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An Investigation on the Forest and Savanna Vegetation Types in Nnamdi Azikiwe University, Awka Campus, in Anambra State of Nigeria

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Abstract An investigation on the forest and savanna vegetation types in Nnamdi Azikiwe University, Awka campus, in Anambra state was carried out. This study was conducted on two communities (Science village forest vegetation type and Bank site savanna vegetation type) both located within the University Awka campus. The plot size of 5000 m^{-2} (50 m × 100 m) for the forest and 650 m^{-2} (25 m × 26 m) for savanna being their respective minimal areas were used. An analysis of the abundance of plant species above 1m in height in the forest vegetation type revealed that *Elaeis Guineensis* had the highest basal area (2268.59 $M^2{}_{ha}{}^{-1}$) and the *Gambeya Albida*had the lowest basal area (0.72 $M^2{}_{ha}{}^{-1}$**)**. It also revealed that *Elaeis Guineensis* had the highest important value index (35.7778 %) and *Gambeya Albida* had the least significant important value index (0.7589 %). The results further revealed that there were 38 families identified in the community. An analysis of the abundance of plant species above 1 metre in height in the savanna vegetation type revealed that 15 families of plant species were identified in the community. It also revealed that *Rothmannia Hispida*(61.53$M^2{}_{ha}{}^{-1}$), had the highest basal area while *Napoleana Vogelii* had the lowest basal area (1.03$M^2{}_{ha}{}^{-1}$). It also showed that *Terminalia Ivorensis* (51.63%) had the highest important value index while *Cnestis Ferruginia*(1.03%) had the lowest important value index. A critical look at the abundance of undergrowth plant species in the forest vegetation type revealed that 12 families of plant species were identified in the community. It further showed that *Setaria Longista* had the higher significant relative density (31.38%) and *Combretum Racemosum* (0.42%), *Cola hispid a*(0.42%), *Andropogangayanus*(0.42%), *Glyphaea Brevis*(0.42%), and *Holarrhaeno Flouribunda*(0.42%) had the least relative density. The abundance of undergrowth plant species in the savanna vegetation type showed that 9 families of plant species were identified. The result also showed that the community had the plant species diversity value of 0.88. Since soil pH, N, P, K and organic carbon are the five main contributing factors for plant growth and diversity in the study area, natural resources managers must consider the budget and balance of these resources for protection and to ameliorate soil, vegetation degradation and nutrient limitation.

Keyword Forest, Savanna, Vegetation, Abundance, Species, Ecology, Floristic

1. Introduction

Vegetation ecology is a complex scientific undertaking, both regarding the overwhelming variation of its object of study in space and time, and its intricate interaction with abiotic and biotic factors [1]. It is also a very modern science with important implications in well-known social activities, nature management, in particular the preservation of biodiversity, sustainable use of natural resources, and detecting 'global change' in the plant cover of the Earth. Vegetation is the plant cover of the earth consisting of assemblages of plants. Together with physiography, it constitutes the most observable element of landscape [2]. Vegetation expresses and reflects environmental conditions, particularly climate [3], [4]. Nigeria has two broad belts of vegetation types, namely, the forest and savanna types. There is, however, also the mountain vegetation of the isolated high plateau regions in the central and far eastern parts of the country.

Forests are vegetation types of plant formations in which trees are the dominant species. Nigeria has a heavily forested coastal south where humid tropical conditions favour tree growth. It maintains a closed canopy with high tree density and wetland [5]. Forest in Nigeria is sub-divided into zones, namely; mangrove swamp forest, freshwater swamp forest, and lowland rainforest. The lowland forest is stratified into three tree layers; lower, middle and top layers. The tropical rainforest is the world's richest biological resource, both in terms of species richness and structure, and is an outstanding feature of the tropics [6]. Tropical plants are distributed in diverse ecological zones, encompassing the humid, sub-humid, semi-arid climate zones. Also, they are known to have adaptations that conserve nutrients, most of which are tied up in living tissues [7].

