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Variation in nutrient concentrations of basement complex and sedimentary rock of teak plantations in Ogun State, Southwest Nigeria

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This study examined the differences in the nutrient concentration of the parent material of teak plantations under basement and sedimentary rocks in south western Nigeria. Systematic line transect was employed to establish 18 plots (30 m x 30 m), each in Ilaro (sedimentary rock) and Olokemeji (basement complex rock) plantations which were 37, 40 and 42 years old while twelve rock samples each from 3 quadrants each of 30 m^2 were selected for rock nutrient analysis. Topsoil (0-15 cm) and subsoil (15-30 cm) samples, above-ground plant parts (leaf, bark, stem, twig and branch) and biomass parameters (bole height, girth, total height and crown diameter) were collected. The soil samples were analyzed for soil physicochemical and micronutrients while plant parts were analyzed for nutrient contents (nitrogen, phosphorous, potassium, calcium and magnesium) using standard procedures. Pearson's correlation and regression analysis were used to establish the type and level of association between soil properties and vegetation parameters respectively at $p<0.05$. The result indicates that there is no significant difference between the various minerals found in the rocks of the two locations. Secondary test indicate that there is significant difference among the three horizons A, B and C on the mean concentration of phosphorus and iron with $p = 0.008<0.05$ and $p = 0.046 < 0.05$ respectively. The multiple comparisons revealed that there is no statistical significant difference in phosphorous concentration between horizons A and B horizon but that there is a statistical significant difference between horizon A & C and B & C with $p = 0.005< 0.05$ for all.

Key words: Bedrock geology, parent rock materials, physical properties, physico-chemical properties, soil nutrients.

INTRODUCTION

In tropical region of Africa underlain by basement complex and sedimentary terrain, parent materials change when the rock type changes. Coastal Plain soils are formed from weathered and eroded rock particles that are moved by water and maybe alluvial or marine sediments. These sediments have similar minerals, so parent material differences are related to changes in the amounts of sand, silt, and clay. Properties of parent

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materials within the same landform vary if changes in texture occur. For example, a single floodplain may contain pockets of sands and clays at different locations. These differences produce changes in soil water holding capacity and fertility. Two different parent materials deposited side by side (same climate, biotic, topography, and age) will result in two soils having different properties Minerals are naturally occurring homogenous solid, inorganically formed, having a definite chemical composition and an orderly atomic arrangement. Most minerals have fairly definite physical properties such as crystal form, color, luster, hardness, specific gravity, and solubility.

Minerals are classified based on their origin and chemical composition. The need for exotic timber species like teak in Nigeria has been recognized since pre-colonial times and this has resulted in the planting of some plantations around existing natural forests with the planting of teak (*Tectona grandis*) and Gmelina (*Gmelina arborea*) being the most popular (Adejuwon and Ekanade, 1988).

Despite the fact that teak was introduced to Nigeria in 1902 along side other countries such as Ghana in 1905, Trinidad in 1913 and Cote d'Ivotre in 1929, the current productivity and supply level of this exotic tree species is far below the need of the market in comparison to other hard wood species such as Gmelina, Eucalyptus and Acacia (Perez and Kanninen, 2005). This has been a serious challenge to professionals in the field of forest management, which includes foresters, pedologist and geographers alike (Aborisade and Aweto, 1990).

Several studies have been conducted on the effects of cultivated tree plants on soil properties in the rainforest ecosystem of West Africa by Ekanade (1988) and Akpokodje (2007) which revealed that the levels of most soil nutrient properties were significantly lower under tree plants than under adjoining forests. So far, the findings have shown that different tree species have different interactions with soil properties. Findings in Nigeria have also shown that different tree crops have different interactions with soil properties and of significant importance are studies conducted on the effect of tree plants on soil characteristics in the forest areas of south-western Nigeria.

Some of these studies as conducted by, all focused on the influence of tree species on nutrient circling while several other studies by Egunjobi (1974) and Nwoboshi (1985) examined the effects of tree plants (in plantations) on forest soils, by comparing soil characteristics between adjoining forest and those under plantation condition.

What is conspicuously absent from the literature either in the tropical environment, temperate, Europe, America or other Africa countries is research on variation in the nutrient concentration of parent material and soil of teak plantation which is the gap my research intend to fill especially in the field of biogeography. In view of the above gap in the literature, this study investigated the influence of the parent materials and soil on the growth of teak under basement rock of Olokemeji and sedimentary sand stone rock of Ilaro formation in Southwest Nigeria.

