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VARIATION OF EDAPHIC-SITE CHARACTERISTICS ON VEGETATIVE PARAMETERS, ALONG A CATENA IN ODUKPANI LOCAL GOVERNMENT AREA OF CROSS RIVER STATE, NIGERIA.

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ABSTRACT

Soil catena in the field with the aid of laboratory analysis of edaphic factors improves understanding of vegetative parameters relationships. Examining soil catena gives a representation of the influence of topography on soil edaphic factors. The study on the variation of edaphic-site characteristics on vegetative parameters, along a catena in Odukpani Local Government Area of Cross River State, Nigeria was carried out. Soil samples were collected at a depth of 0-15cm at the upper, middle and bottom slopes along the toposequence. Thirty replicate of 20m x 20m were randomly collected using soil auger from topsoils across the slope facets. The soil samples were air dried, sieved through a 2mm sieve and taken to the laboratory for analysis. Tree height was measured with Altimeter. Slope angle and site elevation above stream level were measured with aid of Abney level and was determined using the trignometrical principle. The multiple linear regression models were employed to examine the variation on the relative effect of edaphic factors and site characteristics on vegetative parameters. The soil texture varies from coarse, fine, silt and clay soil. Coarse sand was the dominant soil in the upper, middle and bottom slopes. The dominant of coarse sand affects its ability to retain moisture. Water holding capacity was low and Soil PH was acidic (PH 5.4-5.7) in the upper, middle and bottom slopes. Organic carbon, exchangeable calcium, magnesium, sodium, and potassium were generally low in the upper, middle and bottom slopes. Exchangeable acid, cation exchange capacity and base saturation were also low in the upper, middle and bottom slopes. The tree height (R) explains 76.9% variation, seventeen independent variables (Adjusted R-square) explain 49.5% and dependent variables (R-square) explain 59.1% of the total variation from the upper to the bottom slopes. Tree density (R) explains 63.9% variation, seventeen independent variables (Adjusted R-square) explain 26.8% and dependent variables (R-square) explain 40.8% of the total variation from the upper to the bottom slopes. Species richness (R) explains 74.2% variation, seventeen independent variables (Adjusted R-square) explain 44.5% and dependent variables (R-square) explain 55.1% of the total variation from the upper to the bottom slopes. The ANOVA analyses shows, significant difference in edaphic-site characteristics on tree height, tree density and species richness from the upper to the bottom slopes. This suggests that, there were variations of edaphic-site characteristics as it influences tree height, tree density and species richness along the upper, middle and bottom slopes. The study therefore recommends vegetation conservation and sustainable management strategies in the study area.

Keywords: Edaphic factors, Site Characteristics, Vegetative parameters, Upper, Middle, Bottom Slopes.

INTRODUCTION

The word catena was first coined in East Africa (Milne, 1935). The sequence of soil edaphic factors along a slope can be described as soil catena. According to (Said & Ali, 2011), soil catena in the field with the aid of laboratory analyses of edaphic factors improves understanding of vegetative parameters relationships. Examining a soils catena gives a representation of the influence of topography on soil edaphic factors. Soil catena are group of different soils that occur together on a catena having the same parent material with topography as the dominant influencing factor responsible for the differences existing in such soils (Jenny, 1941). Though, the distribution of water and group of different soil on the catena may contribute in the differences in edaphic factors.

According to peter (2015), soil on a catena would form a catena if they show different characteristics at different slopes positions. Soils occurring on a catena vary in morphological and edaphic characteristics. Consequently, the potentials of such soils on vegetative parameters often vary from the upper to the bottom slopes. The distribution of soil sequence on the catena has a considerable influence on the land use pattern of an area and is a function of water movement pattern through the slopes (Moore et al., 1993; De-Alba et al., 2004).

Soil catena on toposequence is broadly recognized as upper slope, middle slope and bottom slope. A toposequence comprises of upper, middle and bottom slope, each is covered by different edaphic factors and vegetation (Lawson, 1970). Edaphic factors may vary from the upper middle and bottom slopes on topographical sequences. Difference in edaphic factors can occur with small differences in topography in a relatively small area (Ray, 2003). Edaphic factors may have imbalance as a result of differences on the topography.