The term savanna denotes a grassland ecosystem characterized by the trees being widely spaced so that the canopy does not close [1]. The open canopy allows sufficient light to reach the ground layer. The savannas' tree densities are more regularly spaced than in the forest. Savannas exist in the tropical and sub-tropical regions of Latin America, Africa and Australia [8] and parts of California, Chile, South Africa and Asia [9]. A noted climatic feature among savannas is their prolonged exposure to wet and dry periods. This climate forcing, combined with fire and grazing, cause savanna canopies to form open, heterogeneous woodland canopies with grass understory [10] [9] [11] [8] In Nigeria, the savanna vegetation type lies within the Guinea, Sudan and Sahel savanna zones of Nigeria. Plants of the savanna are highly specialized and have taproots that can reach the deep water table, thick bark to resist annual fires, trunks that can store water and leaves that drop off during the dry season to conserve water [11].

Comparatively, Forest vegetation is associated with greater nutrient or water availability [12] [13], but often this association is imperfect or non-existent [14] [12] [15] [16] [17]. Several conditions may explain a weak association between vegetation type and soil properties. First, savanna–forest boundaries are known to shift location in response to climate and fire regimes [18] [19] [20] [16] [21], therefore, vegetation distribution is not expected to be always in equilibrium with soil properties. The distribution of a forest may be limited by total nutrient stocks at the site, rather than the amount in the soil [15]. In the tropics, where a large fraction of ecosystem nutrient stocks resides in the vegetation, soil nutrient concentrations might give a poor reflection of overlying vegetation. Also, understanding the factors that govern the distribution of tropical forest and savanna has important implications for managing savanna ecosystems, elucidating the origin of the savanna biome and projecting the response of tropical landscapes to changing climate and disturbance regimes. Unfortunately, there is no consensus regarding the relative importance of climate, fire, hydrology, herbivory and soil characteristics in mediating the balance between these biomes [22] [19] [13] [3] [4]. Of the multiple factors that limit tree success in savanna, fire appears to be the most widespread and universal in savannas worldwide [23] [24]; so, it is doubtful that the distribution of savanna and forest can be adequately explained without explicitly considering the role of fire.

There is increasing conversion of forests to savanna in Nigeria due to cultivation, trends of human population increase, rapid developmental strides, annual grass fires, and unsustainable natural resource exploitation practices in these ecosystems. This will lead to an increase in the pressure on the species in the forest-savanna vegetation type. Destruction of these vegetation types will release carbon stock in them as carbon dioxide into the atmosphere, thereby increasing the greenhouse effect. Thus, this research work will specifically serve for posterity as a documentary of all the species present in both vegetation types. The aim of this research work is to investigate the forest and savanna vegetation types in Nnamdi Azikiwe University, Awka campus, in Anambra State of Nigeria. The objectives include:

(i) To determine the species composition of the two vegetation types;
(ii) To determine girths of all the species above 1m in height;
(iii) To determine the abundance of undergrowth, and
(iv) To determine the soils properties of both vegetation types.

2. Material and Methods

2.1. Description of the Study Area

This study was conducted on two communities (Science village forest vegetation type and Bank site savanna vegetation type) located within Nnamdi Azikiwe University, Awka campus (Awka lies between latitudes $7^{0}00$'N and $7^{0}10$'N and longitudes $6^{0}05$'E and $6^{0}15$'E), in Anambra State of Nigeria. It lies within the humid tropical rainforest belt of Nigeria characterized by trees, evergreen leaves, thick undergrowth, open vegetative lowland, interspersed with tall oil palm trees and deciduous trees. It has an annual rainfall of 1600 mm to 2000 mm on the average (Richard, 2005). It has Mean annual temperature ranges between 27^{0}C and 35^{0}C (Richard, 2005).

2.2. The Geology

The study site is founded on the outcrops of Imo Shale in the Anambra basin. The Anambra basin is usually characterized by the sediments of the cretaceous and younger ages. The detrital rocks were formed by sedimentation of mineral and rock fragments. The grain size analysis revealed that the sandstones are fine-grain into coarse-grained poorly sorted, leptokuartic, positively skewed, burrowed and trough cross bedded but exhibits ophiomorpha and Paleocene which belongs to the SKIOLITHOS ICHNOFOSSILS [25]. Further heavy mineral analysis reveals an evidence of metamorphic and igneous from Nigerian basement complex and Oban massif. The texture of the soil depends upon the properties of the various fractions of which it is composed. It includes sandy, loamy, and clay. The soil provides water and minerals, providing anchorage for roots and so assists with the plant's mechanical support.

