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Plants Diversity along Watershed Environment: A Case Study at Ikot Uso Akpan Wildlife Sanctuary in Itu L.G.A. of Akwa Ibom State, Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author RMU designed the study, performed the statistical analysis, Authors FOO wrote the protocol, and wrote the first draft of the manuscript. Authors NIE and FOO managed the analyses of the study and literature searches. All authors read and approved the final manuscript.

Research Article

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ABSTRACT

Plant diversity and soil characteristics were studied along watershed environment in Ikot Uso Akpan Wildlife Sanctuary of Itu Local Government Area, Akwa Ibom state. The systematic sampling method was used to sample the vegetation in 10m x10m quadrats. Plants were identified to species level. Vegetation attributes such as frequency, density, height, basal area and crown cover, were measured for each species. In each quadrat, two soil samples were collected and bulked into one composite sample. A total of twenty soil samples were collected. Soil physicochemical properties were analyzed in the Soil Science Laboratory of University of Uyo, Uyo. 42 plant species belonging to 33 families and 38 genera were identified in all the sampling area. The results showed that *Elaeis guineensis* was the most abundant species with 70% frequency of occurrence while *Rauvolfia vomitoria* was the least with 10% frequency of occurence. *Carpolobia lutea* had the highest mean density of 250±0.00stems/ha while 6 plant species had the least mean density of 25±0.00stems/ha. *Brachystegia eurycoma* had the highest mean height while *Aframomum sceptrum* was the shortest plant. *Brachystegia eurycoma* had the highest mean basal area of 1.10±0.001m^2/ha, while *Costus afer* had the smallest mean basal area of

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0.00002±0.000008m^2/ha. *Brachystegia eurycoma* had the highest mean crown cover of 213.71±0.00m^2/ha, while *Aframomum sceptrum* had the smallest mean crown cover of 0.077±0.009m^2/ha. The soil was slightly acidic with pH mean value of 5.41±0.15. Organic Carbon, Total Nitrogen, Sodium and Potassium were low with mean values of 1.53±0.33%, 0.07±0.01%, 0.06±0.004 Cmol/kg and 0.10±0.01 Cmol/kg, respectively. Among the heavy metals, Iron (Fe) had the highest mean value of 36.16±8.94mg/kg, followed by Manganese (Mn) with mean value of 6.48±0.46mg/kg. The soil had high sand content of 89.20±0.80%, and low silt and clay contents of 5.40±0.20% and 5.40±0.60%, respectively. Linear regression of soil parameters and vegetation components showed that soil characteristics affected the abundance and distribution of vegetation components. This indicates that they play a vital role in plants diversity and distribution along watershed environments.

Keywords: Watershed; plant diversity; Akwa Ibom State.

1. INTRODUCTION

Plants are the primary foodstuffs for livestock and wildlife, and the key to a healthy watershed. Plants are universally recognized as a vital component of the world's biological diversity and an essential resource for the planet. Plants play a key role in maintaining the planet's basic environmental balance and ecosystem stability and provide an irreplaceable component of the habitats for the world's animal life, Pearson [1]. Of urgent concern is the fact that many plant species, communities, and their ecological interactions, including the many relationships between plant species and human communities and cultures, are in danger of extinction, threatened by such human-induced factors as, inter alia, climate change, habitat loss and transformation, over-exploitation, alien invasive species, pollution, clearing for agriculture and other development [2]. Furthermore, plant diversity is of special concern to indigenous and local communities, and these communities have a vital role to play in addressing the loss of plant diversity [2]. Diversity comes from adaptation and species conflict. Plant diversity refers to the variety of plants that exist in the world (Pearson, 2012). Plants compete with other plants and organisms to survive in an ecosystem [1]. The diversity of plants may drop during climate change. As temperatures change in diverse regions, even by just a few degrees, species can lose their ability to adapt, and die off. Other areas warm up and become more ideal for plant growth, but plant diversity takes a very long time to develop [1]. Environmental conditions play a key role in defining the function and distribution of plants, in combination with other factors [3] It is predicted that climate change will remain one of the major drivers of biodiversity patterns in the future [4,5].

The diversity of plant life is an essential underpinning of most of our terrestrial ecosystems [6]. Humans and most other animals are almost totally dependent on plants, directly or indirectly, as a source of energy through their ability to convert the sun's energy through photosynthesis [6]. Another important role of plant life is the provision of ecosystem services the protection of watersheds, stabilization of slopes, improvement of soils, moderation of climate and the provision of a habitat for much of our wild fauna [7]. A watershed is the area of land where all of the water that is under it or drains off of it goes into the same place. John Wesley Powell, scientist geographer, put it best when he said that a watershed is: "that area of land, a bounded hydrologic system, within which all living things are inextricably linked by their common water course and where, as humans settled, simple logic demanded that they become part of a community" [8,9]. Because the water naturally moves downstream in a watershed, any activity affecting the water quality, quantity, infiltration, or rate of drainage at one location in the watershed can change the physical, chemical, and biological characteristics at downstream locations [10].

