Characterization, Classification and Land Capability Evaluation of an Obuohia-Ibere Toposequence, Southeastern Nigeria

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Abstract
A toposequence at Obuohia-Ibere, Ikwuano L.G.A, Abia State was characterized, classified and evaluated for its capability. The toposequence was stratified into summit, upper slope, toe slope and valley bottom. Four (4) profile pits, one (1) per topographic strata was dug and characterized. The results indicated that the soils along the toposequence were medium to fine textured. Chemically, the soils of the summit and upper slopes were strongly acid (pH 4.4-5.1), low in organic carbon (0.3-1.5g/kg), available phosphorus (5.3-13.0mg/kg) and exchangeable bases. The soils of toe slope and valley bottom were moderately acid (pH 5.0-5.8) in reaction. These soils also had moderate to high levels of organic carbon (1.2-14.1g/kg), available phosphorus (7.5-23.0mg/kg) and exchangeable bases. Soils at the summit and upper slope were classified as Psammentic Paleudults based on the criteria of USDA which correlated Haplic Arenosols in the WRBSR system. Those at the toe slope and valley bottom qualified as Cumulic Humaquepts in the USDA and correlated Gleyic Cambisol in the WRBSR. Land capability evaluation of the study area placed the soils of the summit and upper slope in sub-classes Vft and Vf on grounds of fertility and slope limitations respectively. The soils of toe slope were classed III, sub-class IIIfw, due to moderate limitations of soil fertility and wetness, whereas the soils of valley bottom were placed in the sub class IVw, due to severe wetness limitations. Land uses that best suit the various strata of the toposequence, would enhance its economic benefit and sustainability. Consequently the soils of summit and upper slope should be restricted to pasture, grazing and forestry due to high erosion risk. On the other hand, the soils of toe slope and valley bottom can be adapted for agronomic activities by applying moderate conservation practices such as liming, manuring, fertilization and good water control.

Keywords: Characterization, classification, toposequence, land capability

Introduction
The essence of soil resource inventory is to acquire information on soil properties in their natural environment. Nuga *et al.* (2006) stated that land use ought not to be based primarily on the needs and demand of the users, but rather on the understanding of the capability of such a land for the intended use in order to achieve environmental sustainability. Physical land evaluation is the first step in agricultural planning for sustainable crop production. The choice of land for a particular use will determine the potential impact of that use on the surrounding environment.

Land capability evaluation characterizes and appraises land units from a general point of view without taking into consideration the kind of its use. Michael (2006) noted that land evaluation was developed by the USDA to group soil mapping units based on their capability to produce common cultivated crops and pasture without deterioration over a long period of time. Land capability evaluation is a pragmatic approach to the interpretation of soil survey results towards estimating the potential of land for alternative kinds of use. Land capability shows in general the potentials and possible limitations of land for the cultivation of common field crops and associated risk of deterioration or degradation.

Topography plays an important role as one of the factors that dictates the distribution and use of soils on the landscape. Soil-landscape relationships had been used to study soil variability in large geomorphic regions (Olatunji *et al.,* 2007 and Esu *et al.,* 2008). Osujieke *et al.* (2016) observed that intensive cultivation of slope land has caused soil deterioration due to erosion, fertility depletion and poor management. Toposequence should be an important consideration in the overall land use and management of soils (Nsor and Akamigbo, 2014).

Soil's attributes such as texture, structure, water retention and overall fertility status are highly influenced by its parent material (Udoh and Akpan, 2015). Nsor and Okonkwo (2014) reported that soils derived from sandstones are characterized with high sand content, very low silt and relatively low clay content whereas shale parent materials gave rise to soils high in clay but low in sand content. The soils of Obuohia-Ibere in Ikwuano L.G.A. of Abia State, Nigeria are derived majorly from sedimentary rocks and alluvial parent materials. The soil-landscape relationship in the study area had not been intensively studied. Consequently, a survey of the potentials, limitations and management of these soils is thus apt, as it will provide basic soil information on soil-landscape relationship for their productive use on a sustainable basis.

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This study is timely and geared towards characterizing and classifying as well as evaluating the capability of the soils along a toposequence in the study area.