2.3. Data Collection for the Species Composition

In an attempt to determine the soil and vegetation types of both communities, a preliminary survey was conducted around those areas of savanna and forest with a view to identifying them. Two communities (a savanna and a forest) were selected. The plot size of 5000 m^{-2} (50 m × 100 m) for the forest and 650 m^{-2} (25 m × 26 m) for savanna being their respective minimal areas were used [26] After marking out the plots, pegs were used at each end to peg them for proper delineation. A complete enumeration was adopted in sampling for the abundance of all the trees above 1 m in height in both communities. In order to avoid edge effect, 3 m gap was given from edge of the plot. A quadrant measuring 1 m × 1 m was used to count all the undergrowth vegetation. The girths of all the species above 1 m in height were measured at breadth height, using a tape measure.

All the species encountered were identified using the services of experts and employing relevant flora such as a Handbook of West Tropical Africa Weeds by [27] and Flora of West Tropical Africa by [28]. In addition, some photographs were taken in both vegetation types using camera and twigs of plants were also collected and coded for ease of species identification.

2.4. Computation of Data

After the sampling, the species inventory of the study area was prepared. In order to quantify species abundance in both the savanna and forest, the species abundance measure of the trees above 1 m in height were calculated using the formulae below:

Density = No of each species/*Total area sampled*

Relative density = Density of each species/ *Total density of all sp.1* x 100

Basal area (BA) = $C^2/4\pi$

Where C= girth measurement in metres

Relative basal area (RBA) = *BA of all trees of sp./ Total BA of all species 1 × 100*

2.5. The Species Diversities of the Two Sampled Plots

Shannon – Wiener index of diversity was used to determine the species diversity of the study communities, using the formulae below:-

$$H = -\sum_{i=r}^{s} (Pi \times \ln pi)$$

H max = L n S

Equitability = H-/ H max

Where - ∑ =summation

S =number of species

i– I =individual species to one

pi = proportion of individual species

l n pi = natural log of the proportion of species

2.6. Collection of Soil Samples

Within the study sites, grass was cleared using a matchet. By means of a soil auger, soil was collected to a depth of 15 cm (top soil). To ensure that all parts of the plot were sampled, each plot was divided into four quarters and three sampling points were randomly located in each plot. Nine soil samples were collected from each plot. All the soil samples from a site were bulked, large lumps were broken into small pieces, stones and gravel were discarded and the soil was mixed thoroughly. In the end only 2 kg of the composite sample were taken, placed in a polythene bag and carefully labelled with the location before it was transported to the laboratory.

In the laboratory, large lumps were further broken up and the soil was finally spread out on large sheets of paper on laboratory benches and allowed to air- dry.

When air-dried, this soil sample was ground in a mortar with a wooden pestle which allows the aggregate to be crushed, but no actual grinding or breakdown occurred. The sufficiently ground soil was sieved through a 2 mm sieve, while stones and large root residues were discarded. The fine soil which passed through a 2 mm sieve was stored in labelled small bottles. The particle size distribution was determined by the hydrometer method [28].

3. Results

3.1. Floristics and Structural Features of the Vegetation Types

An analysis of the abundance of plant species above 1m in height in the forest vegetation type in Table 1 revealed that *Elaeisguineensis* had the highest basal area (2268.59 $M^2{}_{ha}{}^{-1}$) and the *Gambeya albida*had the lowest basal area (0.72 $M^2{}_{ha}{}^{-1}$). It also revealed that *Elaeis guineensis* had the highest important value index (35.7778 %) and *Gambeya albida* had the least significant important value index (0.7589 %). The results further revealed that there were 38 families identified in the community. The result also showed that the community had high species diversity of 0.94. Also, the results revealed that the families Fabaceae, Euphorbiaceae, Apocynaceae, Moraceae, Sterculiaceae, and Bignoniaceae had the highest number of species and Loganiaceae, Olacaceae, Hyperiaceae, Bombacaceae, Dichapetalaceae, Annonaceae, Sapindaceae, Rubiaceae, Smilacaceae, Meliaceae, Passifloraceae, Tiliaceae, Palmaceae, Malvaceae, Sapotaceae, and Burseraceae had the least number of plant species. Also, in the table, the result showed that *Elaeis guineensis*and *Barteria nigritiana* had more than 57%relative basal area (RBA).