A watershed being an area of land from which all water drains, running downhill, to a shared destination (a river, pond, stream, lake, or estuary) could also be defined as a catchment basin that is bound by topographic features, such as ridge tops [11]. A watershed has three primary functions:

First, it captures water from the atmosphere. Ideally, all moisture received from the atmosphere, whether in liquid or solid form, has the maximum opportunity to enter the ground where it falls. The water infiltrates the soil and percolates downward. Several factors affect the infiltration rate, including soil type, topography, climate, and vegetative cover [11].

Second, a watershed stores rainwater once it filters through the soil. Vegetation in the riparian zone affects both the quantity and quality of water moving through the soil [11].

Finally, water moves through the soil to seeps and springs, and is ultimately released into streams, rivers, and the ocean which forms the basis of watershed function [11].

There are four primary factors that affect the quality and function of resources in a watershed: Water quality, Flow regime, Habitat (structure and function) and Energy source [12]. This paper therefore examines the importance of watershed, plant diversity and the factors which affects them in determining the diversity of plants in that area.

2. MATERIALS AND METHODS

2.1 Study Area

This study was carried out in Ikot Uso Akpan Wildlife Santuary in Itu Local Government Area of Akwa Ibom State. Akwa Ibom State is situated between latitudes 4º31' and 5º30' N and longitude 7º31' and 8º20' E. It has a total land area of about 8,412km^2 [13]. The topography is partly plain (flat) and hilly, the surrounding lands are cultivated. The area has characteristically two seasons, dry and wet seasons. The dry season of the area occurs between November and April, while the wet season stretches between May and October. Rainfall is heavy and ranges from 3,000mm along the coast, but decreases to 2,000mm on the North fringe. Mean temperature of the area is usually uniformly high throughout the year with slight variation between 25ºC and 28ºC. Relative humidity is high between 75% and 85%.

The study area covers an area of about twenty hectares upon which vegetation and soil were sampled. The vegetation is dense and evergreen in some plots.

2.2 Vegetation and Soil Sampling

Systematic sampling method was used in sampling the area [14], species were sampled in 10m x 10m quadrat, spaced at regular interval of 100m. Plants were enumerated and species were properly identified to the species level. Vegetation measurement includes the frequency of plant species, density, basal area, height and the crown cover of the plant species encountered. Tree height was measured with a Hagar Altimeter. Diameter at breast height was measured with a girthing tape; crown cover was obtained by the crown diameter method [15]. In each of the quadrants two soil samples were obtained to a depth of 40cm using soil auger. The soil samples were put in plastic bags and transferred to the soil science laboratory for further treatment and analysis. The collected plant specimens were identified up to species level with the standard flora given by [16] and the collected herbarium specimens of plants were deposited at the Department of Botany and Ecological Studies of the Department for further reference.

2.3 Physicochemical Analysis of Soil Samples

Soil samples were analyzed following the standard procedures outlined by the Association of Official Analytical Chemist [17]. Soil pH was measured using Beckman's glass electrode pH meter [18]. Organic Carbon by the Walkey Black wet oxidation method [19], available Phosphorus by Bray P-1 method [19]. The total Nitrogen content was determined by Micro-Kjeldahl method [20]. Soil particle size distribution was determined by the hydrometer method [21] using mechanical shaker, and sodiumhexametaphosphate as physical and chemical dispersant. Exchange Acidity was determined by titration with 1N KCL [22]. Total Exchangeable Bases were determined after extraction with 1M NH4OAc (One molar ammonium acetate solution). Total Exchangeable Bases were determined by EDTA titration method while sodium and Potassium were determined by photometry method. The Effective Cation Exchange Capacity (ECEC) was calculated by the summation method (that is summing up of the Exchangeable Bases and Exchange.

3. RESULTS

The summary of the mean vegetation characteristics (attributes) in the watershed environment are represented in Table 1. The result shows the structural characteristics of component plant species in watershed environments.

