that plantation was dominated by few species like *Commelina benghalensis, Ageratum conyzoides, Celosia leptostachya, Asystasia gangetica,* and *Acanthus montanus*. This higher dominance is attributable to continued anthropogenic disturbances which favoured herbaceous layer (Ares *et al.,* 2010; Lu *et al.,* 2011).

The lower values of species evenness recorded in the study may also be an indication of poor representation of some genera and families, most of which were represented by only one species, even though they contribute greatly to the diversity indices. This poor representation was also recorded by Rasingam and Parathasarathy (2009) in India and Adekunle *et al.* (2013) in a strict nature reserve in the rainforest of south western Nigeria. It also indicates that most of the families in the area have species that are not evenly distributed; giving rise to fragile nature of most of the families, genera and species. The ecological implication of this is that continued disturbance of this ecosystem may cause local extinction of some of the species or genera or even some families. The decrease in plant species diversity from core to plantation indicates that land use has an impact on plants diversity in the study area (Bobo *et al.,* 2006). Other studies also show similar pattern (Fusjisaka *et al.,* 1997; Sagar *et al.,* 2003; Gradstein *et al.,* 2007; Mbue *et al.,* 2009).

However, there was an exception with herbs, as the composition and diversity increased from core to plantation and was highest in the farm fallow, suggesting that herbs are favoured by land use change as competition from trees for light and below-ground resources is reduced (Ares *et al.,* 2010). This is in line with the observation by Schulze *et al*. (2004) that, diversity indices may not always decrease with human disturbances, but in some instances it may stimulate increase in occurrences of other species.

The decreased diversity values of the other life forms (trees, shrubs and climbers) from core to plantation, according to Norris *et al.* (2010), could be as a result of land preparation method for the establishment of such plantation. This view was expressed by Bobo *et al.* (2006) in a different way which links it to poor farm management methods. This study however, agrees with the view of Norris *et al.* (2010), which ascribed the observation to poor land preparation in which the land is bulldozed or slashed and burned.

Similarity Index

Not much variation was observed between buffer and the core in terms of floristic composition, richness and diversity in the study area. There was no discernible pattern of flora species occurrence as one moved from buffer to the core of the park. The species richness and diversity values are similar. A similar pattern was reported in the Korup National Park (Zapfack *et al.,* 2002; Bobo *et al.,* 2006; Mbue *et al.,* 2009). This similarity is an indication that the buffer and core are the same forest with minimal human impacts. Another possible reason for the similarity could be an indication of recovery of buffer areas after human disturbance especially logging activities, which allows for the re-establishment of species which are usually considered old growth forest specialists in the buffer (Fujisaka *et al.,* 1998; Laidlaw *et al*., 2007; Chazdon *et al.,* 2009). Chazdon *et al.* (2009), opined that this similarity could be age-dependent., even though the present study did not assess the age of the secondary forest but the similarity was more pronounced in Aking, Ekuri, Obung / Old Netim Erokut and Ifumkpa where human activities especially farming, in the buffer, was minimal.

CONCLUSION

There is significant impact of land use on plant species diversity in the study area. Tree species composition decreased from 444 in 1996 to 329 in 2013 implying a loss of about 26%. Herbs were favoured by forest conversion to other land uses especially agriculture (farm fallow and plantation). Vascular plant species especially trees, shrubs and climbers are more reactive to the land-use change as they exhibit a decrease in species richness and diversity from core to plantation. Even though the area is highly diverse, especially the core of the park, where the vegetation is near primary forest the biotic community appears to be ecologically fragile, as there is a high number of rare flora species with many species and families represented by only one individual or species. Some of the species and families are endemic and have specialized habitats which make them more vulnerable to extinction. Medusandraceae, one of the five endemic families in Oban Hills was not recorded during this study, and it appears the family has become locally extinct. Therefore continued conversion of their particular habitat by human activities is a threat to their continued existence in the area.

It is recommended that, good land use planning be put in place and implemented. Also conservation efforts in the area should extend beyond the core and buffer zones to include support zone communities if the future of this remnant of the biologically diverse Gulf of Guinea forest in Nigeria is to be saved.

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