Materials and methods

Site description

This study was conducted on a toposequence in Obuohia-Ibere in Ikwuano Local Government Area of Abia State. The area falls within latitudes 05° 24' and 05°30' N and longitudes 07°32' and 07°37' E in the tropical rainforest belt of southeastern Nigeria. The toposequence extends across a farm land of 31 ha. The climate of the area is characterized by heavy precipitation of about 2000-3000 mm per annum with high temperatures (29-31 °C) and relative humidity (70-80 %). The rainfall is evenly distributed in at least nine months of the year (Amos-Uhuegbu *et al.,* 2014).

Although most soils in Ikwuano L.G.A are derived from coastal plain sand (Nsor and Adesemuyi, 2015 and Nuga *et al.,* 2006). However, sandstone-shale intercalations constitute the dominant geological basement of the toposequence studied.

Sampling technique and field work

A reconnaissance visit of the area was carried out to obtain relevant information on geology, size and farming system pattern. Free survey sampling technique was adopted for the study. Soil mapping units were then delineated on the basis of changes in topography or gradient along the identified toposequence. Four (4) profile pits were dug, one on each of the identified mapping units or topographic positions (summit, upper slope, toe slope and valley bottom) at geo-referenced locations using a global positioning system (GPS), as indicated in Fig. 1.

The profile pits were dug, described and sampled based on the FAO guidelines for soil profile description (FAO, 2006). The soil samples were air dried under laboratory condition and crushed gently with a wooden roller. The samples were sieved using a 2 mm mesh sized sieve, properly bagged and labeled for physical and chemical analysis.

Laboratory analysis

Particle size distribution was determined by the pipette method (Gee and Bauder, 1986). Bulk density was assessed by the cylindrical core method (Black and Hartge, 1986). Soil pH was evaluated in a 1:2.5, soil: water suspension (Thomas, 1996). Organic carbon was analysed by the dichromate wet oxidation method of Walkley and Black (Nelson and Sommers, 1996). Total nitrogen was assessed according to the macro kjeldahl digestion method (Bremner, 1996). Available phosphorus was extracted by the molybdenum blue colour technique (Kuo, 1996). Cation exchange capacity (CEC) was determined by the ammonium acetate (NH_4OAc) method. Exchangeable cations (Na^+ and K^+) in the extract were estimated by flame photometry while (Ca^{2+} and Mg^{2+}) were determined by atomic absorption spectroscopy. Exchangeable acidity was determined by titration method.

Land evaluation procedure

The capability of soils along the toposequence was evaluated based on limitations of soil properties and terrain features. The land evaluation method used was the simplified form of the USDA system of land capability classification modified by Sys *et al.* (1991) and Oluwatosin *et al.* (2006). The land limitation places the soils into different classes, I-IV (arable) and V-VIII (non arable). The classification thus depended more on the severity of the limitation than the number of limitations (FAO, 1983).

Results and discussion

Morphological characteristics

The morphological characteristics of the soils are presented in Table 1. The toposequence examined had effective soil depths between 80-150 cm, above the critical limit of greater than 45 cm. FAO (1986) recommended that most crops give good to excellent yields with effective soil depth of only 45 cm, provided the soils are adequately protected against erosion. Under moist condition, the soils at the summit were characterized by brownish grey (7.5 YR 7/6) surface soils over dull orange (7.5 YR 6/4) to orange (7.5 YR 7/6) sub-surface soils. Soils at the upper slope had moist surface colours of brownish grey (7.5 YR 4/1) over dull yellow orange (10YR 7/3) and light grey (10 YR 7/1) subsurface colours (Table 1). The dominance of shale parent material over sandstone in the sub soils of summit and upper slope topographic positions rather than reducing condition might be responsible for this greyish colouration. This observation corroborated Nsor and Okonkwo (2014) on their study on the characterization, classification of a toposequence developed on shale-sandstone parent material in Cross River State. The soils of the toe slope topographic position were characterized by brownish grey (7.5 YR 4/1) to orange (10 YR 7/6) moist epipedons over light grey (10 YR 7/1) to grey (7.5 YR 5/1) endopedons. The soils at the valley bottom had brownish black (10 YR 3/1) top soils over brownish grey (10 YR 5/1) sub soils. The sub soils of toe slope and valley bottom soils had few fine to medium, faint to distinct orange (7.5 YR 7/6) mottles indicating evidence of gleization arising from very poor drainage and seasonal fluctuation of the water table. The mottle colours observed in the sub soils of the toe slope and valley bottom of the toposequence may be due to loss of pigment which may be as a result of oxidation/reduction of iron and or manganese coupled with their removal and translocation. This observation corroborates Fanning and Fanning (1989).

