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Properties of two landscape units formed over Alluvial Deposits in Okpanam Delta Region, Southern Nigeria

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Abstract
The study was conducted on soils formed over fluvial deposits in Okpanam Delta State to investigate the properties and classify soils, as well as compare variability among the properties of the soils. Soils within two geomorphic land units, Backswamp and Terrace in the site were characterized and classified using the USDA Soil Taxonomy and World Reference Base for soil resources. Pedons were sunk at each geomorphic land unit. Soil samples were collected based on horizon differentiation and analyzed in the laboratory using standard methods. Statistical tools such as mean, standard deviation, and coefficient of variation were used to analyze data generated in the study. Results showed that soils were high in clay content to moderate sand, silt and clay were 528.4, 124 and 347.6 g/kg respectively at the Backswamp and 622.4, 54.0 and 323.6 g/kg for sand, silt and clay respectively at the terrace. The two pedons had Argillic [Bt] horizons as a result of clay movement down depth and low silt to clay ratio indicating advanced stage of weathering. Backswarnp had base saturation of 35 % while terrace had base saturation of 55 % .the soils were classified as Typic Kandiaquult [Gleyic Acrisols] and Typic Kandiudalf [Haplic Luvisols]. In comparing variabilities among properties, pH in water ranges from 5.00 to 6.65 in pedon 1 and 5.17 to 7.35 in pedon 2, Total exchangeable bases was low in pedon 1 ranging from 0.91 to 1.10 cmol/kg and 0.68 to 1.75 cmol/kg in pedon 2. Total exchangeable acidity ranges from 1,44 to 2.40 cmol/kg in pedon 1 and 0.24 to 3.36 cmol/kg in pedon 2. Effective cation exchange capacity was lower in pedon 1 with 2.38 to 3.48 cmol/kg relative to pedon 2, with 1.26 to 5.11 cmol/kg . Organic matter recorded highest in pedon 1 from 5.9 to 29.1 g/kg relative to pedon 2 with 10.7 to 27.6 g/kg. The nitrogen content was found to be greatest in pedon 1 than in pedon 2. Fluvial soils are suitable for roots and tuber crops in Backswamp and other parts are suitable for vegetables and other annuals.
Keywords: Alluvium, Pedogenesis, Geomorphology, Soil Quality, Humid Environment

1.0 Introduction

The knowledge of the characteristics and soil groups of fluvial and alluvial deposits in soils is an integral part of soil quality studies. The need to provide information on the effects of fluvial and alluvial deposits on soil physical and chemical properties is more demanding now than before because of the problem arising from the misuse of these soils. Fluvial ecosystem is complex mosaic of landform differing in sedimentary composition and succession state which together shade ecological heterogeneity of the surrounding landscape (Bridges, 1996).

One of the major factors limiting agricultural development in southern Nigeria is lack of detailed information on soil characteristics. Currently there is enormous pressure on the land resources particularly in tropical soils in developing countries thus the need to improve current standards of fluvial and alluvial soils (Borlaug & Dowsell, 1997) and the dwindling reserves of quality alluvial soils (Alexandrotos, 1996).

Fluvial soils are associated with streams and rivers. The alluvial soil category is primarily composed of unconsolidated basin fill that has been deposited and then altered by water. Alluvial soils are rich in humus and organic matter but deficient in nitrogen and potash. It is loamy, consisting of fertile silt deposit by the river. Also, alluvial soils are rich in Fe and Al (sesquioxides), they are also porous and fragile in nature.

Brady & Weils, (2002) observed that nutrient rich materials lost through fluvial processes are deposited on floodplains. Soils derived from alluvium generally have characteristics such as desirable for agriculture. These characteristics include proximity to water, high fertility and high productivity. Sometimes if over a period of time, there is change in grade, a river may cut down through its already well-formed alluvial deposits. This cutting action leaves terraces above the floodplain at different elevations, reflecting a past period of alluvial deposits of greater extension in certain area. Lithologically alluvial deposits are made up of sand, gravel, clay, lime and conglomerates that are both horizontal and semi horizontal (Brady & Weils, 2002).

Montgomery (2002), stated that when these loose alluvial materials are deposited or cemented into a lithological unit, referred to as alluvial deposit. Alluvium can contain valuable ores such as gold, coal and whole variety of germstones.

A number of changes occur as a result of fluvial and alluvial deposits in the soil. The physical changes include soils structure, texture, soil colour, aeration and temperature while chemical changes may involve organic matter accumulation, leaching of nitrogen and potassium from the soil. Electrochemical changes like increase in soil pH as a result of sesquioxides present and changes in cation and anion exchanges reaction

Most fluvial and alluvial soils cut across vegetation, geological and topological boundaries. The largest concentrations of alluvial and fluvial soils occur in southern Nigeria in form of coastal plain sands and alluvium. Alluvial soils are useful for cultivation of crop plants and vegetables because of the high humus content and high fertility.

