THE INTERNATIONAL JOURNAL OF SCIENCE & TECHNOLEDGE

Characterization and Classification of Soils Along a Toposequence in Ajata-Ibeku Abia State South Eastern Nigeria

Audu S. D.
National Cereals Research Institute, Badeggi
G. Lekwa
Department of Soil Science, Micheal Okpara University of Agriculture Umudike Abia State

Abstract:
The study of the characterization and classification of soils along the toposequence in Ajata-Ibeku was carried out using transect and soil augering to identify eight soil units representing three physiographic positions of crest, mid slope and foot slope. The study aimed at characterizing and classifying the soil of Ajata-Ibeku, Umuahia southeast Nigeria. Soil profile pits were dug and samples collected based on degree of horizon differentiation. The study showed that the morphological and physio-chemical properties of the soil along the toposequence reveals that percentage of sand in all the horizons of the soil profile were high with clay particles increasing with depth. The soils were classified as Typic Hapludult (USDA) or Haplic Acrisol (FAO/UNESCO Legend) at the crest slope; Vertic Epiaquept, Vertic Hapludults and Aeric Epiaquept (USDA) or Gleyic Cambisol, Haplic Acrisol and Gleyic Cambisol (FAO/UNESCO Legend) at the middle slope and Vertic Epiaquept (USDA) or Gleyic Cambisol (FAO/UNESCO Legend) at the valley bottom.

Keywords*: characterization, classification, toposequence, Ajata-Ibeku soils*

1. Introduction

Soil classification is the systematic arrangement of soils into groups or categories on the basis of their characteristics (Onyekanne et al., 2012). Each soil based on its characteristics has a predictable response to management or any form of manipulation (Ogunkunle, 2004). Soil classification is the grouping of soil into classes (Russel, 1985) and its major purpose is to facilitate the transfer of information about the use and management of soil related technologies from one location to another. It involves the determination of morphological, chemical and mineralogical properties of importance to agriculture and fitting of such soils into widely accepted soil classified system. It is used to provide guideline information for regional development and is useful for national planning purposes (Ogunkunle et al., 1992). Taxonomic classification of Nigerian soils was conducted by vine (1954) who divided it into three (3) broad zones, which were further divided into 16 soil groups based on differences in mechanical composition and organic matter content (Ojanuga, 2003).

In pedogenesis, topography is both an internal and external factor and it influence soil formation (Temgoua et al., 2005). Different geochemical conditions are experienced on different landscape positions (upper slope, middle slope and foot slope), depending upon the influence of topography on the drainage and the hydrology of the soil cover (Lucas and Chanvel, 1992). There is currently no information on the nature and properties of the soils in Ajata-Ibeku environment. A lot of agricultural activities are going on in the area and is therefore of enormous potential socio-economically. Information on the physio-chemical characteristics will be of immense importance for the sustainable development. The aim of the present study was to generate and document data on the properties of soils of Ajata-ibeku as well as their classification for sustainable usage.

2. Materials and Methods

The study area covers about 120 hectares of land in Ajata-Ibeku Umuahia North L.G.A., Abia State. It is located between latitude $4^{o}15'$ and 7^{o}N and longitude 5050' and $9^{o}30'$E.