The outcome of this study will form the basis for the formulation of better silviculture management for the cultivation of teak and to establish the best geological formations suitable for the growth of teak and which will recycle and restore soil nutrients on time. In addition, a monitoring system for detecting changes in critical site parameters (especially biophysical and chemical characteristics) under different geological formations is expected to be designed for silviculture monitoring purposes which is one of the major contribution this research intend to add to the study of bio-geomorphology (Juo and Manu, 1996).

METHODOLOGY

Study area

The teak stands used for this study were purposively selected from two forest reserves located in south-western Nigeria. The reserves fall within the humid tropics which support the tropical rainforest ecosystem (Richards, 1952). The two selected reserves are specifically located in Olokemeji and Ilaro, Ogun State, Nigeria. The two reserves are sources of enormous economic benefits to the state because of their rich wood resources (Adeyoju, 1971; Okali and Onyeachusim, 1991) (Figure 1).

Location and extent of Olokemeji and Ilaro plantations

The Olokemeji teak plantation is located in the heart of Olokemeji forest reserve located between latitudes 7° 05' and 7° 40'N and longitudes 3°15' and 3°46'E. According to Aminu-Kano and Marguba (2002), the plantation occupies a total land area of 58.88 km^2 (approximately 5,000 ha). The reserve, which was established in 1899 is the second forest reserve in Nigeria. It lies approximately 32 km west of Ibadan, and 35 km north-east of Abeokuta. It falls within the middle course of Ogun River, which drains the western half of the Basement Complex area of South Western Nigeria.

The second location (Ilaro) is bounded on the north by the Oyo Province, on the South by Lagos, on the east by the Egba Division and on the west by Dahomey (Republic of Benin). The boundary on the South is defined in the "Colony of Nigeria Boundaries Order in Council 1913" (Volume IV, page 311 of Laws of Nigeria). Ilaro forest reserve is defined roughly by latitude 06 38' 51.36 N and 06 57' 24.40 N and Longitude 02 49 06.12'E and 03 10 43.60 E. This reserve covers an area of about 34.2 by 39.9 km^2.

Plantation sampling techniques

Sampling design for this study was based on two premises, first, the need to spread sample sites objectively over the study area and second, the needs to ensure that plant and site characteristics are adequately depicted. Therefore, in order to obtain detailed soil and plant representation, one teak plantation each established on Basement Complex and Sedimentary formation parent rocks were purposefully selected and divided into plantation quadrants based on the information extracted from the forest resources study of Nigeria (FORMECU, 1999). The two teak stands are those established in Olokemeji and Ilaro forest reserves in Ogun State, Southwest Nigeria. The two selected teak stands were distinctively