Table 1. The abundance of plant species above 1m in height in the forest vegetation type.

S/NO	Plant species	Family	Density **(M^{-2})**	Rel. density (%)	Basal area **($M^2{}_{ha}{}^{-1}$)**	RBA (%)	IVI (%)	Shanon-Wiener Index of species diversity
1.	*Anthocleista djalonensis*	Loganiaceae	0.0006	2.24	24.94	0.3069	2.5469	0.94
2.	*Alchornia cordifolia*	Euphorbiaceae	0.0006	2.24	66.96	0.8240	3.0640	
3.	*Napoleona vogelii*	Lecythidaceae	0.0012	4.48	22.47	0.2765	4.7565	
4.	*Holarrhena floribunda*	Apocynaceae	0.0008	2.99	18.39	0.2259	3.2159	
5.	*Dalbergia welwistshii*	Fabaceae	0.0006	2.24	38.54	0.4743	2.7143	
6.	*Musanga cecropoides*	Moraceae	0.0008	2.99	60.21	0.7410	3.7310	
7.	*Pterocarpus osun*	Fabaceae	0.0012	4.48	82.55	1.0159	5.4959	
8.	*Arungana madagascarinsis*	Hyperiaceae	0.0004	1.49	20.38	0.2508	1.7408	
9.	*Ceiba pentandra*	Bombacaceae	0.0002	0.72	894.59	11.0911	11.8111	
10.	*Pterocarpus santalinoides*	Fabaceae	0.0008	2.99	188.83	2.3238	5.3138	
11.	*Cola hispida*	Sterculiaceae	0.0004	1.49	3.26	0.0401	1.5301	
12.	*Alstonia boonei*	Apocynaceae	0.0004	1.49	14.30	0.1760	1.6660	
13.	*Cola gigantean*	Sterculiaceae	0.0006	2.24	354.21	4.3590	6.5990	
14.	*Treculia Africana*	Moraceae	0.0006	2.24	1339.34	16.4823	18.7223	
15.	*Dichapetalum barteri*	Dichapetalaceae	0.0008	2.99	17.91	0.2204	3.2104	
16.	*Sterculia tragacarntha*	Sterculiaceae	0.0008	2.99	298.20	3.6697	6.6597	
17.	*Dialium guineense*	Fabaceae	0.0012	4.48	16.51	0.2032	4.6832	
18.	*Alstonea congensis*	Apocynaceae	0.0008	2.99	31.21	0.3841	3.3741	
19.	*Cleistopholis pateris*	Annonaceae	0.0006	2.24	313.00	3.8519	6.0919	
20.	*Paullinia pinnata*	Sapindaceae	0.0008	2.99	1.61	0.0198	3.0098	
21.	*Rothmannia longiflora*	Rubiaceae	0.0008	2.99	108.10	0.1330	3.1230	
22.	*Malaranga barteri*	Euphorbiaceae	0.0002	0.75	1.45	0.0181	0.7681	
23.	*Albizia zygia*	Fabaceae	0.0004	1.49	6.45	0.0794	1.5694	
24.	*Baphia nitida*	Fabaceae	0.0012	4.48	15.61	0.1921	4.6721	
25.	*Newbouldia laevis*	Bignoniaceae	0.0014	5.22	13.66	0.1681	5.3881	
26.	*Khaya senegalensis*	Meliaceae	0.0004	1.49	5.75	0.0708	1.5608	
27.	*Elaeis guineensis*	Arecaceae	0.0020	7.46	2263.59	27.9178	35.3778	
28.	*Glyphaea brevis*	Tiliaceae	0.0008	2.99	4.24	0.0522	3.0422	
29.	*Landolphia dulcis*	Apocynaceae	0.0008	2.99	0.92	0.0113	3.0013	
30.	*Ficus carpensis*	Moraceae	0.0012	4.48	39.59	0.4872	4.9672	
31.	*Millettia aboensis*	Fabaceae	0.0012	4.48	15.83	0.1948	4.9672	
32.	*Tabebuia rosea*	Bignoniaceae	0.0002	0.75	20.38	0.2508	1.0008	
33.	*Barteria nigritiana*	Passifloraceae	0.0004	1.49	1650.96	20.3171	21.8071	
34.	*Dalbergin saxatilus*	Fabaceae	0.0012	4.48	159.08	1.9577	6.4377	
35.	*Carapa procera*	Meliaceae	0.0002	0.75	5.10	0.0628	0.8128	
36.	*Icacina senegacensis*	Fabaceae	0.0002	0.75	0.82	0.0101	0.7601	
37.	*Gambeya albida*	Sapotaceae	0.0002	0.75	0.72	0.0089	0.7589	
38.	*Dacryodes edulis*	Bursaraceae	0.0002	0.72	1.27	0.0156	0.7656	