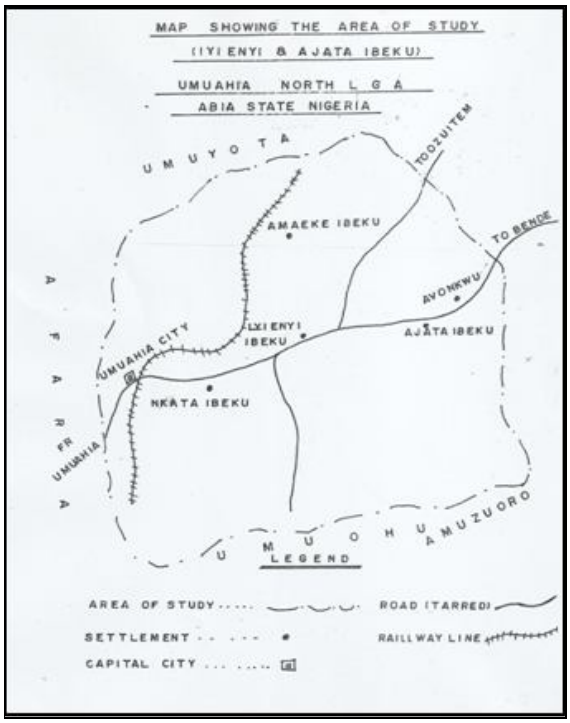

Figure 1: Map showing the study areas

The climate is typically tropical, characterized by bimodal rainfall regime with annual rainfall between 1900mm and 2200mm, annual temperature range of 27-30^{o}C, and high relative humidity throughout the year reaching its maximum during the rainy season when values are above 90% (NRCRI, 2007).

The parent materials of the area are sandstone and shale of Bende-Ameke formation while coastal plain sands are connected with the sea by a large number of creeks. The vegetation of the area is tropical rainforest and prevalent plants available are oil palm, guinea grass, elephant grass and giant star grass.

A total of eight (8) soil profile pits were dug (1.5 X 1.5 X 2m) along the toposequence and designated as AD (01-03) crest slope at Iyienyi-Ibeku, AD (04-06) middle slope at Ajata-Iyienyi and AD (07-08) valley bottom at Ajata-Ibeku rice farm. Handheld global positioning system receiver was used to geo-reference all pedons for the investigation. The GPS receiver indicates latitude, longitude and elevation of the area while soil augering was carried out by transversing representation area to identify soil units based on toposequence.

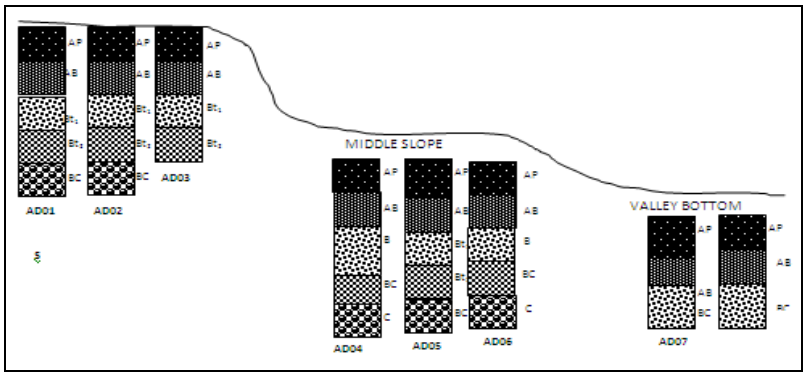

Figure 2: Sketch of the toposequence sampled from crest to zalley floor

Laboratory analyses of the soil samples were carried out using appropriate procedures to determine both physical and chemical properties of the soil. The representative soil profiles for each slope category were described and the horizons were designated in situ according to the guidelines of FAO (2006). Soil colour notation was described according to Munsell colour chart (KIC, 2000). From the result of the soil laboratory analysis and field morphological properties the eight (8) pedons was classified according to the soil taxonomy (USDA, 2010) with side by side correlation of the FAO/UNESCO and the World Reference Base (WRB) soil map of the world legend.

3. Results and Discussion

3.1. Morphological Properties

3.1.1. Data for Soil Profile Description of the Area

The field morphological properties of the horizons/soil units studied are presented in table 1 and table 2 shows the chemical properties of the study areas. The toposequence designated as AD01-03 which represents the crest slope situated at Iyienyi-Ibeku is characterized as well drained sandy clay loam to sandy clay. The colour matrix varies within the soil horizon from dark brown (10YR3/3) at the upper region to dark red (2.5YR3/6) at the lower horizon/subsoil. The nature of the parent material is Bende-Ameke soil formation which includes sandstone and shale with undulating plains of 6-9% upper slope. They are also characterized by weak sub-angular blocky structure, friable, gradual smooth boundary with common fine, woody roots and interstitial pores at the upper horizon to angular blocky, friable and plastic.