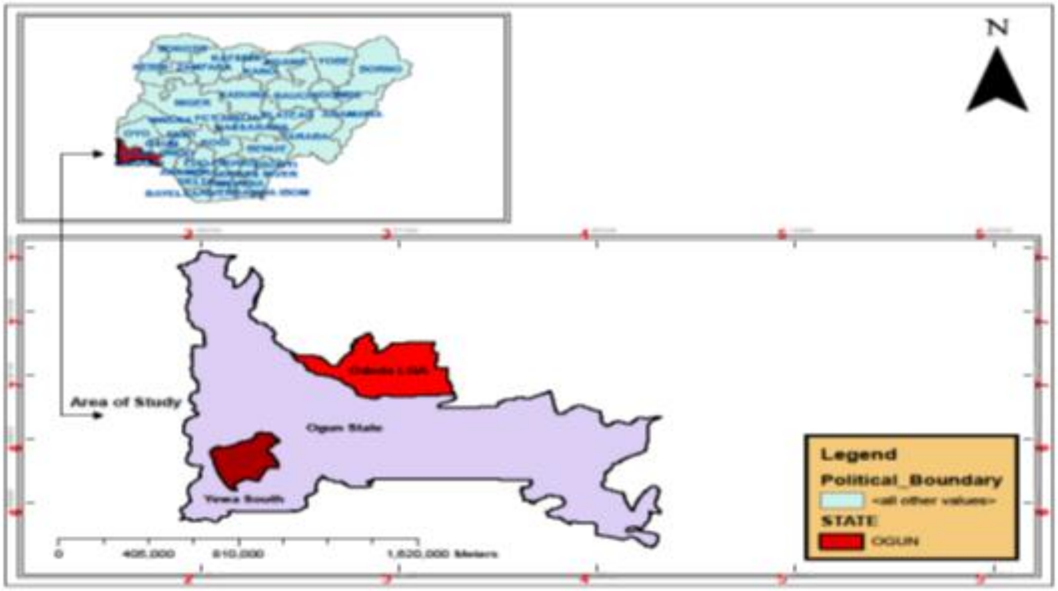

Figure 1. Map of Nigeria showing the study areas.

established under basement complex and sedimentary formation in Olokemeji and Ilaro respectively (Kogbe, 1976; Hushley, 1976). The choice of teak as the study species is because of its high quality as hardwood which led to its high demand (Raymond, 1996).

According to FORMECU (1999), Olokemeji forest reserve has 15 teak plantations of 50 ha (750 ha) while Ilaro forest has 11 teak plantations, also of 50 ha each (550 ha). The twenty-six teak plantations were established between 1970 and 1975 across the two sites. Therefore, due to the uniformity in the area sizes and the ages of the plantations, random and systematic sampling techniques were adopted to select the quadrant plots where various soil and plant samples were collected.

Rock and soil sampling techniques

Three soil profiles were sampled in each plantation from both existing road cuttings and dugged pits. From each soil profile and dugged pit, three soil samples were collected from three horizons of A, B and C making the total soil samples from each profile per plantation to be nine and 18 for both plantations. This was done for better understanding of the mineralogical composition of the bedrock geology underlying the basement complex and sedimentary formation. Rock samples were also collected from the sampled quandrant plots and road cuttings as well as the dugged pit using the geological Hammer from which tin sections and modal analysis were carried out in the petrological laboratory of the Department of Geology, University of Ibadan.

Systematic line transect was employed to establish 18 plots (30 m x 30 m), each in Ilaro (sedimentary rock) and Olokemeji (basement complex rock) plantations which were 37, 40 and 42 years old from June to August 2010. Topsoil (0-15 cm) and subsoil (15-30 cm) samples, above-ground plant parts (leaf, bark, stem, twig and branch) and biomass parameters (bole height, girth, total height and crown diameter) were collected. The soil samples were analyzed for soil physicochemical and micronutrients while plant parts were analyzed for nutrient contents (nitrogen, phosphorous, potassium, calcium and magnesium) using standard procedures.

Laboratory soil and statistical analytical procedures

The mechanical analysis was carried out on the soil samples by the Bouyoucos method to determine the various sizes of particles present in the fine earth (that is, particle < 2 mm) of the soil using international scale. For chemical analysis in the laboratory, available Phosphorus (P) was extracted with 0.1 M sulphuric acid and measured colourmetrically by the ascorbic acid blue method (Olsen et al., 1954). Exchangeable Ca and Mg were measured after extraction using 1 M ammonium acetate at pH 7.0. Concentrations for Ca and Mg in the extracts were analyzed using an atomic absorption spectrophotometer, while K was determined by flame photometry (Black et al., 1965). After extraction with neutral 1 N ammonium acetate, total N was also determined by the micro-Kjeldahl method (Schnitzer, 1982). Cation exchange capacity (CEC) was estimated titrametrically by distillation of ammonium that was displaced by sodium (Chapman, 1965). Descriptive statistics, such as arithmetic mean were applied in order to determine the general characteristics of all parameters and indices. In addition, pearsons correlation and stepwise multiple regression was employed to determine the effects of soil parameters on biomass. This method enables only potent variables to be retained for model formulation.

Statistical analysis

The data were subjected to different analytical tools:

Descriptive statistics: This include statistic such as the mean, Standard Deviation and Standard error of mean of each of the indices.

Generalized Linear Model: This was executed using the GLM of SAS version 9. Under this GLM, different sources of variation including both main and interaction effect were investigated. Where significant differences occurred, mean separation of the different sources of variation was done using Duncan Multiple Range Test. In addition, factor analysis was carried out using Principal

Plate 1. An extensive low lying outcrop of Migmatite in the Olokemeji forestry study area.