Table 2 shows the undergrowth plant species encountered along the watershed environment. The results in this study showed that 42 plant species were identified belonging to 33 families and 38 genera. Among the plant species identified, *Elaeis guineensis* was the most abundant with 70% frequency of occurrence, followed by *Raphia hookeri* with 50% frequency of occurrence. 2 plant species, *Brachystegia eurycoma* and *Barteria nigritiana,* had 40% frequency of occurrence; *Musanga cecropioides* had 30% frequency, while 3 plant species, *Palisota hirsuta, Pterocarpus osun* and *Homalium letestui* had 20% frequency of occurrence. 12 plant species, *Persea americana, Coelocaryon preussi, Rauvolfia vomitoria, Parkia biglobosa, Costus afer, Pentaclethra macrophylla, Costus schlechteri, Dracaena arborea, Baphia nitida, Aframomum sceptrum, Carpolobia lutea* and *Tristemma hirtum* were the least abundant with 10% frequency of occurrence. The density of the plant species encountered were in the decreasing order of *Carpolobia lutea* with the highest mean density of 250±0.00 stems/ha, followed by *Palisota hirsuta* with mean density of 150±0.00 stems/ha, with 6 plant species, *Tristemma hirtum, Musanga cecropioides, Pentaclethra macrophylla, Parkia biglobosa, Coelocaryon preussi* and *Persea americana*, having the least mean density of 25±0.00 stems/ha. *Brachystegia eurycoma* was the tallest plant species with a mean height of 25±0.00m, followed by *Parkia biglobosa* with a mean height of 19±2.21m, while *Aframomum sceptrum* had the least mean height of 0.44±0.05m. *Brachystegia eurycoma* had the highest mean basal area of 1.10±0.001m^2/ha, followed by *Parkia biglobosa* with a mean basal area of 0.35±0.00m^2/ha, while *Costus afer* had the smallest mean basal area of 0.00002± 0.000008m^2/ha. *Brachystegia eurycoma* had the highest mean crown cover of 213.71±0.00m^2/ha, followed by *Parkia biglobosa* with a mean crown cover of 73.45±.25.92m^2/ha, while *Aframomum sceptrum* had the smallest mean crown cover of 0.077±0.009m^2/ha.

Table 1. Summary of mean (±S.E) vegetation attributes of watershed environment

S/N	Plant species (Families)	Frequency (%)	Density (stems/ha)	Height (m)	Basal Area (m^2/ha)	Crown cover (m^2/ha)
1	*Aframomum sceptrum* (Oliv. & Hanb.) K. Schum. (Zingiberaceae)	10	125±0.00	0.44±0.05	0.00004±0.0000	0.077±0.009
2	*Baphia nitida* Lodd. (Papillionaceae)	10	50±0.00	1.80±0.20	0.004±0.003	1.50±0.30
3	*Barteria nigritiana* Hook. F. (Typus) (Passifloraceae)	40	75±10.21	2.16±0.45	0.003±0.002	1.17±0.42
4	*Brachystegia eurycoma* Harms (Caesalpiniaceae)	40	31.25±6.25	25±0.00	1.10±0.001	213.71±0.00
5	*Carpolobia lutea* G. Don. (Polygalaceae)	10	250±0.00	0.77±0.05	0.0004±0.0001	0.56±0.08
6	*Coelocaryon preussi* Warb. (Myristicaceae)	10	25±0.00	11±0.00	0.029±0.00	9.62±0.00
7	*Costus afer* Ker-Gawl. (Costaceae)	10	75±0.00	1.10±0.06	0.00002±0.000008	0.36±0.08
8	*Costus schlechteri* H. J. P. Winkl. (Costaceae)	10	50±0.00	1.40±0.10	0.00002±0.00001	0.19±0.00
9	*Dracaena arborea* Vand. ex L. (Dracaenaceae/Agavaceae)	10	75±0.00	4.67±0.88	0.03±0.01	1.90±0.68
10	*Elaeis guineensis* Jacq. (Arecaceae/Palmae)	70	42.86±7.14	13.67±1.82	0.11±0.02	23.19±3.31
11	*Homalium letestui* Pellegrin (Flacourtiaceae)	20	50±0.00	7.75±1.93	0.013±0.003	4.22±1.14
12	*Musanga cecropioides* R. Br. (Cecropiaceae)	30	25±0.00	7.67±1.20	0.05±0.02	11.19±6.28
13	*Palisota hirsute* (Thunb.) K. Schum. (Commelinaceae)	20	150±25.00	1.05±0.13	0.0014±0.0006	0.36±0.07
14	*Parkia biglobosa* (Jacq.) R. Br. ex G. Don. (Fabaceae)	10	25±0.00	19±2.21	0.35±0.00	73.45±25.92
15	*Pentaclethra macrophylla* Benth. (Mimosaceae)	10	25±0.00	2.50±0.00	0.003±0.000	0.78±0.00
16	*Persea Americana* Mill. (Lauraceae)	10	25±0.00	3.5±0.00	0.019±0.00	4.91±0.00
17	*Ptero carpus osun* Craib (Papillionaceae)	20	37.50±12.50	1.60±0.21	0.22±0.08	0.99±0.39
18	*Raphia hookeri* Mann. (Arecaeae/Palmae)	50	65±15.00	10.54±3.03	0.069±0.008	15.69±3.39
19	*Rauvolfia vomitoria* Afzel. (Apocynaceae)	10	75±0.00	8±1.15	0.033±0.009	17.40±3.32
20	*Tristemma hirtum* P. Beauv. (Melastomataceae)	10	25±0.00	0.50±0.00	0.0008±0.000	0.19±0.00