The middle slope designated as AD04-06 has gently undulating mid slope of 4-6% is also of Bende-Ameke formation. They have moderately drained sandy loam to sandy clay texture. The colour matrix varies from dark brown (10YR3/3), weak sub angular blocky, friable, gradual smooth boundary with common fine roots and pores to angular blocky, friable, slightly sticky to plastic varying colour at the lower horizon.

The lower slope designate as AD07-08 has flat slope of 0-1% of alluvium () formation. They have poorly drained sandy clay loam to clay soil texture. Other characteristics include weak sub angular blocky, friable, plastic (wet), clear smooth boundary with common fine roots and pores to angular blocky, friable, sticky and plastic (wet).

SOIL UNITS	USDA SOIL TAXONOMY	FAO/UNESCO
AD01	Typic Hapludults	Haplic Acrisol
AD02	Typic Hapludults	Haplic Acrisol
AD03	Typic Hapludults	Haplic Acrisol
AD04	Vertic Epiaquept	Gleyic Cambisol
AD05	Typic Hapludults	Haplic Acrisol
AD06	Aeric Epiaquept	Gleyic Cambisol
AD07	Vertic Epiaquept	Gleyic Cambisol
AD08	Vertic Epiaquept	Gleyic Cambisol

Table 3: Taxonomic Classification Of Soil Units

The soils of the toposequence are classified according to soil taxonomy (USDA soil taxonomy, 2010), FAO/UNESCO and the World reference base (WRB) soil map of the world legend. The soils are formed under udic moisture regime that is not dry in any part as long as 90 cumulative days in normal years. Soil unit AD01 to AD03 is classified as Hapludults or Acrisol because of the argillic or kandic B-horizon with low base saturation. The clay content decreases with increasing depth by more than 20% from its maximum amount (B-horizon with highest clay content) within 150cm of the mineral soil surface and have a colour value of 4 or moist in some sub surface argillic horizon. Soil unit AD 04, 07 and 08 are classified as Vertic Epiaquept or Gleyic Cambisol because of the cambic B-horizon and an Ochric A-horizon with mineral soil development as a result of high chroma (3 or more) in B-horizon with light colour, structure or consistency change due to weathering. Soil unit AD 06 are classified as Aeric Epiaquept or Gleyic Cambisol because of the cambic B-horizon and an Ochric epipedon with minimal soil development indicating either shorter period of saturation of the whole soil or deeper ground water than the soils of the typic subgroup.

4. Conclusion

The characterization and classification of soils along a toposequence in the study area revealed their morphological properties. The interaction of topography on soil properties inferred that soil properties vary with topographic positions. Therefore the users of the soil are left to exploit the interactions for meaningful planning and agro-ecological transfer. The protection of soils against erosion should be the integral part of the management of soils for agricultural productivity.

5. References

1. Kollomorgen Instruments Corporation (KIC) (2000). Munsell Soil Colour Charts Baltimore USA.
2. Lucas, Y and Chanvel, A. (1992). Soil Formation in Tropically Weathering Terrains. In Regolith Exploration Geochemistry in Tropical and Sub-tropical Terrains, Butt, C.R.M and Zeegers, H. (eds). Handbook of Exploration Geochemistry.Volume 4, Govett, G.J.S. (eds) Elserver.
3. National Root Crop Research Institute Umudike (2011). Agro Climatology Report.
4. Ogunkunle, A.O. and Onasanya, C.T. (1992). Soil Landscape Relationship in Forest Zone in South Western Nigeria. Samara Journal of Agriculture Research 9:19-33.
5. Ojanuga, A.G. (2003). "Soil Survey, Classification and Land Use". Proceedings of the Annual Conference of the Soil Sc. Soc. Of Nigeria Umudike.
6. Russel , E.W. (1988). Soil Survey, Soil Classification and Land Evaluation. Russel Soil Condition and Plant Growth. Pp 815 – 843.
7. Temgoua, E.F.D., Tehapga, E., Tanawa, E., Guenat and Pfeifer, H. (2005). Ground Water Fluctuation and Footslope Fericrete Soils in the Humid Tropic Zone of Southern Cameroun. Hydrol Process 19: 3097 – 3111.