Plate 2. Redish sandy Clay on a road cutting at Ilaro.

Component Analysis of the MINITAB (version17). Specifically, one-way analysis of variance (ANOVA) was conducted for detecting statistically significant differences in soil physicochemical properties, biomass production and distribution, tree nutrient concentrations across geological formations at 0.05 and 0.001 significance levels.

RESULTS AND DISCUSSION

Description of rocks with their respective minerals

The quartz grains show high degree of roundness which is an evidence of far travelling before being deposited in Ilaro soil (Plate 1). In fact, the geology of the area suggests that the quartz were from the coastal plain sands and move into the study area during the marine incursion of the continent during the Cenomanian/Santonian).

The implication is that the grains sizes would not be able to hold the mineral component in the soil because the degree of interlocking of minerals grains of quart is weak, thereby allowing the passage of minerals in soluble component from the soil which should have been trapped. On the other hand at Olokemeji (Plate 2).

In tropical region of Africa which is underlain by basement complex and sedimentary terrain, parent materials change when the rock type changes. Coastal Plain soils are formed from weathered and eroded rock particles that are moved by water and may be alluvial or marine sediments. These sediments have similar minerals, so parent material differences are related to changes in the amounts of sand, silt, and clay. Properties of parent materials within the same landform vary if changes in texture occur. For example, a single floodplain may contain pockets of sands and clays at different locations. These differences produce changes in soil water holding capacity and fertility. Two different parent materials deposited side by side (same climate, biotic, topography, and age) will result in two soils having different properties.

Minerals are naturally occurring homogenous solid, inorganically formed, having a definite chemical composition and an orderly atomic arrangement. Most minerals have fairly definite physical properties such as crystal form, color, luster, hardness, specific gravity, and solubility. Minerals are classified as to their origin and chemical composition Based on origin, minerals may be primary and secondary. Minerals rocks are simply aggregates of two or more minerals.

Primary minerals

These are formed by the cooling and solidification of original molten material.

(1) Quartz: SiO_2

(i) Most common soil forming mineral
(ii) Make up 13% of earth's crust and from 30 to 40% of the average soil
(iii) Commonly a translucent milky-white color
(iv) Hard enough to scratch glass
(v) Resistant to weathering
(vi) Present in granite; absent from basalt
(vii) Present in almost all sandstone
(viii) Does not contribute plant nutrients to the soil

(2) Feldspar -alumino-silicates with bases of K, Na, and Ca

(i) Account for 60% of the earth's crust

(A) Orthoclase Feldspar---$KA1Si_3O_8$

(i) Slightly harder than glass
(ii) Commonly white, orange, or pink in color
(iii) Fine wavy lines may occur within crystals
(iv) Flat surfaces are common (intersecting at 88-90° angles)
(v) The most abundant mineral in granite
(vi) Is an important source of potassium

(B) Plagioclase feldspar--Na AlSi308↔Ca $Al_2Si_2O_8$

(i) Slightly harder than glass
(ii) Common gray color (from almost white to dark bluish gray)

(3) Horneblende --- $NaCa_2$ (Mg, Fe, Al)5 (Si, Al)8 O22 (OH)2

(i) Slightly harder than glass
(ii) Black, dark brown, or dark green in color

(4) Micas-alumino-silicates with K, Mg, and Fe basic components

(i) Easily spilt into thin flexible elastic plates
(ii) Has shiny surface

Secondary minerals

These are formed by the weathering of primary minerals

Gypsum - $CaSO_4$ $2H_2Q$

(i) Forms from evaporating calcium sulfate-bearing waters
(ii) Very soft and weathers fairly readily

Iron oxides

(i) Formed through chemical weathering
(ii) **Geothite** (FeOOH): gives yellow color in soils
(iii) **Hematite** (Fe_2O_3): responsible for red coloration in soils

Clay minerals (kaolinite)

(i) Highly colloidal
(ii) Formed primarily form chemical weathering of primary minerals
(iii) Ability to adsorb or hold nutrient ions on their surfaces.