Table 2. Undergrowth plant species

S/N	Plant species (families)
1	*Aframomum sceptrum* (Oliv. & T. Hanb.) K. Schum. (Zingiberaceae)
2	*Aspilia africana* (Pers.) C. D. Adams (Asteraceae)
3	*Asystasia gangetica* (L.) T. Anders. (Acanthaceae)
4	*Combretum racemosum* P. Beauv. (Combretaceae)
5	*Commelina benghalensis* Linn. (Commelinaceae)
6	*Costus afer* Ker-Gawl. (Costaceae)
7	*Costus schlechteri* H. J. P. Winkl. (Costaceae)
8	*Cyclosorus interruptus* (Willd.) H. Ito (Thelypteridaceae)
9	*Cyperus zollingeri* Steud. (Cyperaceae)
10	*Cyrtosperma senegalense* (Schott) Engl. (Araceae)
11	*Diplazium sammantii* (Retz) Sw. (Polypodiaceae/Athyriaceae)
12	*Hydrolea glabra* Schum &Thonn. (Hydrophyllaceae)
13	*Justicia schimperi* (Hochst.) Danby (Acanthaceae)
14	*Lasianthera africanum* P. Beauv. (Icacinaceae)
15	*Lygopodium smithianum* C. Presl. (Lygopodiaceae)
16	*Marantochloa cuspidate* (Rosc.) Milne-Redh. (Maranthaceae)
17	*Melanthera scandens* (Schum. and Thonn.) Roberty (Asteraceae)
18	*Nephrolepis biserrata* (Sw.) Schott. (Polypodiaceae)
19	*Palisota hirsuta* (Thunb.) K. Schum. (Commelinaceae)
20	*Pteridium aquilinum* (L.) Kuhn (Dennsteadtiaceae)
21	*Pteris burtonii* Bak. (Pteridaceae/Polypodiaceae)
22	*Selaginella myosorus* (Sw.) Alston (Selaginellaceae)

Table 3 shows the summary of the mean soil parameters of the watershed environment. It reveals that the particle size analysis of the soil samples obtained from the plots had sand fractions as the most abundant (89.20±0.80%), clay with a contribution of 5.40±0.60% and silt with the least (5.40±0.20%). The most abundant cation was Calcium (2.43±0.09 Cmol/kg), followed by Magnesium (1.12±0.06 Cmol/kg) while the least was Sodium with 0.06±0.004 Cmol/kg. Total Nitrogen was relatively low (0.07±0.01%) while the Available Phosphorus was moderate (5.02±0.81 mg/kg). The Organic Carbon had an average value of 1.53±0.33%. The heavy metals present in the soil were relatively low ranging from 0.43±0.02 mg/kg in Lead, 2.30±0.16 mg/kg in Copper, up to 36.16±8.94 mg/kg in Iron. Exchangeable acidity (EA) had a mean value of 2.16±0.04 Cmol/kg, while the effective cation exchange capacity (ECEC) was 5.94±0.16 Cmol/kg. The Base Saturation has an average value of 63.52±0.78% in this area. The soils of the study area (Ikot Uso Akpan Wildlife Sanctuary, Itu L.G.A) were slightly acidic with a pH mean value of 5.41±0.15, with low nutrient values. The texture of the soil was Loamy Sand, determined using a textual triangle.

Table 3. Mean (±S.E) values of physical and chemical characteristics of soils (x)

S/N	Apparatus	Units	Mean
1	pH	-	5.41±0.15
2	EC	ds/m	0.043±0.007
3	Org. Carbon	%	1.53±0.33
4	Total Nitrogen	%	0.07±0.01
5	Av. P	mg/kg	5.02±0.81
6	Ca	cmol/kg	2.43±0.09
7	Mg	cmol/kg	1.12±0.06
8	Na	cmol/kg	0.06±0.004
9	K	cmol/kg	0.10±0.01
10	EA	cmol/kg	2.16±0.04
11	ECEC	cmol/kg	5.94±0.16
12	B. SAT	%	63.52±0.78
13	Sand	%	89.20±0.80
14	Silt	%	5.40±0.20
15	Clay	%	5.40±0.60
16	Fe	mg/kg	36.16±8.94
17	Co	mg/kg	1.57±0.49
18	Cu	mg/kg	2.30±0.16
19	Pb	mg/kg	0.43±0.02
20	Mn	mg/kg	6.48±0.46

3.1 Relationships between Vegetation Characteristics and Soil Parameters

Figs. 1, 2, 3 and 4 show relationships between soil parameters and plant vegetation attributes (density, height, basal area, and crown cover). The relationship between the variables in figures 1, 2, 3 and 4 shows positive results indicating that as the soil parameters increase, the vegetation attributes also increase. Thus, the positive results between these variables show that soil parameters play a vital role in plant species distribution in the environment, resulting in plant species diversity especially along this watershed environment.