Table 2. The abundance of plant species above 1 metre in height in the savanna vegetation type.

S/NO	PlantSpecies	Family	Density(M^{-2})	Rel.density(%)	Basal area(M^2ha^{-1})	RBA(%)	IVI(%)	Shannon Wiener index of species diversity
1	Anthocleista djalonensis	Loganiaceae	0.0231	4.68	1.99	0.9	5.58	0.62
2	Vitex doniana	Verbenaceae	0.0108	2.19	31.85	14.44	16.63	
3	Acacia farnesiana	Fabaceae	0.0077	1.56	2.68	1.21	2.77	
4	Alchornia cordifolia	Euphorbiaceae	0.0108	2.19	25.25	11.45	13.64	
5	Annona senegalensis	Annonaceae	0.0031	0.63	5.89	2.67	3.3	
6	Nauclea latifolia	Rubiaceae	0.0169	3.43	21.94	9.94	13.37	
7	Bridelia ferruginea	Euphobiaceae	0.0015	0.3	20.38	9.24	9.54	
8	Napoleana vogelii	Lecythidaceae	0.0046	0.93	1.03	0.47	1.4	
9	Holarrhena floribunda	Apocynaceae	0.0015	0.3	31.85	14.44	14.74	
10	Cnestis ferruginia	Conaraceae	0.0031	0.63	2.87	1.3	1.93	
11	Rothmannia hispida	Rubiaceae	0.0062	1.26	61.53	27.9	29.16	
12	Olax viridis	Olacaceae	0.0154	3.12	2.32	1.05	4.17	
13	Terminalia ivorensis	Combretaceae	0.2415	48.97	5.89	2.66	51.63	
14	Uvaria chamae	Annonaceae	0.0901	18.27	1.68	0.76	19.03	
15	Lonchocarpus cyanescense	Fabaceae	0.0569	11.54	3.47	1.57	13.11	

An analysis of the abundance of plant species above 1 metre in height in the savanna vegetation type in Table 2 revealed that 15 families of plant species were identified in the community. It also revealed that *Rothmanniahispida*(61.53 $\mathbf{M^2}_{\mathbf{ha}}{}^{\mathbf{-1}}$), had the highest basal area while *Napoleanavogelii* has the lowest basal area ($1.03M^2{}_{ha}{}^{-1}$). It also showed that *Terminaliaivorensis*(51.63%) had the highest important value index while *Cnestisferruginia*(1.03%) had the lowest important value index (IVI). It further revealed that *Terminaliaivorensis*had the higher significant density value while *Holarrhena floribunda,* had the least density value. More so, the result revealed that the community had the species diversity value of 0.62. Also, it is revealed that the families Fabaceae, Annonaceae, Euphorbiaceae had higher number of species and Loganiaceae, Rubiaceae, Verbenaceae, Lecythidaceae, Apocynaceae, Conaraceae, Olacaceae, Combretaceae had the least number of species. In the table, it showed that *Vitexdoniana* followed by *Holarrhena floribunda* had the higher relative basal area while *Uvariachamae,* followed by *Napoleanavogelii* had insignificant relative basal area.