The soils at the summits possessed loamy sand top soils over sandy loam and sandy clay loam sub soils textural classes. The upper slope topographic position revealed a loamy to clay loam top soil over silty clay and clayed sub soils (Table 1). The medium to coarse texture observed at the summit and upper slope indicates the prevalence of sand stones while the fine textures down the toposequence might be as a result of the dominance of shale over sandstones. This observation corroborates the report of Gray and Murphy (1999) on parent materials and soils.

Structurally, the soils at the summit and upper slope had weak, fine to medium granular epipedons over moderate to strong medium sub-angular blocky endopedons structural aggregates. The structure of soils at the toe slope and valley bottom contrasted the summits and upper slope by possessing weak to moderate, fine to medium crumb or granular top soils over moderate medium prismatic sub soil structural aggregates. The consistence of soils at the summit and upper slope was soft at the surface and slightly hard at its subsurface (dry); very friable to friable top soil over firm sub soils (moist); and non-sticky, non-plastic top soils over slightly sticky, slightly plastic to plastic sub soils (wet). This observation in consistence at various moisture conditions might be due to the intercalations of sand stones over clay yielding shale lithology. Nsor and Okonkwo (2014) encountered similar observations in their study of a toposequence developed on shale-sandstone. The consistence of the toe slope and valley bottom indicated a friable over firm to very firm (moist) and slightly sticky-slightly plastic top soil over sticky-plastic (wet) sub soils (Table 1). The sticky-plastic sub soils consistence might have been influenced by the dominance of shale over sandstone parent material at the toe slope and valley bottom of the toposequence.

The high sub soil clay content (Table 2) is therefore the primary reason why the entire sub soil pedons were structurally well developed. Clay is the most active mineral that aids aggregation of primary soil particles and ensures aggregate stability (Igwe, 2001).

Physical characteristics

As The physical characteristics of the toposequence are presented in Table 2. The particle size distribution showed that sand fraction along the toposequence ranged from 63 to 81 % at the summit, 54 to 74 % at the upper slope, 27 to 43 % at the toe slope and 21 to 44 % at the valley bottom (Table 2). Silt fraction ranged from 4 to 6 % at the summit, 4 to 10 % at the upper slope, 29 to 35 % at the toe slope and 20 to 29 at the valley bottom. Clay separate ranged from 13 to 33 % at the summit, 22 to 38 % at the upper slope, 25 to 38 % at the toe slope and 27 to 59 % at the valley bottom (Table 2). Soils of the toposequence indicate medium to coarse texture at the summit and upper slope, whereas the soils at the toe slope and valley bottom were fine to medium textured.

Generally, there was a decrease in sand content down the profile while clay increased. The low to medium contents of organic carbon of these soils under humid climates prevalent in the study area must have predisposed the soils to dispersing its clay content within profile marking the 'B' horizon argillic. This corroborates Esu *et al.* (2008) who also observed increase in clay with depth in soils along a Typical Hill Slope in Afikpo Area of Ebonyi State, Nigeria. Soils of toe slope and valley bottom had higher silt content than the upper slope and summit. The high clay content observed in the sub soils of the entire toposequence might be partly due to clay illuviation (Nsor, 2017) and the dominance of clay yielding shale over sand stone parent material (Gray and Murphy, 1999).

The bulk density values for soils along the toposequence are in the range 1.24-1.60 gcm^{-3} (Table 2). FAO (1986) showed that bulk densities of highly productive soils usually range from 1.0-1.5 gcm^{-3} for medium to fine textured soils. Factors that increase bulk densities include intensive agricultural cultivation, movement of machinery and cattle grazing. However, the study area is not under any of these threats and its bulk densities are not likely to exceed their critical limits.

Chemical characteristics

Chemical characteristics of the soils are presented in Table 2. The results revealed a strong acid (pH 4.4-5.1) soil reaction at the summit and upper slope topographic positions whereas soils of the toe slope and valley bottom were moderately acid (pH 5.0-5.8) in reaction. The high acidic content of these soils is synonymous to most soils of Eastern Nigeria, probably due to high rainfall and intensive leaching experienced in the area. Similar results were reported by Oguike and Udo (2017).