Numerous studies have been carried out on the variations in edaphic factors along toposeqence (Vine 1941; Acton, 1965; Lansdale, 1968; Furley, 1971; 1976; Areola, 1982; Strahler, 1990; Abua & Ajake, 2015). Unfortunately, little work has been done on the variation of edaphic-site characteristics relationship on vegetative parameters, along a catena in Odukpani Local Government Area of Cross River State, Nigeria. This limitation forms the conviction of this study. The aim of the study is to examine the variation of edaphic-site characteristics relationship on vegetative parameters, along a catena in Odukpani Local Government Area of Cross River State, Nigeria.

Study Location

The study area is located in Odukpani Local Government Area of Cross River State, Nigeria. The study area lies approximately between longitude 8^0 08' and 8^0 8' E, and Latitude 6^0 09 and 6^0 7'N. The climate of the area is humid tropical and consists of rainy and dry season. The area experiences double rainfall from 1880mm which span from May-August and 240mm which span from December-February. Annual rainfall is approximately 402mm. Temperature are uniformly high with a maximum of 30^0C and minimum of 23^0C. The annual average vapour pressure is 29 Millibars and has a high relative humidity which ranged from 80-100%. The area has a high salinity which ranged from 3.8% in the dry season and low salinity of about 0.5% in the rainy season (Ukpong, 1995). The study area lies within the Flood Plain Zone of Cross River and has relatively low lying terrain from the shore of the Calabar River. The vegetation is a mixture of mangrove and tropical rainforest. The area serves as the only woodlot of the then natives and source of non-timber products.