Davidson (1995), reported that the properties of alluvium are strongly influenced by water current and force of the current. Thus, down the stream, there is increased proportion of silt within the floodplain as this is associated with increased sediment deposition. Silt deposition has a positive influence on moisture availability, planting root and habitat sustainability for various organisms including fungi and invertebrates. It also influences organic matter, nutrients and moisture retention (Buol *et al.,* 1997).

The sorting of fluvial materials involve the rate of alluvial sediments as influenced by water current. This creates strong predictable patterns in the particle size distribution of sediments within alluvial landforms.

Christensen (1996), stated that fluvial sorting establishes a physical templates constraining biochemical interactions which are ultimately reflected in patterns of productivity, species diversity and terrestrial-aquatic exchange. This therefore follows that the rate of soil productivity as we move downstream is determined by fluvial sorting, thus the characteristics of alluvial sediments plays an important role in productivity.This research was aimed at characterizing and classifying soils of Okpanam area in River Niger region of Southern Nigeria.

2.0 Materials and Methods

2.1 Location:

The site is located at Okpanam, Delta State on Latitude 6° 13' N and Longitude 6° 23' E. The study site is formed as a result of fluvial deposits from River Niger. The study area lies within the low land areas of southern Nigeria and in the humid tropics. The main geology material is coastal plain sands (Benin fornation) (Orajaka, 1975). However, the geology is influenced by fluvial deposition of alluvium. The climate is characterized by uniformly high temperature ranging between 20 ° – 30 °C. Soils are derived from alluvial deposits. The region falls within the middle belt in the southern Nigeria with relatively high rainfall distribution of 2,500 to 3,200 mm per annum.

The site lies within the rainforest belt of Nigeria and characterized by abundance of many plant species such as oil palm trees, coconut trees, mango and orange trees which are of economic importance. The vegetation often appears in form of hardy trees in large mass. Some areas are dominated by grass and shrubs and sometimes about 150 different species of plant per hectare are found. This great density makes the rainforest the richest in terms of biomass productivity of all terrestrial ecosystems. The soils of the study site are influenced by River Niger.

2.2 Socioeconomic activities

Farming and fishing are the major socioeconomic activities of the people of Okpanam Community Delta State Nigeria with food crop dominating the practice. Food crop cultivation is still on small scale level. The production is based on bush fallow system of agriculture as this is the main technique used in soil fertility regeneration.

2.3 Sample Collection

The selected site was guided by observed variability in geomorphic features as formed of terrain changes with movement towards the river. A free survey was used in locating profile pits. A profile pit was dug on each physiographic position to give total of two profile pits each in Backswamp and Terrace locations respectively. Soils samples were collected based on horizon differentiation. The description of the horizons was according to FAO guidelines (FAO, 1988, FAO 1998).

2.4 Laboratory Analysis

Particle size distribution was determined by hydrometer method according to the procedure of (Gee & Or, 2002), Bulk Density was measured by core method (Grossman & Reinsch, 2002). Porosity was computed from bulk density and particle density. Soil pH was determined in 1:2.5 soil liquid ratios in water and 0.1 N KCl (Hendershot *et al.,* 1993). Organic Carbon was determined using method described by (Nelson & Sommers, 1982), Organic matter was derived from organic carbon. Total Nitrogen was determined using modified micro Kjeldahl method (Bremner & Mulvaney,1982). Total available phosphorus was determined using Bray II method (Olsen & Sommers, 1982). Cation exchange capacity (CEC) was measured by repeated saturation using 1 M NH_4OAC followed by washing, distilling and titrating (Soil Survey Staff, 1996).

2.5 Data Presentation and Analysis

Coefficient of Variation (C.V) as used by Wilding (1985) was used in this study to estimate the degree of variability existing among soil properties in the study site. Comparisons were drawn from the results from the laboratory analysis of the pedons. Percentage coefficient of variation was calculated using Standard Deviation and ranked as follow:

CV $\leq$15 % = Low variation

> 15% $\leq$35 % = Moderate Variation

> 35 % = High variation

3.0 Results and Discussion

Physical Properties: The Results show that in the backswamp, there is preponderance of sandy clay loam to clay soils in the textural class ranging from 64.24 % - 40.24 % sand; 6.0 % – 16.0 % Silt and 29.76 % – 43.76 % clay (Table 1). Terrace as revealed in pedon 2 showed that texture ranged from loamy sand to sandy clay loam and clay loam soils having 82.24 % - 44.24 % total sand, 8.0 % - 2.0 % silt and 9.76 % – 47.76 % clay (Table 4.1). From the results, terrace has the highest depth extending up to 150 cm and AB horizon was higher in depth relative to backswamp with depth of 20 – 50 cm when compared to 20 – 40 cm of backswamp. This shows that the depth of AB horizon increases at the terrace region suggesting the possibility of movement of alluvial or eroded materials down the slope.