Organic carbon content across the toposequence was in the range of 0.3-14.1 gkg^{-1} (Table 2). The values of organic carbon were low at the summit (0.4-0.9 gkg^{-1}) and upper slope (0.3-1.5 gkg^{-1}) but medium to high at the toe slope (1.2-10.2 gkg^{-1}) and valley bottom (5.5-14.1 gkg^{-1}). The low organic carbon content of the summit and upper slope may partly be due to rapid decomposition and mineralization of organic debris as well as removal by erosion from the upper section of the toposequence down the slope.

Poor management practices by farmers such as burning of crop residue and inadequate erosion control might also be the reason for this low organic carbon content, as equally observed by FMANR (1990). The medium to high level of organic carbon at the toe slope and valley bottom might be attributed to erosional deposition of organic sediments as also reported by Lawal *et al.* (2012) in their studies on fadama soils. Organic carbon is known for its high influence on soil chemical properties such as soil N,P,S, CEC and exchangeable cations (Agbede, 2009). Where organic carbon is low these properties are also likely to be low.

Total nitrogen value across the toposequence beginning from the summit (0.1-0.5 gkg^{-1}), upper slope (0.3-0.6 gkg^{-1}), toe slope (0.2-1.0 gkg^{-1}) and valley bottom (0.6-1.4 gkg^{-1}) were considered low (FMANR, 1990). The low total nitrogen value across the toposequence might be due to its mobile nature and vulnerability to leaching. Low total nitrogen values had previously been reported by Nsor and Okonkwo (2014) for soils of shale-sandstones parent materials in Cross River State, Nigeria. The results obtained corroborated Agboola (1990) that tropical soils were inherently low in total nitrogen, due to intensive rainfalls.

Available phosphorus was generally low at the summit (7.3-10.1 $mgkg^{-1}$) and upper slope (5.3-13.0 $mgkg^{-1}$). Values of available phosphorus were however moderate at the toe slope (7.5-12.8 $mgkg^{-1}$) and valley bottom (8.0-23.0 $mgkg^{-1}$). The low to moderate level of available phosphorus observed in the study area may be attributed to the shale-sandstone parent material which inherently yield soils low in phosphate minerals as reported by Best (1982) and to continuous cultivation under poor soil management practice.

Among the exchangeable bases, sodium was rated low (0.02-0.20 $cmolkg^{-1}$) across the toposequence, potassium was moderate to high at the summit (0.17-0.59 $cmolkg^{-1}$) and upper slope (0.19-0.52 $cmolkg^{-1}$) and high at the toe slope (0.20-0.44 $cmolkg^{-1}$) and valley bottom (0.28-0.36 $cmolkg^{-1}$). Calcium was low (0.2-1.1 $cmolkg^{-1}$) at the summit, low to moderate at the upper slope (1.1-3.4 $cmolkg^{-1}$) and toe slope (1.4-2.2 $cmolkg^{-1}$) but moderate at the valley bottom (2.1-2.4 $cmolkg^{-1}$). Magnesium was generally moderate to high (0.4-1.8 $cmolkg^{-1}$) across the toposequence studied. The moderate to high level of magnesium might be attributed to the moderate content of magnesium oxide in shale parent material (Best, 1982). The generally increasing trends in exchangeable cations down the toposequence from the summit to the valley bottom might be the result of redistributive effect of slope.

The cation exchange capacity of soils in the study area was in the range 5.7-14.5 $cmolkg^{-1}$ (Table 2). Cation exchange capacity was observed to be low to moderate at the summit (5.7-8.5 $cmolkg^{-1}$), moderate to high at the upper slope (8.7-15.2 $cmolkg^{-1}$) and toe slope (9.5-12.5 $cmolkg^{-1}$) but high at the valley bottom (12.5-14.5 $cmolkg^{-1}$). Cation exchange capacity was observed to vary directly proportional with clay content horizontally along the slope (toposequence) and vertically with soil depth. The low CEC at the summit and upper slope might probably be due to the vulnerability of these slope positions to leaching. This imply that the nutrient reserve of the toposequence increases towards the valley bottom, hence crop performance is expected to be better at the toe slope and valley bottom than the summit and upper slope.

Classification of soils in the study area

The soils of summit and upper slope were characterized by low pH, low to medium levels of basic cations and possessed argillic sub soils with less than 35% base saturation by NH_4OAc method. The soils of these two topographic positions were classified under the Ultisol soil order (Soil Survey Staff, 2014). Their udic soil moisture regime placed them as Udults at the sub order level. These soils also possessed medium to course textures and were thus classified Paleudults and Psammentic Paleudults at the great group and sub group levels respectively. The WRBSR equivalent of Psammentic Paleudults is Haplic Arenosols.