A critical look at the abundance of undergrowth plant species in the forest vegetation type in Table 3 below revealed that 12 families of plant species were identified in the community. It further showed that *Setarialongista* had the higher significant relative density (31.38%) and *Combretum racemosum* (0.42%), *Cola hispida* (0.42%), *Andropogan gayanus*(0.42%),*Glyphaeabrevis* (0.42%), and *Holarrhaeno flouribunda*(0.42%) had the least relative density. It is also revealed that the community had a species diversity value of 0.76. Also, in the Table, the families Poaceae, Fabaceae, and Sterculiaceae had higher number of undergrowth species while Malvaceae, Asteraceae, Olacaceae, Lecythidaceae, Combretaceae, Apocynaceae, Bignonaceae, Smilacaceae, Arecaceae, Tiliaceae, had the least number of undergrowth species.

Table 3. The abundance of undergrowth plant species in the forest vegetation type

S/NO	Plant Species	Family	Density(M-2)	Rel. density(%)	Shannon-Wiener index of species diversity
1	Urena lobate	Malvaceae	0.5	4.18	0.76
2	Chromolena odorata	Asteraceae	0.45	3.77	
3	Olax viridis	Olacaceae	1.25	10.46	
4	Baphia nitida	Fabaceae	0.2	1.67	
5	Cola gigantean	Sterculiaceae	0.35	2.93	
6	Napoleana vogelii	Lecythidaceae	1.05	8.79	
7	Combretum racemosum	Combretaceae	0.05	0.42	
8	Cola hispidia	Sterculiaceae	0.05	0.42	
9	Holarrhena floribunda	Apocynaceae	0.05	0.42	
10	Newbouldia laevis	Bignonaceae	1.55	12.97	
11	Smilax kraussiana	Smilacaceae	0.25	2.09	
12	Elaeis guineensis	Arecaceae	1	8.39	
13	Glyphaea brevis	Tiliaceae	0.05 -	0.42	
14	Millettia aboeusis	Fabaceae	0.35	2.93	
15	Setaria longista	Poaceae	3.75	31.38	
16	Senna obtusifolia	Fabaceae	0.1	0.84	
17	Oplismenus burmannii	Pocaeae	0.8	6.69	
18	Impomea involucrata	Convulvuaceae	0.1	0.84	
19	Andropogan gayanus	Poaceae	0.05	0.42	

Table 4. The abundance of undergrowth plant species in the savanna vegetation type.

S/NO	Plant Species	Family	Density(M-2)	Rel. density(%)	Shannon- Wiener index of species diversity
1	Uvaria chamae	Annonaceae	0.4	3.17	0.88
2	Lonchocarpus cyanescens	Fabaceae	0.25	1.98	
3	Annona senegalensis	Annonaceae	0.65	5.16	
4	Alchornia cordifolia	Euphorbiaceae	0.15	1.19	
5	Acacia farnesiana	Fabaceae	0.2	1.59	
6	Anthocleista djalonensis	Loganiaceae	0.65	5.16	
7	Urena lobata	Malvaceae	2.55	20.24	
8	Chromolena odorata	Asteraceae	1.2	9.52	
9	Eclipta alba	Asteraceae	0.05	0.4	
10	Imperata cylindrica	Poaceae	1.2	9.52	
11	Andropogan tectorum	Poaceae	1.65	13.1	
12	Leptochloa caerulescens	Poaceae	0.85	6.75	
13	Cymbopogon citrates	Poaceae	0.05	0.4	
14	Diodia scander	Rubiaceae	1.05	8.33	
15	Schwenekia Americana	Solanaceae	0.5	3.97	
16	Vernonia cinerea	Asteraceae	0.9	7.76	

The abundance of undergrowth plant species in the savanna vegetation type in Table 4 showed that 9 families of plant species were identified. The result also showed that the community had the plant species diversity value of 0.88. The result further revealed the *Urenalobata* (2.55 M^{-2}) had the highest density and *Ecliptaalba* (0.05 M^{-2}), *Mimosa pudica* (0.05 M^{-2}) had the lowest density value. It also revealed that the families Fabaceae, Poaceae, Asteraceae, Annonaceae had the higher number of plant species while Euphorbiaceae, Loganiaceae Malvaceae, Rubiaceae, Solanaceaehad the least number of species.