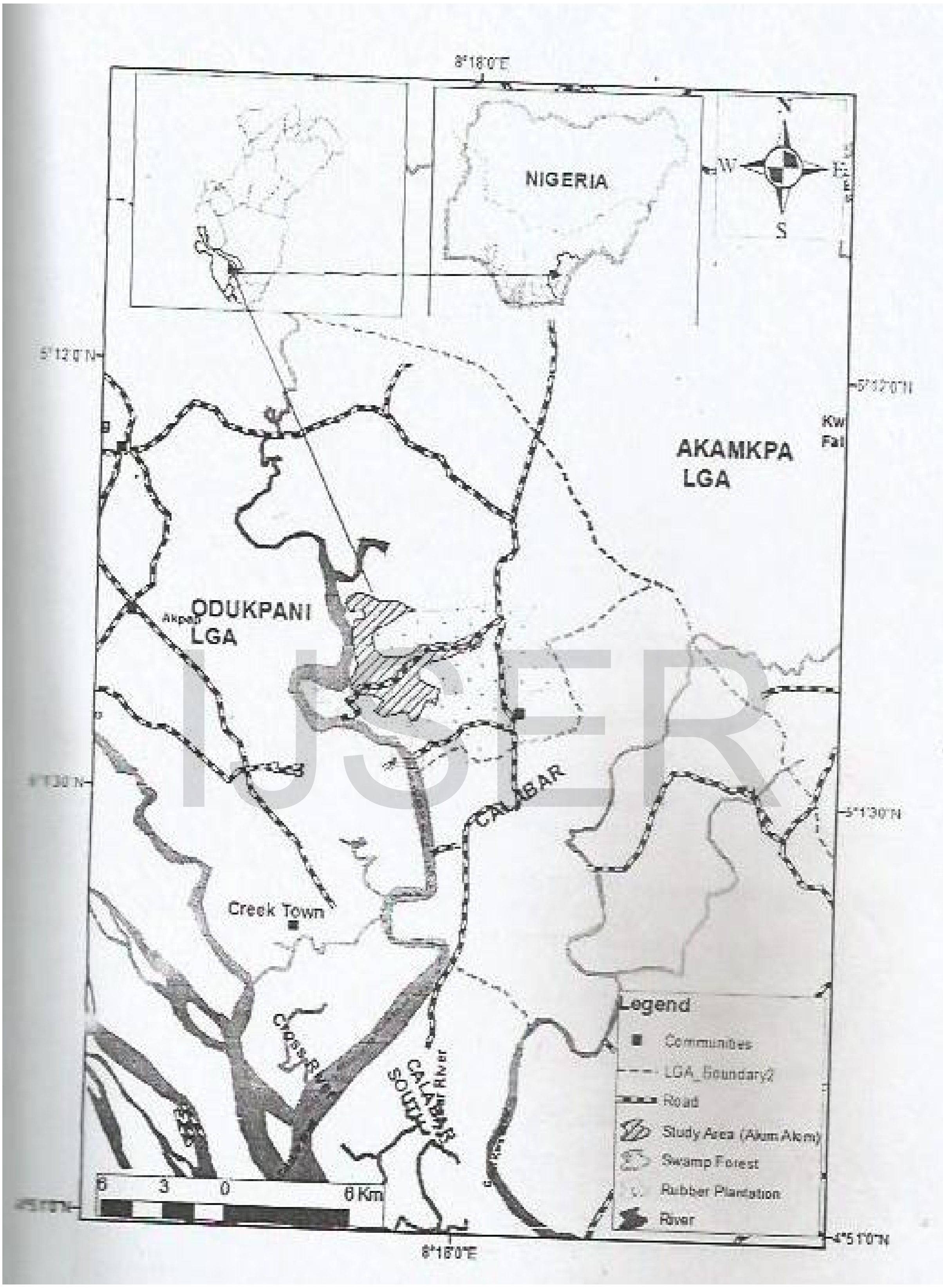

Figure 1: Showing map of Odukpani Local Government Area in Cross River State, Nigeria.

MATERIALS AND METHODS

Field Study

The upper, middle and bottom slopes were dug 0-15cm depth. Thirty replicate of 20m×20m were collected from topsoil on the upper, middle and bottom slopes. The samples were collected randomly from selected points using soil Auger. The soil samples were air dried, sieved through a 2mm sieve and taken to the Laboratory for analysis. Tree height was measured with Altimeter. The context of a tree ranged from 2 meter tall and breast width 2cm diameter (Aweto, 1987). Slope angle and site elevation above stream level were measured with the aid of Abney level. The elevation was determined by the trignometrical principle.

Laboratory Procedure

Particle size composition was analyzed using hydrometer (Bouyocous, 1926). Water holding capacity was determined by saturating the soil sample and later subjecting them to gravitational draining, and oven drying for 24 hours at 105^0C. Exchangeable bases were determined by first leaching the soil sample with 1m neutral ammonium acetate. The concentrations of calcium, potassium and sodium were determined with a Flame Photometer. Magnesium was determined with an Atomic Absorption Spectrophotometer. Soil PH was determined Potentiometrically in 0.01m calcium chloride using soil to calcium chloride solution ratio 1:2. Cation exchange capacity was determined by summation method (Chapman, 1965). Soil organic matter was determined by Anglicizing the organic carbon content of the soil. The percentage Organic Matter was converted by multiplying 1.724 (Walkey& Black, 1934).

Statistical Analysis

The multiple linear regression models and ANOVA in (SPSS Software version 22) were used to analyze the variation of edaphic factors and site characteristics on vegetative parameters, from across the slopes. The vegetative parameters are tree height, tree density and species richness as dependent variables. Seventeen edaphic factors and site characteristics represent independent variables.

RESULTS AND DISCUSSION

Edaphic Factors

Table 1 is the representation of the results of edaphic factors. The table represents the results of topsoil in the upper, middle and bottom slopes. The total size distribution of coarse sand in the topsoil varies from 60.3, 62.1 and 57.5% in the upper, middle and bottom slopes respectively. Fine sand constitutes 16.0, 14.5 and 18.3%, silt varies from 15.4, 14.8 and 1.6%, while clay varies from 8.2, 8.1 and 11.1% respectively in the upper, middle and bottom slopes. Coarse sand is the dominant soil particle and constitutes over 50% in the upper, middle and bottom slopes. Fine sand, silt and clay were less than 19% in the upper, middle and bottom slopes. The water holding capacity in the topsoil varies from 37.9, 36.3 and 38.4% respectively in the upper, middle and bottom slopes. The water holding capacity decrease slightly in the middle slope and increases slightly in the bottom slope.

Organic carbon content varies from 1.6, 1.7 and 1.7% respectively, in the upper, middle and bottom slopes. The organic content was very low below 2% and increases slightly in the middle and bottom slopes by 0.1%. The organic matter accumulates in the middle and bottom slopes, as a result of slow decomposition rate due to water logging. Soil PH ranged from PH 5.4-5.7. This indicates that, the soils are acidic and may not favor majority of agricultural crops. Soil PH for majority of agricultural crops ranged from PH 6.0-7.5 (Brady, 1990). Exchangeable calcium varies from 1.7, 1.5 and 1.5me/100g, magnesium ranged from 1.3, 1.1 and 1.4me/100g, sodium constitutes 0.2, 0.2 and 0.1me/100g, and potassium ranged from 0.1, 0.1 and 0.1me/100g respectively in the upper, middle and bottom slopes. Exchangeable bases in the upper, middle and bottom slopes were generally low. Exchangeable acid ranged from 0.4, 0.5 and 0.5me/100g respectively in the upper, middle and bottom slopes. Cation exchange capacity varies from 3.9, 3.6 and 3.9me/100g respectively in the upper, middle and bottom slopes. Base saturation ranged from 86, 83 and 85% respectively in the upper, middle and bottom slopes.