The soils of toe slope and valley bottom had umbric epipedons and cambic (Bg) diagnostic endopedon horizons. They also had medium to high levels of basic cations. The soils of toe slope and valley bottom were thus placed under the Inceptisol soil order (Soil Survey Staff, 2014). Their Aquic moisture regime qualified them as Aquepts at the sub-order level. The soils of this unit were further classified as Humaquepts due to high organic carbon content > 0.2 % that decreased irregularly with depth and as Cumulic Humaquepts at the great group and sub group levels respectively. The WRBSR equivalent of Cumulic Humaquepts is Gleyic Cambisol.

Land capability evaluation

Soils of the summit and upper slope constitute land unit 1 and 2. The soils of these units are on steep slopes (4-12 %), stoneless on the surface and gravely in sub soils, coarse textured (63-81 % sand), freely drained (well drained) and low in fertility. The soils are also strongly acidic (pH 4.6-5.1). The soils of summit and upper slope were placed in capability sub-classes Vf (Table 4). These land topographic positions require major conservation practices such as efficient erosion control mechanisms and should be restricted to pasture, grazing and forestry in farm sted planning.

The soils of toe slope location of the toposequence represented by pedon 3, constitute land unit 3. The soils of this unit are on nearly flat to gentle slopes (2-4 %). The soils are stoneless and imperfectly to poorly drained. These soils are moderate in fertility and acidity (pH 5.0-5.3) with evidence of soil mottling. The toe slope in the study area is placed in land capability class III, sub class IIIfw (Table 4) due to moderate fertility and wetness and thus require moderate fertilization with NPK 15:15:15, manuring and drainage.

Valley bottom soils constitute land unit 4. The soils of this topographic position occur on flat to nearly flat (0-2 %) slopes. The soils are stoneless and gravel free, except for the presence of soft iron-oxide concretions below 50cm depths and mottling (gleization) due to a high fluctuating water table. The soils have poor internal drainage and are shallow to moderately deep with moderate acidity (pH 5.1-5.8). The valley bottom soils (pedon 4) are placed under capability class IV, sub-class IVw, due to their wetness limitation. The valley bottom soils will require adequate water control strategies such as drainage.

Conclusion

This study indicated that the soils of the toposequence belonged to two soils orders: Ultisols (summit and upper slope) and Inceptisols (toe slope and valley bottom). Soils at the summit and upper slope were classified as Psammentic Paleudults based on the criteria of USDA which correlated Haplic Arenosols in the WRBSR system. Those at the toe slope and valley bottom qualified as Cumulic Humaquepts in the USDA and correlated Gleyic Cambisol in the WRBSR. The main distinguishing features between the various locations of the toposequence are slope gradient and drainage or water condition which are likely to constitute considerable limitations to their agricultural use. The land capability evaluation of the toposequence studied, placed the summit and upper slope under capability class V on grounds of steep slope and low fertility. The toe slope was placed under class III on grounds of moderate fertility and wetness limitations while the valley bottom soils were classed IV based on severe wetness limitation.

Consequently, with proper fertilization or manuring, installation of efficient erosion control and drainage technologies, the capability of the toposequence studied could be improved for enhanced agricultural utilization.

Recommendations

This study makes the following recommendations:

- The soils of the summit and upper slope can be efficiently managed through application of efficient erosion control mechanisms such as grassing, contour terracing and proper water channeling. These soils would also require liming, manuring and fertilization. Land uses that best suits the summit and upper slopes such as pasture, grazing and forestry will not only be economically beneficial but will as well sustain these terrains.

The toe slope and valley bottom with wetness limitation can be ameliorated through efficient water management strategies such as drainage. This wetness limitation could also be overcome by introducing water loving crops (hydrophytes) such as rice, sugarcane etc as well as adapting the area for fish farming.

