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Impact of deforestation on biodiversity in Anambra State, Nigeria

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ABSTRACT

Deforestation, particularly in the developing countries, is a major cause for concern. It has negative consequences on the environment. Its impact on biodiversity in Anambra State of Nigeria was what this work sought to investigate. The research was carried out in four agro-ecological zones of the state. Field inventories (of plant species) and population count of trees were carried out to generate data for biodiversity analysis. Species diversity indices such as Shannon-Wiener Index, Simpson Index and Importance value percentage were used to assess biodiversity. The results revealed that deforestation has negative impact on biodiversity in the state. Zone D has the highest species diversity and evenness compared to other zones while Zone B has the least species diversity and evenness. The impact of deforestation on biodiversity in Anambra State is seen in terms of loss of valuable plant species, reduced plant biomass, extinction of species and reduced species richness and evenness. The study recommended measures to curb deforestation. These include launching of biodiversity conservation campaigns and seminars, and the need to declare more areas as protected areas.

Keywords: Deforestation, biodiversity, exotic organisms, genetic variation, botanicals.

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INTRODUCTION

One very serious impact of deforestation is loss of biodiversity. According to Heywood and Baste (1995), biodiversity is defined in its broadest sense, as the "variety of life on earth," otherwise described in terms of gene, species and ecosystem. However, exotic organisms that have been introduced and communities such as agricultural fields that are maintained by regular intervention were excluded (Sala, 2000) from this definition. In cases where any species, either exotic or indigenous, is an integral part of the bio-ecological landscape, such definition becomes inappropriate. Biodiversity or biological diversity can be studied at different levels (genetic, species, ecosystem and community level). Biodiversity is mostly measured at species level using species richness (number of species), species diversity (types of species) and endemism (uniqueness of species to a certain area) as the most useful characteristics for comparison.

According to the Global Biodiversity Assessment by the Global Environmental Change (1995) species are now becoming extinct at 10,000 times the natural rate. There is a global increase in the rate of biodiversity loss. This can be attributed to the large-scale destruction of areas of forest cover resulting in loss of wildlife habitat, destruction of genetic variation (such as crop resistance), and loss of useful plant species of medicinal and economic values. Forest biotopes are irreplaceable source of new drugs such as taxol (Bio-medicine, 2008). According to Mittermeier et al. (2003) the Amazon region is estimated to harbor some 40,000 vascular plant species, of which 30,000 are endemic. Ter Steege et al. (2003) further stated that in the region of the Deforestation Arch, the number of such trees in an area of 1 km^2 of forest may vary from 45,000 to 55,000.

Sofowora (1993) reported an increasing trend in the use of medicinal plants amongst both urban and rural dwellers in Nigeria. According to him, this trend has serious implications on the survival of some plants species because of the unsustainable manner in which many species are harvested. Uneke and Ibeh (2009)

further reported that malaria control is suffering a setback in many rural southern Nigeria societies because deforestation has led to loss of plants that could provide new treatments for malaria and other diseases. In Ekiti State of Nigeria, the gradual extinction of botanicals used for treating malaria by indigenous people has been documented (Kayode, 2006). This work was carried out with a view to determining the impact of deforestation on biodiversity in Anambra State of Nigeria.

MATERIALS AND METHODS

Study area

This study was carried out in Anambra State of Southeastern Nigeria with the study sites located in four agro-ecological zones of the state established from the soil and vegetation maps modified from Ofomata, 1975. Anambra is a state in South-Eastern Nigeria. Its boundaries consist of Delta State to the west, Imo State to the south, Enugu State to the east and Kogi State to the north. Anambra state lies between Longitudes 6°35'E and 7°21'E and Latitudes 5°40'N and 6°45'N (Figure 1). The climate is tropical with high annual rainfall ranging from 1,400 mm in the north to 2,500 mm in the south, with a mean monthly temperature of 27.6°C. Heavy rainfall occurs within the months of April to October while the months of November to February have low rainfall, higher temperature and low humidity. Annual rainfall in Anambra State ranges from 1400 mm in the north to 2500 mm in the south. As a result, the natural vegetation in the state is predominantly tropical dry or deciduous forest, comprising of tall trees with thick undergrowth and numerous climbers in its pristine state. The typical trees are deciduous, shedding their leaves in the dry season. Such trees include *Ceiba pentandra* (Silk cotton) and *Pentaclethera macrophylla* (Oil bean). Deforestation has reduced the forest cover in the state. What remains of the vegetation is mostly secondary regrowth or a forest savanna mosaic. For this reason Anambra State is chosen as the study area to determine the impact of deforestation on the biodiversity of the state.