8. Vine, H. (1954). Latosol of Nigeria and some related soils. 2nd Proceedings Inter-African Soil Conference (Leopoldville) No. 1: pp 295 – 305.
9. Ogunkunle, A.O. (2004). Soil Survey and Sustainable Land Management: In Proceedings of 29th Annual Conference of the Soil Science Society of Nigeria. Pp 19-24.
10. Onyekanne, C.F., Akamigbo, F.O.R. and Nnaji, G.U. (2012). Characterization and Classification of Soils of Ideato North L.G.A. Nigerian Journal of Soil Science 22 (1): 11-17.
11. F.A.O. (2006).
12. U.S.D.A. (2010)

Profile No				Exchangeable Cations Cmol/kg					Exchangeable acidity Cmol/kg								
	Depth Cm	PH H2O	PH kcl	Ca	Mg	K	Na	Tea	H+	Al3+	TN %	OC %	Avail P(mg/kg)	B.D g/cm3	CEC cmol/kg	% BS
AD01	0-15	5.7	4.6	3.60	1.60	0.57	0.23	1.90	1.00	0.09	0.23	2.67	9.13	1.32	15.5	31
	15-32	5.6	4.6	1.80	1.20	0.21	0.23	1.20	0.70	0.50	0.13	1.57	6.21	1.40	10.0	34
	32-75	5.2	4.3	2.40	1.60	0.12	0.24	2.00	1.20	0.80	0.12	1.47	5.35	1.65	9.0	38
	75-126	5.1	4.1	1.20	0.80	0.07	0.15	2.30	1.40	0.90	0.06	0.71	4.30	1.62	6.0	36
	126-180	50.	4.1	1.60	1.20	0.09	0.18	1.10	0.70	0.40	0.05	0.65	5.90	1.63	7.0	44
AD02	0-14	5.8	5.0	3.60	2.80	0.13	0.55	2.10	1.30	0.70	0.07	2.2	8.20	1.33	18.50	31
	14-35	5.6	4.8	3.20	1.20	0.08	0.11	2.20	1.25	0.95	0.04	1.0	7.50	1.41	50.00	31
	35-80	5.3	4.2	3.20	2.00	0.08	0.05	1.70	1.00	0.70	0.00	0.8	6.15	1.43	12.00	40
	80-120	5.2	4.1	2.80	1.60	0.07	0.09	1.30	0.90	0.40	0.05	0.5	7.50	1.60	10.00	55
	120-180	5.1	4.1	2.80	1.60	0.07	0.06	1.25	0.95	0.30	0.03	0.4	7.25	1.62	10.00	45
AD03	0-10	6.9	5.3	2.40	2.80	0.08	0.36	0.74	0.60	0.14	0.40	3.52	5.40	1.67	12.0	47.0
	10-35	6.8	5.3	2.08	1.60	0.04	0.09	0.65	0.58	0.07	0.30	2.29	3.16	1.34	10.0	37.0
	35-75	6.6	5.2	3.40	1.20	0.04	0.07	0.30	0.25	0.05	0.22	2.25	3.72	1.35	9.5	31.0