Analysis of the mineralogy of the bedrock geology

The soil sampled from the profile on the Olokomeji soil revealed that the soil has higher enrichment for nutrients on the A-Horizon and show depletion through B-Horizon to C-Horizon (Table 1). Nitrogen shows maximum values of 5.60, 3.22 and 1.54 mg/g in A, B and C-Horizon respectively. OC, Mn, Fe and Zn follow the same trend with Nitrogen with Maximum values of 33.56, 21.20 and 9.45 mg/g, 126.11, 6.800 and 2.60 mg/g, 62.34, 43.23 and 28.11 mg/g and 7.60, 3.33 and 2.02 mg/g respectively. This is attributed to higher degree of weathering at the top soil which produces high enrichment of these nutrients at the A-Horizon. On the other hand P and K, show contrary values with higher enrichment at B-Horizon with Maximum values of 34.23, 36.07 and 16.20 mg/g; and 0.42, 1.23 and 0.18 mg/g in A, B and C-Horizons respectively.

Cu shows higher enrichment in the C-Horizon with maximum values of 1.19, 0.74 and 2.30 mg/g in A and B to C-Horizon. The enrichment of P and K in the B-Horizon could be attributed to their high solubility which allows their easy percolation when dissolved in water into deeper horizon as the porosity is expected to decrease with depth. Higher enrichment of Cu in the C-Horizon is as a result of higher resistant of Copper to weathering which in turn reduces its availability in A and B-Horizon. The literature from the previous works such as Aweto

Table 1. Summary of the result of chemical/nutrient analysis of the soil profile for Olokemeji Plantation.

Parameter	Olokemeji Horizon-A			N=3	Olokemeji Horizon-B			N=3	Olokemeji Horizon-C			N=3
	AV.	Min	Max	Std	AV.	Min	Max	Std	AV.	Min	Max	Std
N (mg/kg)	3.74	2.37	5.63	1.68	2.42	1.460	3.220	0.89	0.97	0.64	1.54	0.49
OC (mg/kg)	27.8	22.84	33.56	5.39	17.5	14.12	21.20	3.54	6.97	5.23	9.54	2.26
P (mg/kg)	28.5	25.14	34.23	4.94	31.7	27.10	36.07	4.49	15.1	13.60	16.20	1.36
K(Cmol/kg)	0.24	0.15	0.42	0.15	0.83	0.500	1.23	0.36	0.14	0.11	0.18	0.03
Mn (mg/g)	110	96.0	126.11	15.11	4.94	3.560	6.80	1.67	2.04	1.52	2.60	0.54
Fe (mg/g)	47.6	38.22	62.34	12.92	35.2	30.44	43.23	6.97	24.8	22.54	28.11	2.88
Cu (mg/g)	0.96	0.76	1.19	0.21	0.60	0.52	0.740	0.21	1.36	0.57	2.30	0.87
Zn (mg/g)	4.97	3.12	7.60	2.34	2.50	1.89	3.33	0.74	1.68	1.45	2.02	0.30

Table 2. Summary of the result of Chemical/Nutrient Analysis of the Soil Profile for Ilaro Plantation.

Parameter	Ilaro horizon-A			N=3	Ilaro horizon-B			N=3	Ilaro horizon-C			N=3
	Aver	Min	Max	stdev	Aver	Min	Max	Stdev	Aver	Min	Max	Stdev
N (mg/kg)	0.40	0.33	0.49	0.08	0.96	0.88	1.02	0.07	0.69	0.56	0.79	0.11
OC (mg/kg)	4.06	3.80	4.30	0.25	9.35	8.40	10.1	0.86	7.57	6.70	8.40	0.85
P (mg/kg)	33.21	28.4	41.2	6.96	31.50	28.6	34.2	2.80	11.5	10.9	12.5	0.88
K (Cmol/kg)	0.24	0.06	0.60	0.30	0.06	0.04	0.08	0.02	0.07	0.06	0.09	0.01
Mn (mg/g)	8.6	7.9	10.0	1.2	9.8	8.0	12.4	2.2	6.3	5.5	7.2	0.8
Fe (mg/g)	41.5	38.2	47.5	5.2	31.0	28.6	34.4	3.0	30.5	26.3	34.3	4.02
Cu (mg/g)	0.66	0.56	0.76	0.10	0.61	0.56	0.70	0.07	0.77	0.55	1.23	0.39
Zn (mg/g)	3.34	2.62	4.20	0.79	2.95	2.53	3.45	0.46	3.44	2.69	4.20	0.75

(1987), Ogidiolu (1988) and Gbadegesin (2004)) have all proven that soil originate from bedrocks/parent rock material, therefore the properties (both chemical and physical) are in no doubt depend on the properties of the parent rock with other abiotic factors such as climate, topography and organisms. Olokemeji Plantation is known to be underlain by basement rocks such as metamorphic and igneous rocks, the common rock forming minerals as evidenced from the above modal analysis include: Quartz, Orthoclase-Feldspar, Plagioclase-Feldspar, Muscovite Mica, Biotite Mica, Hornblende, Pyroxene and other accessory minerals.