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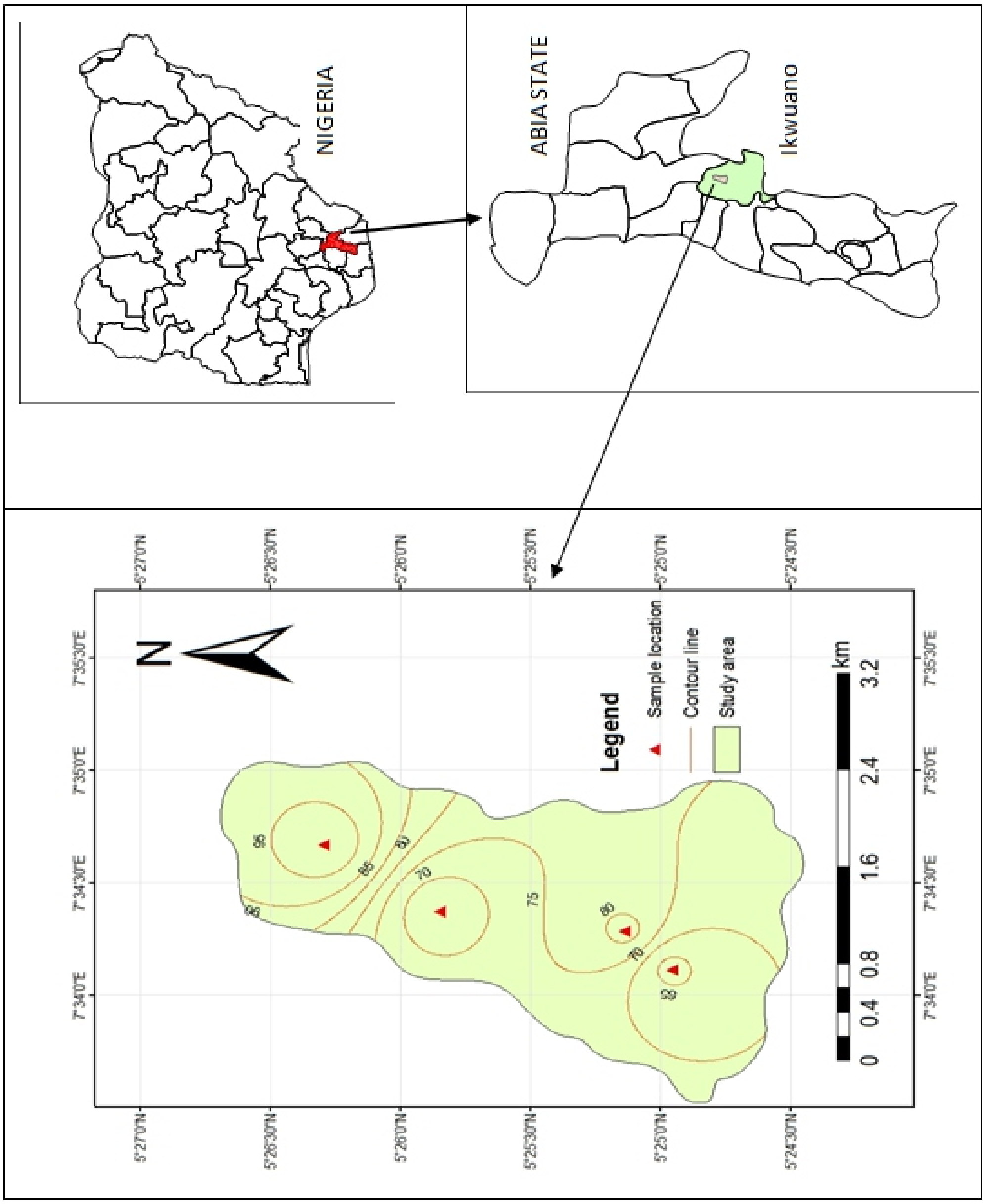

Figure 1: Topographic map of Obuohia-Ibere, Ikwuano Southeastern Nigeria showing sampling locations

Table 1: Morphological Characteristics of a Toposequence on Shale-Sandstones Lithology at Obuohia-Ibere, Ikwuano L.G.A., Abia State