Site Characteristics

Table 1 is the representation of the results of site characteristics. The table represents the results of topsoil in the upper, middle and bottom slopes. Site characteristics constitutes slope gradients, elevation of sampling points above stream level, and distance of points between the streams and crest summit. The mean gradient ranged from 3.1^0, 2.3^0 and 0.9^0 respectively in the upper, middle and bottom slopes. Mean elevation above stream level ranged from 4.3m, 3.2m and 1.0m respectively in the upper, middle and bottom slopes. Mean distance between the stream and crest summit varies from 110m, 292m, and 510m respectively in the upper, middle and bottom slopes. Mean gradient and elevation decreases downward from middle to bottom slopes. Though, the mean distance between the stream and crest summit decrease upward from middle to upper slope.

Vegetative Parameters

Vegetative parameters constitute tree height, tree density and species richness in the upper, middle and bottom slopes (Table 1). Tree height ranged from 28.2m, 26.7m and 18.4m respectively in the upper, middle and bottom slopes. Tree density varies from 147.8m^2, 142.9m^2 and 112.1/400m^2 respectively in the upper, middle and bottom slopes. Species richness ranged from 14.8m^2, 14.2m^2 and 11.4/400m^2 in the upper, middle and bottom slopes. Tree height decreases in the middle and bottom slope, similarly there is a decrease in tree density and species richness in the middle and bottom slopes. This can be attributed to the elevation and position of points on the slopes.

Mean Water Holding Capacity (%)			Mean Coarse Sand (%)			Mean Fine Sand (%)			Mean Silt (%)		
Upper	Middle	Bottom	Upper	Middle	Bottom	Upper	Middle	Bottom	Upper	Middle	Bottom
37.91	36.38	38.47	60.36	62.17	57.56	16.03	14.52	18.35	15.46	14.80	1.60
Mean Clay (%)			Mean Organic Carbon (%)			Mean Soil PH			Mean Base Saturation (%)		
Upper	Middle	Bottom	Upper	Middle	Bottom	Upper	Middle	Bottom	Upper	Middle	Bottom
8.2	8. 1	11.1	1.67	1.71	1.71	5.7	5.4	5.5	86.9	83.9	85.8
EXCHANGEABLE BASES											
Mean Ca^{++} me/100g			Mean Mg^{++} me/100g			Mean Na^{+} me/100g			Mean K^{+} me/100g		
Upper	Middle	Bottom	Upper	Middle	Bottom	Upper	Middle	Bottom	Upper	Middle	Bottom
1.75	1.54	1.59	1.39	1.16	1.48	0.21	0.20	0.19	0. 16	0. 15	0. 15
Mean Exchangeable Acid me/100g			Mean Cation Exchange Capacity me/100g			Mean Gradient (Degree)			Mean Elevation above stream level (m)		
Upper	Middle	Bottom	Upper	Middle	Bottom	Upper	Middle	Bottom	Upper	Middle	Bottom
0.49	0.58	0.52	3 .90	3 .61	3. 92	3.1	2.3	0.9	4.3	3.2	1.0
Mean Distance from Crest Summit (m)			Mean Tree Height (m)			Mean Tree Density (No./400m²)			Mean Species Richness (No./400m²)		
Upper	Middle	Bottom	Upper	Middle	Bottom	Upper	Middle	Bottom	Upper	Middle	Bottom
110	292	510	28.2	26.7	18.4	147.8	142.9	112.1	14.8	14.2	11.4

Table 1: Mean values of edaphic factors, site characteristics and vegetative parameters

The Variation of Edaphic Factors and Site Characteristics on Tree Height

Multiple linear regression models were used to analyze the relative influence of edaphic factors and site characteristics on vegetative parameters from the upper to the bottom slopes (Tables 2 and 3). Seventeen independent variables of edaphic and site characteristics were regressed with tree height as dependent variable. The model summary (R) explains 76.9%, seventeen independent variables (adjusted R-Square) explain 49.5% and dependent variables (R-Square) explain 59.1% of the total variation of edaphic factors and site characteristics on tree height from the upper to the bottom slopes. The ANOVA table shows, significant difference in the edaphic factors and site characteristics on tree height from the upper to the bottom slopes. The significant level was less than (F=6.1, $p<0.05$). This implies that, there is significant variation of edaphic-site characteristics as it relates to tree height along the upper, middle and bottom slopes.