Contrary to the observed trend in Olokemeji soil, the nutrients in the Ilaro soil profile revealed that Nitrogen (N), Organic Carbon (OC) and Manganese (Mn) show maximum values of (0.49, 1.02 and 0.79 mg/kg), (4.30, 10.100 and 8.400 mg/kg) and (10.00, 12.40 and 7.200 mg/g). P, K, Fe and Zn show maximum values of (41.20, 34.20 and 12.56 mg/kg), (0.60, 0.08 and 0.09 mg/kg), (47.51, 34.46 and 34.30 mg/g) and (4.20, 3.45 and 4.29 mg/g) respectively with Copper (Cu) recording the values of (0.76, 0.70 and 1.23 mg/g) in A through B to C-Horizon respectively (Table 2.). The enrichment of N, OC and Mn in B-Horizon could be attributed to the high porosity of marine sediment dominated by intercalation of sand and sandy clay materials of the Ilaro formation. Higher values of P, K, Fe and Zn in A-Horizon could be attributed to enrichment from oxidation, decay of plant materials and other surface reactions (Figures 2 to 6).

Analysis of the nutrient concentration of parent material using factor and component analysis

Origin of the nutrient/minerals in the soil can be further explained using the factor and component analysis. This approached has being employed by several workers in the past for classification of parameters base on characteristics/properties, origin, and other types of grouping in data analysis which signifies relevant association and similarity by reduction. In this work, data from each plantation site were subjected to component analysis separately from which three Components were derived as shown in Tables 3 and 4 Ilaro and Olokemeji respectively.

In Ilaro component analysis, C1 compose of assigned factor loading values ranges from -0.00 to 0.84 with extracted factor (factor percentage variance) and cumulative percentage of 29.84% in both cases. The loading variables include Nitrogen, Organic carbon and Potassium. C2 comprises of assigned factor loading values range from -0.26 to 0.80 with extracted factor

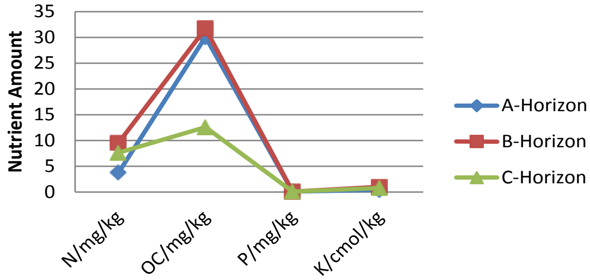

Figure 2. Ilaro macronutrients for profile 1.

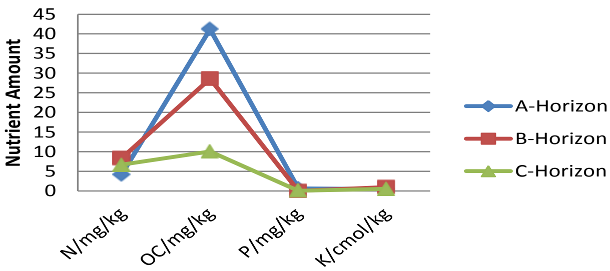

Figure 3. Ilaro macronutrients description of profile 2.

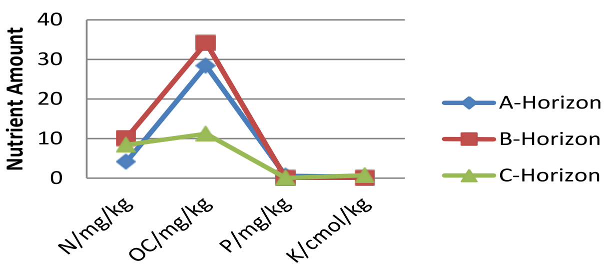

Figure 4. Ilaro macronutrients for profile 3.