3.2. Comparison of the Floristic and Structural Attributes of the Forest and Savanna

The floristic richness of the forest over the savanna vegetation were well establish in this study. Consequently, in comparison forest vegetation type in the tables above revealed that plants species above 1m in height had 38 plant species, 20 families, higher latex-producing plant, higher basal area, higher species diversity value and woody climbers when compared to savanna vegetation that had 15 plant species, 9 families and virtually no woody climber.

Nevertheless, despite the apparent richness of the forest vegetation type discussed above, the undergrowth plant species in the savanna vegetation type were floristically rich when compared to forest vegetation type as depicted by the result.

3.3. Soil Properties

Soil analysis in Table 5 result below showed that the forest vegetation type had the higher soil pH (6.129), organic carbon (0.6185%), porosity (44.55%) nitrogen (6.046%), potassium (0.063 meq/100 g), and phosphorus (14.60 ppm), concentrations of nutrients compared to soil properties of the savanna vegetation: nitrogen (0.065%), soil pH (5.763), potassium (0.033 meq/100 g), organic carbon (0.5786%), phosphorus (9.20 ppm), porosity (38.96%).

The analysis of the soil textural classes of both the forest and savanna vegetation type in Table 6 revealed that the forest vegetation type had the higher percentage composition of sand (80.24%), clay (4.76%) content compared to the percentage composition of sand (72.24%), clay (1.76%) of the savanna vegetation type. The result also showed that the forest vegetation type had the lower percentage composition of silt (15.00%) compared to the percentage composition of silt (26.00%) of the savanna vegetation type. Both communities had the same textural class, that is, loamy sand.

Table 5. Some soil properties in both the forest and savanna vegetation type

Community	Nitrogen(%)	Soil pH	Potassium(meq/100 g)	Phosphorus(ppm)	Organic carbon(%)	Porosity(%)
Forest	6.046	6.129	0.063	14.6	0.6185	44.55
Savanna	0.065	5.763	0.033	9.2	0.5786	38.96

Table 6. The soil textural classes in both forest and savanna vegetation types

Community	Sand (%)	Clay (%)	Silt (%)	Textural classes
Forest	80.24	4.76	15	Loamy sand
Savanna	72.24	1.76	26	Loamy sand

Plate 1: *Vernonia cinerea* (Asteraceae)

Plate 2: *Annona senegalensis* (Annonaceae)

Plate 3: *Olax viridis* (Olacaceae)

Plate 4: *Cymbopogon citrates* (Poaceae)

Plate 5: *Cola gigantean* (Sterculiaceae)

Plate 6: *Eleais guineensis* (Areceae)

Plate 7: *Smilax kraussiana* (Smilaceae)

Plate 8: *Nauclea latifolia* (Fabaceae)

Plates 1-8. Photographs of some of the plant species in the study plots

4. Discussion

The observed higher species diversity, higher number of species, higher number of families, higher number of latex-producing plant, higher number of woody climbers is in line with widely established fact that the tropical forest is much more species diverse than the savanna. This assertion was confirmed from this study which revealed that tree species above 1m and girth at 1.3m breast height in forest vegetation type had higher species diversity value compared to savanna vegetation type as depicted by the result with few species being common to both environments. This observed high species diversity of the tropical forest vegetation type in relation to savanna vegetation type was attributed to human impact of both vegetation types since they lie within the same climatic zone. The savanna is derived due to farming and burning as such nutrients are loss. For instance, [30][31][32][33] findings reported that species diversity has a strong correlation to the nutrients composition of the soil. The forest vegetation type had higher number of families and species compared to savanna vegetation type that had lower number of families and species as indication by the results. The observation was attributed to high species diversity of forest vegetation type. This observed high number of plant species and families in the forest vegetation type and lower number of plant species in the savanna vegetation type is in line with the findings of [34][35] who report that the species diversity observed for both forest and savanna lies within the range reported for tropical forests, often higher than savanna vegetation. The higher basal area noticed in the forest vegetation compared to savanna vegetation as depicted by the result, was as a result of the more tree species of the forest. This attribute led to high cover value of the forest vegetation observed. According to [36], tropical forest is a large area of land that has luxuriant vegetation belt and thickly covered with trees. Notably, some plant species from the families such as Annonaceae, Apocynaceae, Fabaceae, Euphorbiaceae, Verbenaceae, etc were very common in both vegetation types. This could be an indication of adaptative ability of the species concerned. In addition, woody climbers ranging from *Landolphiaducis, Smillaxkraussiana, and Combretum racemosum* were also abundant in the forest vegetation and there were virtually none in the savanna vegetation as shown by the result. Latex-producing plants were also abundant and include *Treculiaafricana, Gambeyaalbida,* etc in the forest vegetation type compared to savanna vegetation type that had only *Holarrhena floribunda*. These were attributed to the high diversity of the forest vegetation as shown by the result. This confirmed [46] report that tropical forest ecosystem is highly diverse in nature.