Table 2: Tree height ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2291.313	17	134.783	6.122	.000[b]
	Residual	1585.176	72	22.016		
	Total	3876.489	89			

The variation of Edaphic Factors and Site Characteristics on Tree Density

Tables 4 and 5, show the results of tree density, edaphic factors and site characteristics. Multiple linear regression models revealed that, (R) explains 63.9%, seventeen independent variables (adjusted-R Square) explain 26.8% and dependent variables (R-Square) explain 40.8% of the total variation of edaphic factors and site characteristics on tree density from the upper to the bottom slopes. The ANOVA table shows, significant difference in the edaphic factors and site characteristics on tree height from the upper to the bottom slopes. The significant level was (F=2.9, p<0.05). This indicates that, there is significant variation of edaphic-site characteristics as it influences tree density along the upper, middle and bottom slopes.

Table 5: Tree Density ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	37555.961	17	2209.174	2.920	.001[b]
	Residual	54469.828	72	756.525		
	Total	92025.789	89			

The variation of Edaphic Factors and Site Characteristics on Species Richness

The results on the edaphic factors and site characteristics on species richness is shown in Tables 6 and 7. Multiple linear regression models were used to analyze the relative influence of edaphic factors and site characteristics on vegetative parameters from the upper to the bottom slopes. Seventeen independent variables of edaphic factors and site characteristics were regressed with Species Richnessas dependent variable. The model summary (R) explains 74.2%, seventeen independent variables (adjusted-R Square) explain 44.5% and dependent variables (R-Square) explain 55.1% of the total variation of edaphic factors and site characteristics on species richness from the upper to the bottom slopes. The ANOVA table shows, significant difference in the edaphic factors and site characteristics on tree height from the upper to the bottom slopes. The significant level was (F=5.1, $p<0.05$). This suggests that, there is significant variation of edaphic-site characteristics as it influences species richness along the upper, middle and bottom slopes.

Table 8: Species Richness ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	284.438	17	16.732	5.192	.000[b]
	Residual	232.018	72	3.222		
	Total	516.456	89			

CONCLUSIONS

Study of the relative influence of edaphic factors-site characteristics on vegetative parameters along a toposequence was conducted. The results revealed that, the soil texture varies from coarse, fine, silt and clay soil. Coarse sand was the dominant soil in the upper, middle and bottom slopes. The dominant of Coarse sand affects its ability to retain moisture. Water holding capacity was low and soil PH was acidic along the slope facets. Organic carbon, exchangeable calcium, magnesium, sodium, and potassium were generally low in the upper, middle and bottom slopes. Exchangeable acid, cation exchange capacity and base saturation were also low in the upper, middle and bottom slopes. There was slight decrease on chemical properties in the middle slope and slight increase in the bottom slope. Silt, clay, gradient and elevation dominated and were effective across the vegetative parameters in the multiple linear regression analysis.

The study further revealed that, the model explains (R) 76.9%, (Adjusted R) 49.5% and R-square 59.1% variation of (17) edaphological factors and site characteristics, when regressed with tree height along the upper, middle and bottom slopes segments of the toposequence respectively. The influence of edaphic factors and site characteristics on tree density explains (R) 63.9%, (Adjusted R) 26.8% and R-square 40.8% variation respectively in the upper, middle and bottom slopes segments along the catena. On species richness, edaphological factors and site characteristics explains (R) 74.2%, (Adjusted R) 44.5% and R-square 55.1% variation of species richness respectively along the toposequence. The ANOVA analyses shows, significant difference in the edaphic-site characteristics on tree height, tree density and species richness from the upper to the bottom slopes. This suggests that, there were variation of edaphic-site characteristics as it influences tree height, tree density and species richness along the upper, middle and bottom slopes. The study therefore recommends vegetation conservation and sustainable management strategies in the area.

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