	75-00	5.9	4.9	2.40	2.00	0.05	0.02	0.25	0.22	0.03	0.17	2.03	2.20	1.40	11.5	41.0
AD04	0-14	5.7	4.5	4.40	2.00	0.11	0.04	1.50	1.20	0.30	0.35	2.35	9.5	1.32	17.3	31
	14-35	5.6	4.5	3.60	1.60	0.04	0.10	1.30	0.90	0.40	0.29	2.19	8.0	1.64	12.2	40
	35-76	5.4	4.3	3.80	2.80	0.05	0.09	0.95	0.75	0.20	0.18	1.75	5.6	2.40	10.5	41
	76-125	5.2	4.2	2.40	1.20	0.04	0.08	0.88	0.80	0.08	0.15	1.52	4.9	1.55	9.6	31
	125-158	5.1	4.0	2.40	1.60	0.03	0.06	0.65	0.40	0.25	0.12	1.32	3.8	1.50	10.0	40
AD05	0-12	5.2	4.8	2.40	1.60	0.06	0.05	1.84	0.94	0.90	0.05	0.68	13.4	1.20	12.0	38
	12-28	5.0	4.5	2.50	1.20	0.06	0.06	0.95	0.85	0.10	0.03	0.44	13.0	1.46	10.0	33
	28-60	4.9	3.9	1.80	0.90	0.03	0.03	0.06	0.58	0.08	0.02	0.29	12.6	1.37	12.0	23
	60-110	4.8	3.7	1.04	0.70	0.04	0.15	0.56	0.48	0.08	0.01	0.27	15.7	1.64	8.0	31
	110-135	4.6	3.7	2.10	1.60	0.02	0.02	0.54	0.47	0.07	0.01	0.20	14.9	1.63	10.0	39
ADO06	0-15	5.2	4.8	2.20	2.00	0.17	0.40	1.86	0.95	0.91	0.05	0.68	15.4	1.74	15.9	29
	15-37	5.0	4.5	1.20	0.80	0.12	0.15	0.95	0.85	0.10	0.03	0.44	13.0	1.46	11.2	20
	37-58	4.9	3.9	0.80	0.40	0.17	0.20	0.66	0.58	0.08	0.02	0.29	12.6	1.37	9.6	16.2
	58-95	4.8	3.7	2.40	2.00	0.09	0.14	0.55	0.47	0.08	0.01	0.27	11.7	1.78	15.0	30.8
	95-130	4.6	3.7	2.60	1.20	0.11	0.17	0.54	0.48	0.06	0.01	0.20	13.8	1.64	15.0	27.2
AD07	0-14	5.6	4.4	4.80	1.70	0.07	0.05	1.70	1.62	0.08	0.22	2.35	8.2	Nil	6.29	72
	14-40	5.4	4.3	5.28	2.01	0.05	0.05	1.40	1.30	0.10	0.20	2.33	6.7	1.3	14.92	75
	40-70	5.3	4.2	4.48	1.50	0.06	0.04	0.90	0.58	0.30	0.13	1.88	5.4	Nil	9.06	72
AD08	0-15	5.3	4.0	1.23	0.06	0.08	0.06	1.25	0.95	0.30	0.05	1.2	15.0	Nil	4.0	36
	15-60	5.2	4.1	1.71	1.10	0.49	0.16	1.08	0.98	0.10	0.04	0.6	6.5	13.5	9.3	37
	60-75	5.0	3.9	2.25	1.08	0.46	0.22	0.95	0.90	0.05	0.02	0.3	4.0	13.2	8.0	44