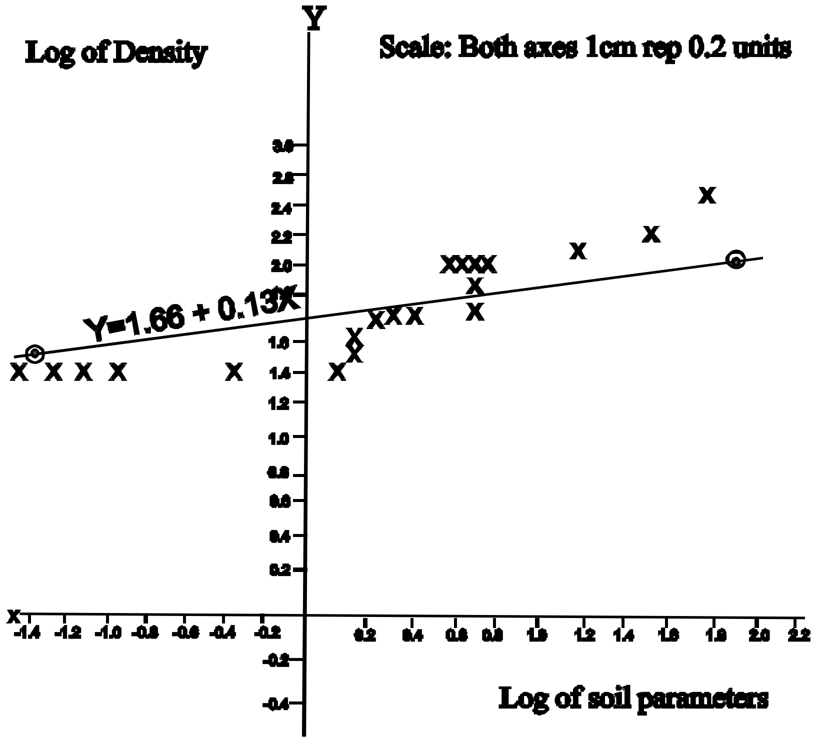

Fig. 1. Relationship between plants density and soil parameters

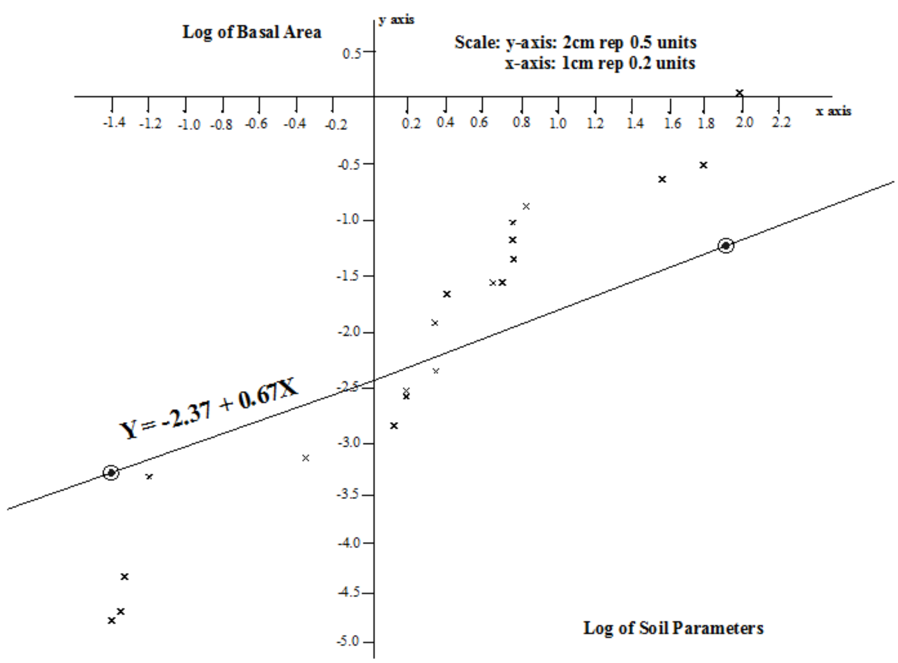

Fig. 2. Relationship between plants basal area and soil parameters

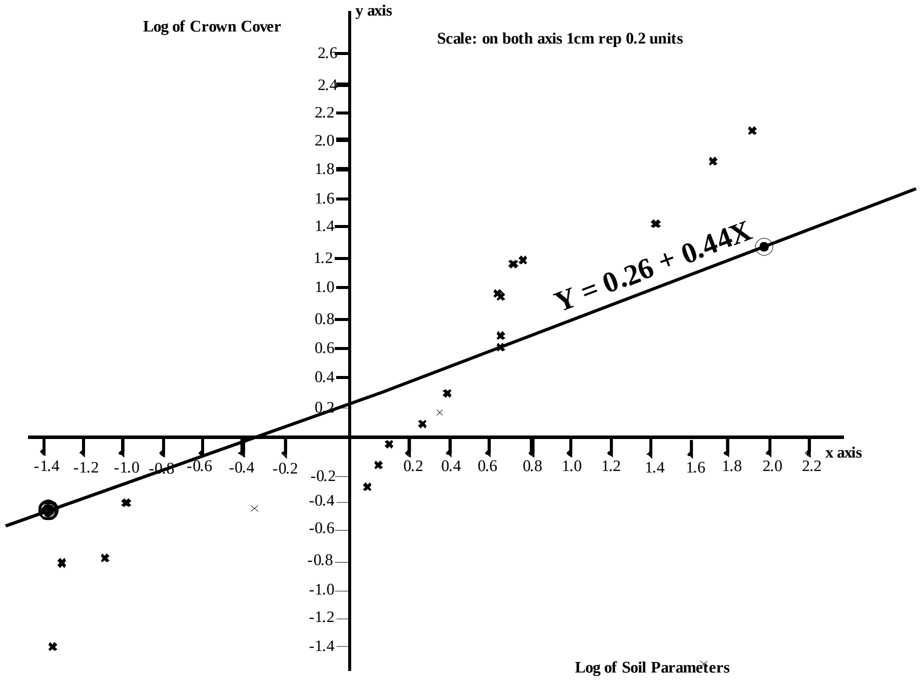

Fig. 3. Relationship between plant crown cover and soil parameters

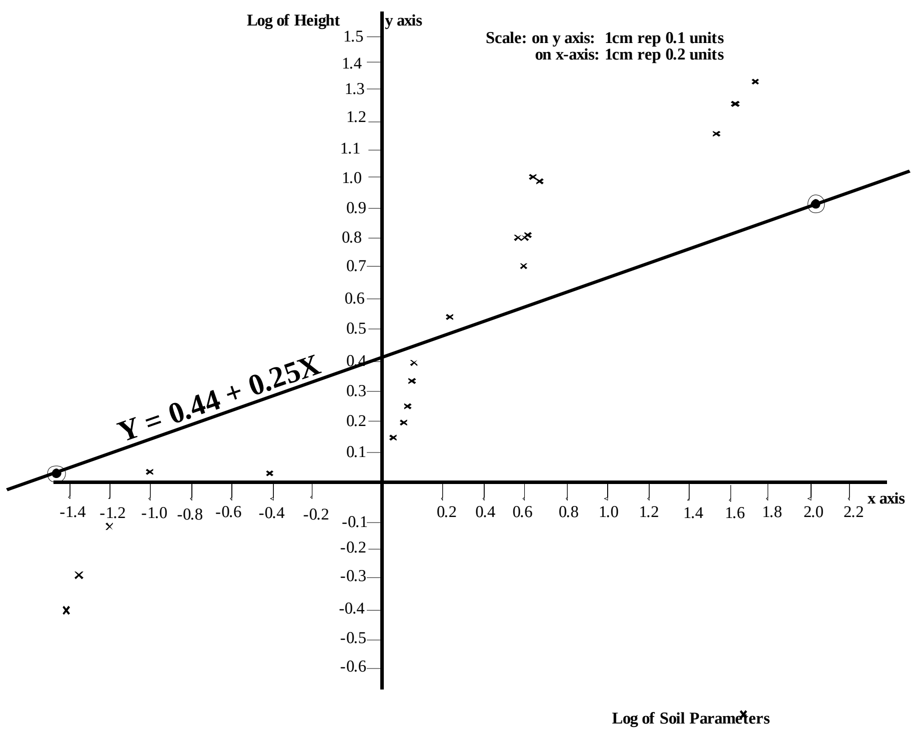

Fig. 4. Relationship between plant height and soil parameters

4. DISCUSSION

The nutrient status along watershed environment of Ikot Uso Akpan Wildlife Sanctuary in Itu L.G.A. was low from the results of the soil analysis showing low composition of nutrients in the soils. However, there was much diversity in plant species composition along the watershed environment. Thus, the high level of plant species present in the environment could have led to the decrease/reduction in the amount of nutrients in the soils along the watershed environment, due to the high level of competition for these nutrients by plants.

The vegetation (structural) characteristics (height, frequency, density, basal area and crown cover) of the watershed environment are represented in Table 1. This table shows that the vegetation variables varied considerably reflecting species responses to environmental factors. Altogether, the variability in the values of these vegetation characteristics in the study area portrays the various developmental stages of trees, shrubs and herbs. The low height of most plant species indicated immature growth stages of the plant species. [23] pointed out that basal area is an important measure of species performance and thus it is considered as a good indicator of the size, volume or weight of a tree. With respect to density, [24] pointed out that density gives an idea of degree of competition, and also pointed that the crown covers is a good measure of the herbage availability. This is evidence for the diversity of plant species density in the study area.

The summary of soil analysis had revealed that the soil was dominated by sand separates followed by clay, and silt. Textually the soil was Loamy - sand. These combine to influence other soil properties of the study area. The soils along the watershed environment were slightly acidic, affecting the nutrient status of the soil with low concentrations of plant nutrients, which also determined the diversity of plant species in the study area. Thus, soil pH is known to have influence on the vegetation components, species composition and performance as they indicate the presence of nutrients in the soil [25]. The clay fraction is a source of plant nutrients and of cation exchange capacity. Clay plays a cementing role between mineral particles and enhances soil nutrient holding capacity. Thus, the low content of clay in the soil must have contributed to low cation contents in the study area. Loamy sand soils are nutrient rich because of the ability to retain nutrients well and retain water, while still allowing the water to flow freely. [26] agreed with this fact and stated that soil texture influences the nutrient status and water holding capacity of the soil, pointing out that soil texture also affects the presence of the soil Nitrogen contents but this is not evidenced in the study area.