Horizon Designation	Horizon Thickness (cm)	Matrix Colour	Mottle	Texture	Structure	Consistence Dry	Consistence Moist	Consistence Wet	Roots	Pores	Horizon Boundary
Pedon 1 (Summits)											
Ap	0-13	7.5YR 4/1; Bg		LS	IF granular	s	vfr	ns-np	mm	cm	cw
AB	13-41	7.5YR 6/4; DO		SL	2M granular	sh	fr	ss-p	cm	cm	gw
Bt_1	41-64	7.5YR 7/4; DO		SCL	2Msbk	h	f	sp	cm	mf	gd
Bt_2	64-111	7.5YR 7/6; O		SCL	2Msbk	h	f	s-p	fc	mvf	-
Pedon 2 (Upper slope)											
Ap	0-23	7.5YR 4/1; Bg		SCL	IF granular	s	fr	ns-np	cm	mm	cw
Bt_1	23-54	10YR 7/3; Dyo		SCL	2Msbk	sh	f	ss-sp	fm	mf	gw
Bt_2	54-100	10YR 7/1; Lg		SC	2Msbk	h	f	s-p	cf	cf	gw
BC	100-146	5YR 7/2; Lg		SC	3Msbk	vh	vf	vs-vp	cf	cf	-
Pedon 3 (Toe slope)											
Ap	0-20	7.5YR 4/1; Bg		L	1F crumb	-	fr	ss-sp	cm	cm	cs
AB	20-38	10YR 7/6; O		CL	2M crumb	-	f	ss-sp	cm	cf	gw
Bg_1	38-82	10YR 7/1; Lg	7.5YR7/6; fff, O	CL	2M prismatic	-	f	ss-p	ff	mf	gw
Bg_2	82-125	7.5YR 5/1; G	7.5YR7/6; fmd, O	SiC	2M prismatic	-	vf	s-p	fvf	mf	
Pedon 4 (Valley bottom)											
Ap	0-12	10YR 3/1;Bb		L	1F granular	-	fr	ss-sp	cm	cm	cw
Bgh	12-52	10YR 5/1; Bg	7.5YR7/6;cmd, O	CL	2M prismatic	-	f	s-p	ff	mf	gs
Bg	52-93	10YR 5/1; Bg	7.5YR7/6;cmd, O	C	2M prismatic	-	vf	s-p	fvf	mvf	-

Key:
1. **Colour:** Bg = Brownish gray, Do = Dull orange, O = Orange, Dyo = Dull Yellow Orange, Lg = Light grey, Bb = Brownish black, G = Grey
2. **Mottles:** cmd = Common medium distinct, fmd = few medium distinct, fff = few fine faint
3. **Structure:** 1 = weak, 2 = moderate, 3 = strong, F = fine , M = medium, sbk = Sub-angular blocky
4. **Texture:** SCL = Sandy clay loam, SC = Sandy clay, SL = Sandy loam, LS = Loamy sand, L= Loam, CL = Clay loam, C = Clay, SiC = Silty clay
5. **Consistence:** S = Soft, sh = slightly hard, h = hard, vh = very hard, vfr = very friable, f = firm, fr = friable, vf = very firm, ns -np = non-sticky-non-plastic, ss-p = slightly sticky-plastic, s-p – sticky plastic, ss-sp = slightly sticky-slightly plastic, vs-vp = very sticky-very plastic.
6. **Roots:** mm = many medium, cm = common medium, fc = few coarse, fm = few medium, cf = common fine, ff = few fine, fvf = few very fine
7. **Pores:** cm = common medium, mf = many fine, mvf = many very fine, mm = many medium, mf = many fine, cf = common fine.
8. **Boundary:** cw = clear wavy, gw = gradual wavy, gs = gradual smooth, gd = gradual diffuse