Table 2: Chemical Characteristics of Soils of the Study Area
TN = Total Nitrogen, OC = Organic Carbon, BS = Base Saturation
DD = Bulk Density, Ap = Available Phosphorus.

SOIL UNIT NO	HORIZON	DEPTH (CM)	COLOUR MATRIX	TEXTURE	STRUCTURE	CONSISTENCY	DEPTH TO WATER TABLE	ELEVATION	DRAINAGE	SLOPE	GEOGRAPHICAL CO-ORDINATES	PARENT MATERIAL
AD 01	**Ap**	**0-15**	Dark brown (10YR 3/3)	Sandy loam	wsb	f	Below 180cm	132 masl	Well drained	Undulating plains, 7-9% upper slope	05 32 19.0 N 007 32 23.6 E	Sandstone and shales
	AB	**15-30**	Strong brown (7.5YR 4/6)	Sandy clay loam	sab	fssp						
	Bt1	**32-75**	Yellowish red (7.5YR 5/6)	Sandy clay	ab	fssp						
	Bt2	**75-126**	Yellowish red (5YR 5/8)	Sandy clay	ab	fsp						
	BC	**126-180**	Dark red (2.5YR 3/6)	Sandy clay	ab	Fsp						
AD 02	**Ap**	**0-14**	Dark brown (10YR 3/3)	Sandy loam	wsb	f	Below 180cm	137 masl	Well drained	Undulating plains, 6-9% upper slope	05 32 19.0 N 007 32 26.0 E	Sandstone and shales
	AB	**14-35**	Strong brown (7.5YR 4/6)	Sandy clay loam	sab	f						
	Bt1	**35-80**	Reddish yellow (7.5YR 6/8)	Sandy clay loam	ab	fssp						
	Bt2	**80-120**	Yellowish red (5YR 5/8)	Sandy clay	ab	fssp						
	BC	**120-180**	Yellowish red (5YR 5/8)	Sandy clay	ab	fssp						
AD 03	**Ap**	**0-10**	Dark brown (10YR 3/3)	Sandy clay loam	wsb	f	Below 90cm	136 masl	Well drained	Undulating plains, 8-9% upper slope	05 32 25.2 N 007 32 28.6 E	Sandstone and shales
	AB	**10-35**	brown (7.5YR 5/6	Sandy clay	sab	f						
	Bt1	**35-75**	Yellowish red (5YR 3/6)	Sandy clay	sab	f						
	Bt2	**75-90**	Dark red (2.5YR 3/6)	clay	ab	f						
AD 04	**Ap**	**0-14**	Dark brown (10YR 3/3)	Sandy loam	wsb	f	Below 158cm	91 masl	Moderately-somewhat poorly drained	Gently undulating plains, 4-6%	05 32 49.9 N 007 33 4.2 E	Sandstone and shales
	AB	**14-35**	Dark brown (7.5YR 3/2)	Sandy clay loam	sab	fsp						
	B	**35-76**	Dark grey (7.5YR 4/0)	clay	ab	fsp						
	BC	**76-125**	Pinkish grey (5 YR 6/2)	clay	ab	fp						
	C	**125-158**	Grey (5YR 6/1)	Clay	ab	fp						
AD 05	**Ap**	**0-12**	Dark brown (10YR 3/3)	Sandy loam	wsb	f	Below 135cm	89 masl	Moderately well drained	Gently Undulating-Undulating plains, 5-7% mid slope	05 32 48.1 N 007 33 43.8E	Sandstone and shales
	AB	**12-28**	Strong brown (7.5YR 4/4)	Sandy loam	sab	f						
	Bt1	**28-60**	brown (7.5YR 5/4)	Sandy clay loam	sab	fsp						
	Bt2	**60-110**	Pinkish grey (5 YR 6/2)	Sandy clay	sab	fsp						
	BC	**110-135**	Reddish yellow (7.5YR 6/6)	Sandy clay	ab	fsp						
AD 06	**Ap**	**0-15**	Dark brown (10YR 3/3)	Sandy loam	wsb	f	Below 138cm	87 masl	Moderately well drained	Gently Undulating-Undulating plains, 4-5% mid slope	05 32 43.8 N 007 33 38.5 E	Sandstone and shales
	AB	**15-37**	Dark yellowish brown (10YR 4/4)	Sandy clay loam	sab	f						
	B	**37-58**	brown (7.5YR 5/5)	Sandy clay	sab	fsp						
	BC	**58-95**	Very dark brown (7.5YR 2/2)	Sandy clay	ab	fsp						

	C	**95-130**	Pinkish grey (5YR 6/2)	Sandy clay	ab	fsp						
AD 07	**Ap**	**0-14**	Dark greyish brown (10YR 4/2)	Sandy clay loam	wsb	fp	Below 78cm	56 masl	Poorly drained	0-1% flat	05 32 32.5 N 007 34 58.3 E	Alluvium
	AB	**14-40**	Dark brown (7.5YR 4/2)	Clay	ab	fp						
	BC	**40-70**	Light reddish brown (5YR 6/3)	Clay	ab	fp						
AD 08	**Ap**	**0-15**	Dark brown (10YR 4/2)			fsp	Below 75cm	56 masl	Poorly drained	0-1% flat	05 32 33.5 N 007 34 56.1 E	Alluvium
	AB	**15-60**	Grey(7.5YR 6/1)			fp						
	BC	**60-705**	Pinkish grey(5YR 6/2)			fp						

Table 1: Data For Soil Profile Description Of The Area

f – friable, fp – friable, sticky and plastic, fsp – friable, slightly sticky and plastic, fssp – friable, slightly sticky and slightly plastic, ab – angular blocky, sab – subangular blocky, wsb – weak subangular blocky, Masl -