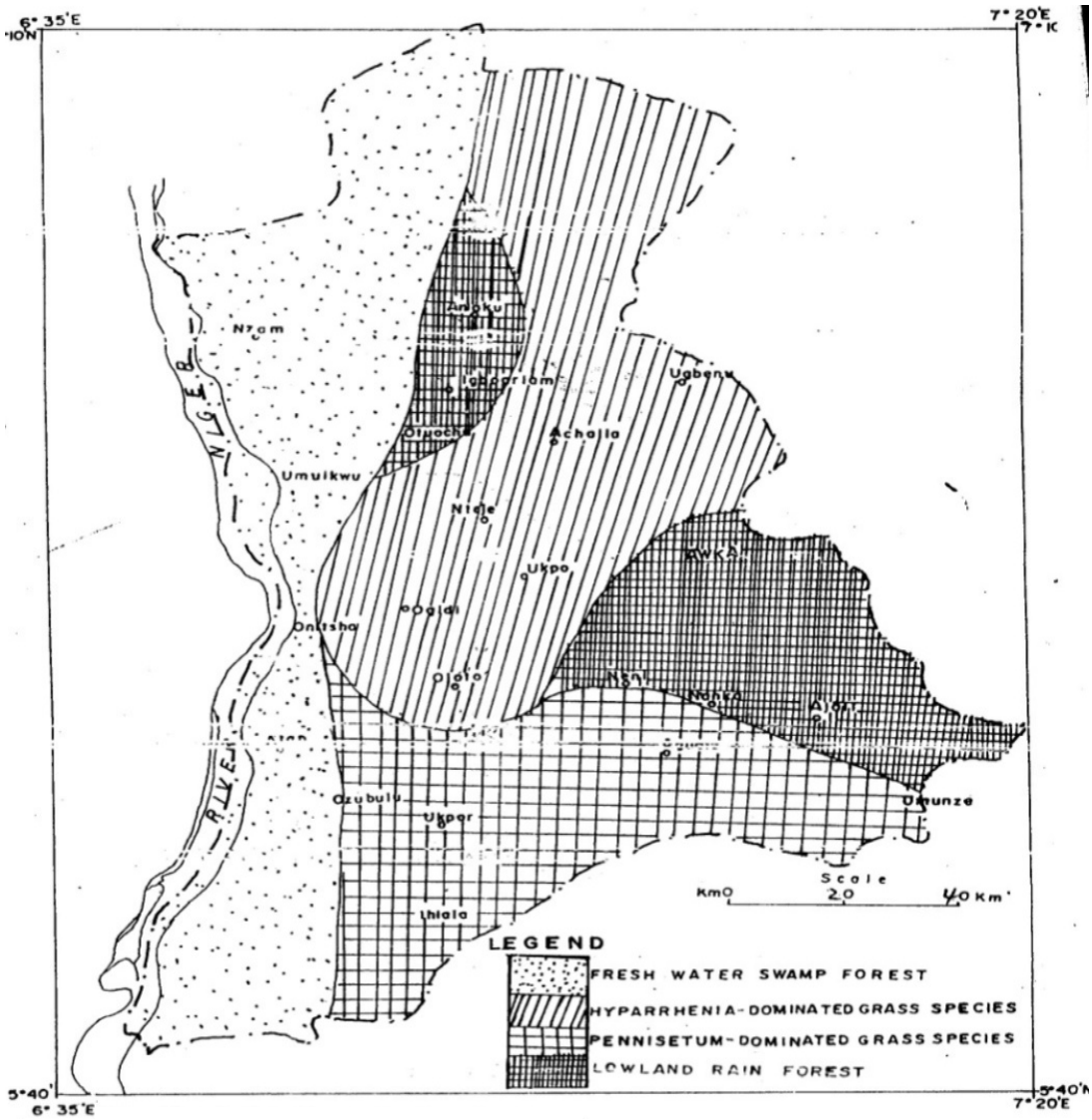

Figure 1. Vegetation map of Anambra State.

Sampling technique

The zones were designated as A, B, C and D. Zone A consist of pale brown loamy alluvial soils and fresh water swamp forest, Zone B consist of dip brown red soils derived from sandy deposits and pennisetum-dominated grass species, Zone C consist of red and brown soils derived from sandstones and shales and vegetation type is lowland rainforest, the type of soil in Zone D is reddish brown gravelly and pale clayey soils derived from shales and vegetation in this zone is hyparrhenia-dominated grass species. Five (5) communities were chosen from each of the four agro-ecological zones in the state by Simple Random Sampling method, making a total of 20 communities out of the 177 communities in the state.