Table 2: Physical and Chemical Properties of Soils in the Study Area

Horizon Designation	Horizon Thickness (cm)	Text. Class	Clay %	Silt %	Total Sand %	BD gcm^{-3}	pH (H_2O)	Org. C	Org.M gkg^{-1}	TN	Avail. P $Mgkg^{-1}$	Ca^{2+}	Mg^{2+}	K^{+}	N cmol/kg	E A	CEC	Base satur. %
Pedon 1 (Summits)																		
Ap	0-13	LS	13	6	81	1.44	4.7	0.9	1.6	0.5	9.7	1.1	0.4	0.18	0.06	1.60	5.7	30.5
AB	13-41	SL	19	4	77		4.6	0.7	1.2	0.4	6.8	1.1	0.4	0.59	0.04	0.90	6.5	32.8
Bt_1	41-64	SCL	25	6	69	1.60	4.5	0.5	0.9	0.3	10.1	0.2	1.1	0.17	0.11	0.90	7.1	20.8
Bt_2	64-111	SCL	33	4	63		4.4	0.4	0.7	0.1	7.3	0.5	1.7	0.44	0.17	0.70	8.5	33.6
Pedon 2 (Upper slope)																		
Ap	0-23	SCL	22	4	74	1.35	5.1	1.5	2.6	0.6	13.0	1.1	1.2	0.52	0.15	1.40	8.7	34.1
Bt_1	23-54	SCL	34	4	62		5.0	0.8	1.4	0.5	9.3	1.9	0.9	0.19	0.15	1.40	9.6	32.7
Bt_2	54-100	SC	38	8	54	1.58	4.8	0.5	0.9	0.4	7.0	2.8	1.8	0.33	0.20	1.30	14.8	34.6
BC	100-146	SC	32	10	58		4.6	0.3	0.5	0.3	5.3	3.4	1.4	0.39	0.10	1.20	15.2	34.8
Pedon 3 (Toe slope)																		
Ap	0-20	L	25	32	43	1.37	5.3	10.2	17.6	1.0	12.8	1.6	1.1	0.44	0.10	1.66	9.5	34.1
AB	20-38	CL	30	29	41		5.2	6.6	11.4	0.7	11.6	1.4	1.0	0.31	0.05	1.70	9.7	28.4
Bg_1	38-82	CL	33	30	37	1.56	5.0	5.1	8.8	0.3	10.1	2.0	1.3	0.20	0.05	1.45	11.6	30.6
Bg_2	82-125	SiC	28	35	27		5.0	1.2	2.1	0.2	7.5	2.2	1.2	0.22	0.05	1.50	12.5	29.4
Pedon 4 (Valley Bottom)																		
Ap	0-12	L	27	29	44	1.24	5.8	14.1	24.3	1.4	23.0	2.4	1.4	0.36	0.09	1.75	12.5	34.0
Bgh	12-52	CL	31	26	43		5.4	10.1	17.4	0.9	10.2	2.1	1.2	0.31	0.07	2.10	13.2	27.9
Bg	52-93	C	59	20	21	1.51	5.1	5.5	9.5	0.6	8.0	2.3	1.2	0.28	0.02	1.20	14.5	26.2

Table 3: Simplified Conversion Table of USDA Land Capability Classification Differentia for Tropical Soils

Land Characteristics	Class I	Class II	Class III	Class IV	Class V	Class VI	Class VII	Class VIII
Topography (t)								
Slope %	< 2	< 6	< 12	< 25	< 25	< 25	> 25	> 55
Wetness (w):								
Flooding	No flooding	No flooding	Slight	Slight	Severe	Severe	Severe	Very severe
Drainage	Good	Moderate	Somewhat imperfect	Imperfect	Poor	Poor	Very poor	Very poor
Physical soil condition (s):								
Surface texture	L-CL	SCL-SL	SL-LS	LS-C	LS-HC	LS-HC	Any	Any
Surface coarse fragment (%)	None	< 15	< 35	< 55	< 55	< 55	< 75	< 75
Rockyness (%)	None	< 2	< 10	< 25	< 50	< 50	< 75	< 75
Soil depth (cm)	< 1.5	> 1.0	> 0.5	> 0.25	> 0.25	> 0.25	> 0.10	> / < 0.10
Fertility (f):								
Aparent CEC	> 16	16-12	12-10	10-6	Any	Any	Any	Any
Base saturation	> 80	> 50	> 35	> 15	> 15	Any	Any	Any
Org. carbon (0-15cm)	> 1.5	> 1.0	> 0.6	> 0.4	> 0.4	Any	Any	Any
pH (H_2O)	6-8	6-8	5-6/8-9	5-6/8-9	< 5/ >9	< 5/ > 9	< 5 / > 9	< 5 / > 9

Key: L = loam, CL = clay loam, SCL = sandy clay loam, SL = sandy loam, LS = loamy sand, HC = heavy clay

Table 4: Land Capability Classification of a Toposequence at Obuohia -Ibere Ikwuano L.G.A, Abia State

Land Characteristic	Pedon 1 (Summit)	Pedon 2 (Upper slope)	Pedon 3 (Toe slope)	Pedon 4 (valley bottom)
Limitations				
Slope (t)	IV	III	I	I
Wetness (w)	I	I	III	IV
Rockyness (r)	I	I	I	I
Effective soil depth (s)	I	I	I	II
Texture (s)	II	I	I	III
pH (H_2O) (f)	V	V	III	III
CEC (f)	V	V	III	III
OC (f)	V	V	III	III
Aggregate LCC	V	V	III	IV
Land Capability Subclass	Vf	Vf	IIIfw	IVw