Despite higher species diversity of the forest vegetation type discussed above, observation from the results had also shown that the undergrowth savanna had high species diversity, higher density, higher frequency, and higher important value index compared to forest vegetation. The high species diversity of the savanna was attributed to the openness of the vegetation and so, more plants had the capacity to adapt to the area as they germinate and grow since there is enough light penetration and thus, less competition for light and space. This observed higher species diversity is in line with widely established fact that savanna vegetation often had high grass understory [8]. These grasses, shrubs, forbs and short trees were more numerous and also because they had the capacity to resprout after the devastating effects of fire and thus, adapted to the community. This observation supported [1] finding that savanna is a grassland ecosystem characterized by trees being widely spaced so that the canopy does not close.

Not minding the higher species diversity of the undergrowth savanna in the vegetation discussed above, results indicated that forest soil had the higher total percentage concentration of nitrogen, mean equivalent per gram potassium, parts per million of phosphorus, percentage porosity, percentage of organic carbon compared to the total percentage of nitrogen, mean equivalent per gram potassium, parts per million of phosphorus, percentage porosity, percentage of organic carbon, in the savanna soil. The higher soil C, N, P and pH in the forest vegetation observed was attributed to the increase imput of organic matter by plant residues (litter) of the dense forest vegetation. This is correlated with the established evidence that nutrient concentration correlated with litter accumulations [37], decomposition rate [38], that most organic matter imput in tropical forest soil is in the form of litter fall [39], so the difference in leaf litter between savanna and forest species have important implication for nutrient cycling in the respective habitats. Secondly, vegetation affects N-mineralization through litter quality and quantity [40]. Forest vegetation is associated with greater nutrient [12] [13]. This observation is suggesting the advantage of forest vegetation in conserving soil fertility. The low nutrient concentration observed in savanna was attributed to poor litter quality and quantity. According to [41] poor nutrient concentration is common trait in nutrient-poor environment. In addition, the low concentration of organic carbon, potassium, phosphorus noticed in the savanna vegetation type as shown by the result may result due to (a) intensive cattle grazing and (b) by prominent deforestation for fuel by people. This suggestion is supported with the findings of [42] who reported that deforestation resulted in loss of 51.2% organic-C and 52.7% organic-N in the Vindhyan Plateau. The observed high soil pH and porosity shown in the forest vegetation could partly result from high soil organic matter content and boring activities of the soil microorganisms that aid soil nutrients decomposition and aeration. For example, [43][44] report that increase in organic matter content led to increase of water retention in sandy soils by increasing soil aggregate stability and porosity. The soil pH and porosity is also known to have large effects on nitrogen cycling in ecosystems [45]. There was no significant difference in the textural classes of the soils underlying both forest and savanna vegetation types as the result depicted.

5. Conclusions

In conclusion, the results have shown clear indications that;

- Tree species above 1m in the forest vegetation type had the highest plant species diversity than the savanna plant species vegetation types.
- Undergrowth plant species in savanna vegetation type had the highest plant species diversity than the forest vegetation type.
- The soil composition in forest vegetation type had the highest mineral composition than the savanna soil vegetation type.
- That both vegetative communities had the same soil textural class (loamy soil).
- Climatic factors, may not be the causal factor of the two vegetation types since they are very close to each other.
- It is suggested that the most contributory factor to the observed differences could be human impact.

Since soil pH, N, P, K and organic carbon are the five main contributing factors for plant growth and diversity in the study area, natural resources managers must consider the budget and balance of these resources for protection and to ameliorate soil, vegetation degradation and nutrient limitation.

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