Since pH can affect the availability of nutrients in the soil; the slightly acidic nature of the soil results in low values of the macro-nutrients (elements) which are readily available for plant use. [27] stated that Nitrogen content in surface mineral soils is about 0.02-0.5% and that Soil Nitrogen occurs as part of organic molecule. This is evident in this research work as Nitrogen content falls within this range. Naturally, major nutrients (N, P, K) are usually lacking or low in the soil because plant use large amounts for their survival and growth [28]. This explains the level of these nutrients in the watershed soils. The moderate values of Iron and Manganese could be attributed to the pH, since both are pH related. The percentage of Organic Carbon present in the soil reflected the level of humus contents in the soil; which could be attributed to decomposition of dead roots, trunks, branches and leaves under the action of various soil bacteria and fungi.

According to [29], the supply of nutrients to plant in appropriate quantities at the right time is essential for plant growth and distribution. Thus, the different and low concentrations of major nutrients may have led to the dense/concentrated distribution and diversity of plant species along the watershed environment. Available Phosphorus was low; this could have been due to less human activities and increase in number of plant species along the watershed environment. According to [30], concentration of Phosphorus is usually insufficiently low especially in fresh water, while Phosphorus is often the most limiting plant nutrient in tropics. The effective cations exchange capacity was low in the soils in this area. This low ECEC value according to [31] is common for South-Eastern Nigerian soils. This phenomenon is attributed to predominant kaolinitic clay properties. They maintained that ECEC could be lower than 14Cmol/kg. This is in consonance with the reports of [32] that low ECEC in soils is due to low clay contents of the soil, which make little contribution to the exchange complex. The low EA and ECEC of the soil supported that the watershed environment of Ikot Uso Akpan Wildlife Sanctuary has a potential low sink for cations particularly Sodium and Potassium. Trace elements such as Lead (Pb) and Cobalt (Co) were low.

The results have shown that the variation in the soil parameters accounts for the diversity of plant species in this vegetation. According to Cole (1982), variation in soil parameters have been shown to be responsible for the distribution of different vegetation types. With respect to species composition and diversity, [33] had stated that both the composition and diversity of vegetation varies with nutrient status.

4.1 Soil Vegetation Interrelationship

The soil characteristics and the watershed vegetation are interrelated as shown by the scattered diagrams of soil properties and vegetation parameters (Figs. 1-4). Regression is a biometric method that obtains an indication as to whether there is any association or interrelationship between variables. It discovers the nature of the association between these variables. Soil parameters showed a direct influence on height, crown cover, density and basal area; as such, as soil parameters increase, vegetation attributes increase. This indicates that the soil parameters play a major role in their distribution. Thus, the relationship found to be existing between vegetation components and soil parameters in this study is an indication that the vegetation components are dependent on the soil parameters.

5. CONCLUSION

Analysis Studies reveals that soil characteristics and nutrient status have major impacts on vegetation nutrition, growth, diversity and distribution. It also reveals that since the soil in this area was slightly acidic in nature and loamy sand in texture, as such nutrients are readily available in free and exchangeable forms; and also available in adequate amount for plant use. This study also suggest that the adequate amount of the major nutrients and favorable soil pH range could be as a result of the ability of abundant species (*Elaeis guineensis*) to restore soil fertility in its capacity to produce litter. Soil pH, nutrients and soil texture (sand, silt and clay) are some of the important factors to be considered that influence plant diversity along watershed environment. The positive interactions of the vegetation parameters with the soil properties indicate the importance of these soil properties in the vegetation ecosystem. Also, the high composition and diversity of plant species observed along the watershed environment from the study has revealed that the loss of nutrients in the soil could have resulted from leaching, erosion and high competition for nutrients amongst the different plant species.