Data analysis

Field inventory of biodiversity was carried out through population count to determine species diversity and species evenness. In the identification of plant species, we employed the services of a field botanist with rapid follow-up identification of the local names of the plant species through interview of the local inhabitants. Two rectangular plots each of 50 m × 50 m size were established and two 10 meter wide transects were laid out parallel. The total area of the transect was kept at 100 m^2 in each plot. The number of individuals of each species was then counted. Two 5 m × 5 m quadrants were laid out along with transects for the measurement of tree seedlings. The numbers of all seedling individuals of each species were counted. For each species the diversity and evenness indices were calculated and the frequency distributions obtained were characterized by their mean, standard deviation and coefficient of variation.

Calculations

The following formulae were used in diversity measurement:

$$\text{Simpson's index (D) } 1\text{-D} = \frac{1\text{-ni (ni-1)}}{\text{N (N-1)}}$$

Where N = total number of individuals, ni = number of individuals of the ith species.

Evenness Index $E = H^1/\log(S)$

Where E= Species Evenness, H^1 = the value of Shannon-Wienner Index, S= number of species (that is, species richness/diversity).

RESULTS AND DISCUSSION

Table 1 shows the result of the population count of trees in the different agro-ecological zones. The result revealed a total of 634 tree species in the sampled forests. Zone A has 149 tree species; Zone B has a total of 143 tree species; Zone C, 158 tree species while Zone D has the highest number of 184 tree species. There is a total of 81 tree species in the sampled farms, with Zones A, B, C and D having 22, 17, 21 and 21 tree species respectively in sampled plots. There were a total of 11,142 individual trees and an average of 557 trees in the sampled forests. While there were a total of 810 trees and average of 41 trees in all the sampled farmlands. Zone D had the highest number (3976) of individuals of tree species in sampled forests, followed by Zone B (2979), and Zone C (2254). Zone A had the least number of individuals of tree species in sampled forests. The mean number of individuals of tree species are 386.6, 595.8, 450.8 and 795.2 respectively for Zones A, B, C, and D. The result further reveals that Zone B had the highest number (253) of individuals of tree species in the sampled farmlands, followed by Zone D (245). Zones A and C had the lowest numbers of 130 and 182 trees respectively in sampled farmlands. Their average values are 26, 51, 36 and 49 trees respectively for Zones A, B, C, and D. It can also be seen from the result that Otuocha had the highest number (45) of tree species in sampled forests followed by Igbariam (39), Ihiala (36), Anaku (35) and Umunze (35). Onitsha had the least number of tree species in sampled forests. The reason could be attributed to the fact that Onitsha is a highly built-up area, in which case a lot of tree species were cut down. Achala had the highest number (1,190) of individual tree species in the forests studied, followed by Ihiala (1,080) Igbariam (1,062) and Otuocha (920). Otuocha and Igbariam had the highest numbers of tree species (7 each) found in sampled farmlands followed by Oroma-etiti (6), Mmiata (5), Ihiala (5), Ekwuluobia (5), Umunze (5).

Furthermore, Igbariam (108), Ihiala (104) and Umunze (82) had the highest numbers of individual trees found in sampled farmlands. Anaku (14) and Ojoto (14) had the lowest number of individuals of tree species followed by Mmiata (16) and Nanka (18). The mean number of tree species in sampled forest is 31.7 and 4.05 in sampled farms. The result also revealed low variability (CV = 16.28) for the number of tree species in the forest and moderate (CV = 37.12) variability for farm trees. Both the number of trees in sampled forest and farmlands showed high variability as indicated in Table 1.

The estimated number of trees was used to compute the diversity indices which were then used to explain the diversity (that is, richness) and evenness (the relative abundance of the different species making up the richness of an area) of species in the study area. The results compared the diversity of species between forests in different communities and between forests and farms in each agro-ecological zone. It also showed the number of species, number of individuals and the species dominance. In Simpson's Index of Diversity (1-D), the value ranges between 0 and 1; the greater the value, the greater the diversity of species. The index revealed that species in the forests recorded higher values than species in the farms in the four agro-ecological zones which is an indication of greater species richness (diversity) in the forests compared to the farms. This implies that conversion of forests to non-forest use, such as farmland has negative impact on the biodiversity of the area. One such impact is decline in species diversity.

Table 1. Estimated number of trees in the different agro-ecological zones of the study area.