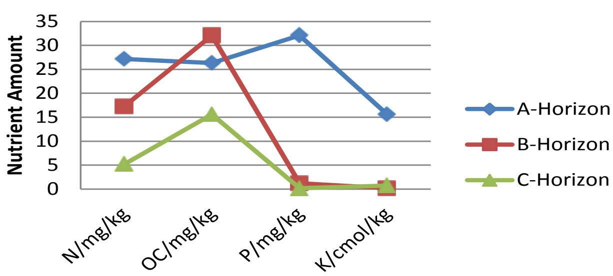

Figure 5. Olokemeji macronutrients for profile 2.

(factors percentage variance) and cumulative percentage of 21.94 and 51.79% with loading variables Phosphorous, Manganese and Copper. C3 comprises of assigned load values ranges from -0.55-0.66 with extracted factor

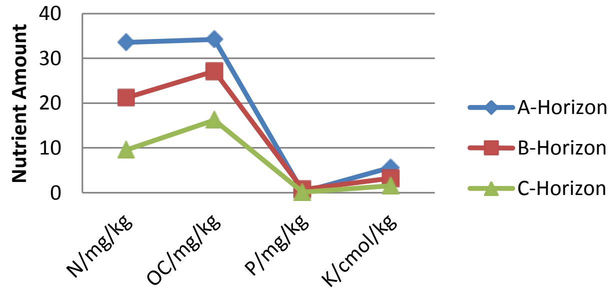

Figure 6. Olokemeji macronutrients for profile.

(factors percentage variance) and cumulative percentage of 16.65 and 68.45% with loading variable of Iron (Fe). Component C1 and C2 indicate soil enrichment from organic matter and parent rock contribution respectively while C3 implies influence of redox reaction which produces enrichment of Iron oxide in the soil.

The loading variables include Nitrogen, Organic carbon and Phosphorous, Potassium Manganese, Copper and Zinc. C2 comprises of assigned factor loading values range from -0.44 to 0.77 with extracted factor (factors percentage variance) and cumulative percentage of 17.20% and 73.25% with loading variable of Iron (Fe). C3 comprises of assigned load values ranges from -0.26-0.52 with extracted factor (factors percentage variance) and cumulative percentage of 12.12 and 85.37% with loading variable of Iron (Fe). Component one C1 implies influence of parent rocks and organic matter. This is more dynamic compare with that of Ilaro soil since the mineralogical complexity of the basement rock produce more mineral influence on the residual soil.

Mineral and nutrient analysis of the parent rock

The result of the hypothesis on nutrient concentrations in parent material indicates that there is no significant difference between the various minerals found in the rocks of the two locations. The result further revealed that there is significant difference among the three horizons A, B and C on the mean concentration of phosphorus and iron with $p<0.05$. The multiple comparisons revealed that there is no statistical significant difference in phosphorous concentration between horizons A and B horizon but that there is a statistical significant difference between horizon A & C and B & C with $p< 0.05$ for all. Hence, we conclude that the mean concentration of phosphorus is highest in B horizon with value of 35.625 followed by A with 30.892 and finally C with 13.343.

For Iron (Fe), the result revealed that there is no significant difference between A & B horizons and similarly between B & C but there is a statistical significant difference between the A & C horizons with $p< 0.05$. This shows that, the mean concentration of iron is

Table 3. Principal component analysis for Ilaro soil chemical data.

Parameter	Component		
	1	2	3
N	0.789	-0.172	-0.395
OC	0.840	-0.232	-0.306
P	-0.004	0.576	0.243
K	0.822	-0.020	0.218
Mn	0.475	0.647	0.444
Fe	0.370	-0.264	0.664
Cu	0.128	0.807	-0.169
Zn	0.080	0.448	-0.556
% of Variance	29.848	21.947	16.657
Cumulative %	29.848	51.795	68.452

Table 4. Principal component analysis for Olokemeji soil chemical data.