In this study, statistical analysis has shown that variation exists among plant species, nutrients, composition and environmental data. Regression plays a role by providing the estimation technique for determining the form of relationship best suited for the patterns exhibited by the measured data. Thus, regression analysis of the watershed environment revealed a strong relationship between the soil nutrients and vegetation components, combined to influence and dictate plant diversity in this area.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Pearson C. Centres for Plant Piversity: The Importance of Plant Diversity. http://www.ehow.com/m/info_7934410_plant-diversity.html retrieved; 2012;20-11-2012.
2. Global Strategy for Plant Conservation. Rationale on Global Strategy for Plant Conservation 2011-2020. www.cbd.int/gspc/intro. Shtmlupdated Retrieved. 2012;20-11-2012.
3. Sahney S, Benton MJ, Falcon-Lang HJ. Rainforest collapse triggered Pennsylvanian tetrapod diversification in Euramerica (PDF). Geology. 2010;38(12):1079–1082.
4. Pressey RL, Cabeza M, Watt ME, Cowling RM, Wilson KA. Conservation planning in a changing world.Trends Ecol. Evol. (Amst.). 2007;22(11):583–592.
5. Sala OE, Chapin FS, Armesto JJ. Global Biodiversity Scenarios for the year 2100. Science. 2000;287(5459):1770–1774.
6. Davis SD, Heywood VH, Herrera-MacBryde O. Centres of Plant Diversity: The Americas v. 3: A Guide and Strategy for Their Conservation (Centres of Plant Diversity ,Vol 3). Union Internationale pour la Conservation de la Nature et de ses Resources Publisher, Switzerland ; 1994;576.
7. Krupnick G. Introduction to Plant Diversity. In Centres of Plant Diversity: "Introduction" written by Heywood VH. and Davis S.D. Available: http://botany.si.edu/projects/cpd/introduction.htm. Retrieved. 2001;20-10-2012.
8. Powell JW. About Watersheds. Available: http://water.epa.gov/type/watersheds/whatis.cfm. Retrieved 2010;20-11-2012.
9. Oregon Watershed Assessment. Watershed Definitions and Fundamentals; 1999:2-15.
10. Phillips N. A Watershed Approach to Urban Runoff: Handbook for Decision makers, Terrene Institute in coop. with USEPA,Chicago IL.;1996:98-102.
11. Srinivas H. An Introduction to Urban Watersheds. Available: www.gdrc.org/uem/water/water shed/introduction.html. Retrieved. 2012;20-11-2012.
12. Hooper DU. Effects of Biodiversity on Ecosystem Functioning: A Consensus of Current Knowledge and Needs for Future Research. Ecological Monographs. 2005;75:3–35.
13. SLUS AK. Soil and Land Use Survey AkwaIbom State. Government Printer, Uyo. 1989;89-92.
14. Knight DH. Methods for Sampling Vegetation: Manual Ark Industries, Laramic Wyoming. 1978;87.

15. Muller-Dombois D, Ellenberg H. Aims and Methods of Vegetation Ecology. John Wiley, London. 1977;74.
16. Etukudo I. Ethnobotany, Conventional and Traditional Uses of Plants, Uyo: The Verdict Press. 2003;84-85.
17. AOAC. Association of Official Analytical Chemist. Methods of Analysis, 12th edition. AVI Publishing Company Inc. Washington DC. 1975;986.
18. Meclean IO. Aluminum. Agron. J. 1965;9:978-988.
19. Jackson MI. Soil Chemical Analysis. Prentice Hall Inc. Englewood Cliffs, New Jersey. 1962;498.
20. Jackobson ST. Chemical Reactions and Air change During Decomposition of Organic Matter. Res. Conserve and Recycle. 1992;6:259-266.
21. Udo EJ, Ogunwale JA. Laboratory Manual for the Analysis of Soil, Plants and Water Sample. University of Ibadan Press, Ibadan; 1986.
22. Kramprath EJ. Conservation of Soils and Tissue Testing for Accessing the Phosphorus Status of Soils. In: The Role of Phosphorus in Agriculture Khagwnch (ed.) American Society of Agronomy. 1967;433-469.
23. Krebs CJ. Ecology: The Experimental Analysis of Distribution and Abundance, 4th ed. Harper and Row Publishers, New York. 1994;625.
24. Verma PS, Agarwal VK. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand & Company Ltd., New Delhi. 2007;790.
25. Ubom RM . Soil Properties Influencing the Abundance and Distribution of *Isoberlina* woodlands in Nigeria. Int. J. Soil Sci. 2006;1:207- 217.
26. Webster CC, Wilson PN. Agriculture in the Tropics, 2nd edition. Longman Group Ltd., New York; 1980:640.
27. Shukla RS, Chandel PS. Plant Ecology including Ethnobotany and Soil Science. S. Chand Publishers, New Delhi. 2008;544.
28. Allen VB and Pilbeam DJ. Handbook of Plant Nutrition. Taylor and Francis/CRC Press, New York. 2007;304.
29. Boto K, Wellington J. Soil Characteristics and nutrient status in a Northern Australian Mangrove Forest. Estuaries. 1984;7:61-69.
30. Busman L, Lamb J, Randall G, Rehm G, Schmitt M. Phosphorus in the Agricultural Environment: The nature of Phosphorus in soils. Available: www.extension.umn.edu/distribution/crop_systems/dc6795.html Retrieved. 2002;20-11-2012.
31. Udo OT, Ekwere S, Abrakasa S. Some Trace Metal in Selected Niger Delta Ccrude Oils: Application in oil-oil correlation studies. J. Min. Geol. 1992;28(2):289-291.
32. Montgomery RF, Askew GP. Soils of Tropical Savannas. In: Bourliere, F. (Ed.) Ecosystems of the World 13: Tropical Savannas. Elsevier, Amsterdam. 1983;63-78.
33. Cole JJ. Interactions between Bacteria and Algae in aquatic ecosystems. Ann. Rev. Ecol. Syst. 1982;13:291-314.

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