Zones	Communities	No. of tree species		Total no. of individuals of species	
		Forest	Farmland	Forest	Farmland
	Nzam	28	4	536	37
	Mmiata	32	5	256	16
Zone A	Oroma-etiti	33	6	431	24
	Atani	27	3	540	31
	Umuem	29	4	170	22
Total		149	22	1933	130
Mean ($\bar{x}$)		29.8	4.4	386.6	26
Std Dev.		2.59	1.14	167.18	8.15
C. Var.		8.69	25.91	43.24	31.35
	Oba	28	4	840	57
	Ojoto	27	2	324	14
Zone B	Ukpor	31	3	420	52
	Ihiala	36	5	1080	104
	Onitsha	21	3	315	26
Total		143	17	2979	253
Mean ($\bar{x}$)		28.6	3.4	595.8	50.6
Std Dev.		5.51	1.14	345.58	34.78
C. Var.		19.27	33.53	58.00	68.74
	Awka	28	4	460	24
	Ekwuluobia	33	5	320	36
Zone C	Nanka	28	3	376	18
	Agulu	34	4	410	22
	Umunze	35	5	688	82
Total		158	21	2254	182
Mean ($\bar{x}$)		31.6	4.2	450.8	36.4
Std Dev.		3.36	0.84	142.05	26.36
C. Var.		10.63	20	31.51	72.42
	Igbariam	39	7	1062	108
	Achala	34	3	1190	48
Zone D	Ebenebe	31	2	524	21
	Otuocha	45	7	920	54
	Anaku	35	2	280	14
Total		184	21	3976	245
Mean ($\bar{x}$)		36.8	4.2	795.2	49
Std Dev.		5.40	2.59	381.32	37.14
C. Var.		14.67	61.67	47.95	75.79
Grand total		634	81	11142	810
Mean ($\bar{x}$)		31.7	4.05	557.1	40.5
Std Dev.		5.16	1.50	303.02	28.48
C. Var.		16.28	37.12	54.39	70.32

Source: Author's Field Work, 2011.

Comparing the diversity of the forests in the different communities and zones, it was noticed that the forests had closely related values of Simpson Index. However some communities and zones have forests with greater diversity. These include Otuocha (0.9731) and Igbariam (0.9711) in Zone D, Ihiala (0.9703) in Zone B. Communities with the least diversity of species include Onitsha (0.9474) in Zone B and Ekwuluobia (0.9489) in Zone C. Shannon-Wiener Index was further used to determine the diversity of species in the study area. Shannon-Wiener Index combines the number of species present and evenness into a single index. The value of the index ranges from 1.5 (low species richness and evenness) to 3.5 (high species richness and evenness). From the result, it was seen that the forests recorded values much higher than the farms in each of the agro-ecological zones. This implies low species richness and evenness for the farmlands. Though the plant species in the forests exceeded the critical value of 1.5, most of them fell below the high species richness and evenness values of 3.5. This is a further indication that the diversity of species is on the decline and this can be attributed to deforestation in the study area. However, communities like Otuocha (3.711) and Igbariam (3.602) in Zone D, and Ihiala (3.544) in Zone B exceeded the high species richness and evenness value of 3.5, which is an indication that these zones have abundance of forest species in some communities. This index further revealed that Onitsha (2.991) in Zone B had the lowest diversity of species.

The general results showed that the diversity and evenness in the forests, which are relatively undisturbed habitats, are much higher than in the farmlands, which are highly disturbed habitats. The forests in addition to having greater number of species also have more equitably distributed individuals among these species. The result also revealed that Zone D has the highest species diversity and evenness compared to other zones and that Zone B has the least species diversity and evenness.

CONCLUSION

Deforestation is having serious impact on biodiversity in Anambra State. This impact is seen in terms of loss of valuable plant species, reduced plant biomass, extinction of species and reduced species richness and evenness. Different degrees of disturbance have different effects on biodiversity. In order to preserve biodiversity in the state, there is need to understand how diversity is impacted by different human activities such as deforestation. The diversity indices employed in this study therefore served as valuable tools that enabled us to attempt a quantification of biodiversity in the study area and description of its numerical structure.

There is need to educate the people so as to create more awareness on the present and future impact of deforestation in the state. The non-governmental organizations and agencies active in environmental issues, including Forestry Commissions and Departments, should intensify efforts towards sensitizing the people on the need for environmental rehabilitation and conservation. This can be achieved through launching of biodiversity conservation campaigns and seminars. In addition, more areas should be declared protected areas. They should be designated forest reserves and there should also be establishment of parks, botanical gardens and zoos. Since farming has been implicated as one of the primary causes of deforestation in the study area, there is need to adopt farming systems that encourage conservation tillage. This should include introduction of organic farming method, hydroponics, greenhouse gardens, slash-and-char rather than slash-and-burn, as well as alley farming in which crops are interspersed with small trees.

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