Parameter	Component		
	1	2	3
N	0.764	-0.446	0.461
OC	0.764	-0.446	0.462
P	0.660	0.159	-0.260
K	0.917	0.224	-0.121
Mn	0.877	-0.100	-0.360
Fe	-0.061	0.779	0.528
Cu	0.641	0.494	0.143
Zn	0.925	0.206	-0.182
% of Variance	56.048	17.208	12.121
Cumulative %	56.048	73..256	85.377

highest in A horizon with value of 44.55 followed by B horizon with 33.14 and finally by C horizon with 27.23. There are no statistical significant differences in the mean concentrations of other minerals such as Nitrogen, Organic carbon (OC), Potassium (K), Magnesium (Mg), Copper (cu) and Zinc (Zn) in the three horizons of A, B, & C on their mean concentrations. This revealed that, there are no significant differences in the mineral concentration of the parent rock in teak plantation under basement (Olokemeji) and sedimentary (Ilaro) rock formations in term of the mineral compositions.

DISCUSSION

The soil sampled from the profile on the Olokomeji Plantation revealed that the material sampled has higher enrichment for nutrients on the A-Horizon and show depletion through B-Horizon to C-Horizon for Nitrogen, OC, Mn, Fe and Zn. This is attributed to higher degree of weathering at the top soil which produces high enrichment of these nutrients at the A-Horizon. On the other hand P and K show contrary values with higher enrichment at B-Horizon, through C-Horizon. Copper (Cu) showed higher enrichment in the C Horizon. The enrichment of Phosphorous (P) and Potassium (K) in the B-Horizon could be attributed to their high solubility which allows their easy percolation when dissolved in water into deeper horizon as the porosity is expected to decrease with depth.

CONCLUSION AND RECOMMENDATIONS

Contrary to the observed trend in Olokemeji soil, the nutrients in the Ilaro soil profile revealed that Nitrogen (N), Organic Carbon (OC) and Manganese (Mn) show similar trend. Unlike in Olokemeji however, Copper (Cu) is higher at A through B to C-Horizon respectively. The enrichment of N, OC and Mn in B-Horizon could be attributed to the high porosity of marine sediment dominated by intercalation of sand and sandy clay materials of the Ilaro formation. Higher values of Phosphorous (P), Potassium (K), Iron (Fe) and Zinc (Zn) in A-Horizon could be attributed to enrichment from oxidation, decay of plant materials and other surfacial reactions.

The quartz grains show high degree of roundness which is an evidence of far travelling before being deposited. In fact, the geology of the area suggests that the quartz in horizon C were from the coastal plain sands and move into the study area during the marine incursion of the continent during the Cenomanian/Santonian.

The implication is that the grains sizes would not be able to hold the mineral component in the soil because the degree of interlocking of minerals grains of quart is weak, thereby allowing the passage of minerals in soluble component from the soil which should have been trapped. The results of this work have clearly shown that though, there are differences but the differences observed are not statistically significant under different parent materials in teak plantations of the two study sites. A critical geographical, pedological (lithological) and edaphic analysis and appraisal is required before siting a plantation other than common political consideration which are peculiar to developing nations in Africa.

Conflict of Interest

The authors have not declared any conflict of interest.

REFERENCES

Aborisade KD, Aweto AO (1990). Effects of exotic tree plantations of teak (*Tectona grandis*) on a forest soil in South-western Nigeria. Soil Use and Management 6(1):43-45.

Adejuwon JO, Ekanade O (1988). Soil changes consequent upon the replacement of tropical rain forest by plantations of Gmelina arborea, Tectona grandis and Terminalia superba. J. World Forest Resour. Manage. 3:47-59.

Adeyoju SK (1971): A synopsis of Nigeria Timber Economy, Nigeria For Inf.

Aminu-Kano M, Marguba LB (2002). History of Conservation in Nigeria. In Exalor, A. U (Ed), Critical Sites. for Biodiversity Conservation in Nigeria, Nigerian Conservation Foundation, Lagos Nigeria.

FORMECU (1999). Federal Department of Forestry, Forest Inventory, Management, Planning, and Recommendations (FORMECU). Revised National Report Vol II. Beak Consultants Limited.

Juo ASR, Manu A (1996). Nutrient effects on modification of shifting cultivation in West Africa. Agric. Ecosys. Env. 58:49-60.

Kogbe CA (1976). Geology of Nigeria, C. A. Lagos: Elizabethan Publishing Co.

Raymond KM (1996). A Consortium Support Model for greatly increasing the contribution of quality tropical hardwood plantations to sustainable development. 'The Amazon Teak Foundation. 'teak 2000. Amsterdam. The Netherlands.