Backswamp and terrace have sandy clay loam texture. The general sandy nature of the study site could be due to the climate and parent material as well as depositional activities of the Niger River. Backswamp has preponderance of clay fraction with mean of 34.76 % with coefficient of variability of 39.7 % compared to the terrace soils having mean and coefficient of variability of 32.36 % and 32.4 % respectively. Similarly, silt was higher as the Backswamp with mean of 16.0 % and moderate CV of 34.3 % while at the terrace soils, silt was low with relatively moderate coefficient of variation of 8.0 % and 21.7 %, respectively.

Smith *et al* (1998), noted that measures of particle size distribution specifically silt and clay percent as well as organic matter have good relationship with specific surface area, soil compatibility and compressibility all of which affect the productivity of soils. It therefore follows that within a mineralogical class, soil fertility correlates with clay content except in oxide soils. This result shows that since high clay content was in Backswamp which resulted from depositional materials from river, plant growth especially the annual crops will likely be lower in the Backswamp. This is as a result of the interaction effect of clay on soil water and nutrient status (Scholes *et al,* 1994). However, the availability of these nutrients depends on the clay activities as clay soils are able to trap and hold certain nutrient element in their colloidal surfaces thus will be suitable for perennial crops and heavy tuber crops that have the ability to absorb nutrient element because of the nature of their roots.

Table 1: Physical properties of the Fluvial soils of Okpanam

Hori	Depth (cm)	Sand	Silt (%)	Clay	SCR	TC	BD (g/cm3)	Poros (%)	MC (%)
		Backswamp (0-1 % slope)							
A	0-20	64.24	6	29.76	0.2	SCL	1.61	40	13.49
AB	20-40	79.24	8	12.76	0.63	SCL	1.49	44	14.23
Bt1	40-60	42.24	16	41.76	0.38	CL	1.37	48	27.69
Bt2	60-80	38.24	16	45.76	0.35	C	1.29	51	26.71
Bt3	80-100	40.24	16	43.73	0.37	C	1.36	49	24.73
	Mean	52.84	12.4	34.76	0.39		1.42	46.4	21.37
		Terrace (0-3 % slope)							
A	0-20	82.24	8	9.76	0.82	LS	1.25	47	12.48
AB	20-50	62.24	4	33.76	0.12	SCL	1.43	54	12.51
Bt1	50-70	60.24	5	34.76	0.14	CL	1.36	51	23.51
Bt2	70-90	62.24	2	35.76	0.06	CL	1.58	41	11.83
Bt3	90-150	44.24	8	47.76	0.17	CL	1.42	54	22.83
	Mean	62.24	5.4	32.36	0.26		1.41	49.4	16.63

TC=Textural class, SCR=Silt-clay ratio, BD=Bulk density, MC=moisture content, SCL=sandy clay loam, CL= Clay loam, LS = Loamy sand, C= clay.

Chemical Properties: Soil Reaction (pH) in H_2O was slightly lower in backswamp than in terrace soils. Backswamp having mean pH of 5.40 and terrace with mean value of 6.04. The slight difference in pH in water might be considered non significant. This variation shows higher levels of acidity in backswamp than in terrace. Higher organic matter content and a preponderance of basic cations (Table 2) in the terrace class may be responsible for lower acidity obtained in this region relative to the other soil. This is particularly because soil pH determines the activities of soil micro organisms which help the decompose of organic matter present in soils, and soil organism decreases when pH increases while the buffering capacity of the soil increases with increase in organic matter (Ezedinma & Onazi, 1999). Higher level of acidity may be, attributed to acidic nature of the coastal plain sands from which the soils are derived (Ofornata, 1975) & Brady and Weil, (2002) suggested that parent materials exhibit much impact on soil pH determining whether the soils would be acidic or alkaline, also due to the prevalence of high precipitation which results to the eluviations of basic cations into lower horizons of the soil profile. This is one of the characteristics of the humid tropical soils that have always been subjected to severe weathering resulting from its harsh climate. Also, Brady & Weil, (2002) have shown the possibility of tectonic fluvisols which are acidic in nature as a result of preponderance of acidic cations and leaching of basic cations down the slope thus cultivation in Backswamp should be done on moulds or ridges. Soil acidity has an effect on nutrient availability. Soil pH however indicated a non significant relationship (Table 6) all soil properties investigated and varied lowly $Cv \leq 15$ % (Tables 5, 7) in the terrace and Backswamp soils.

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Table 2: Chemical Properties of Studied Soils

Horiz	Depth (cm)	pH (H_20)	pH (0.1N K Cl)	Ca	Mg	K	Na	TEB	Al^{3+}	H^+	TEA	ECEC	Al Sat	BS	OM	TN	Avai P (mg/kg)
						Backswamp (0-1 % slope)											
A	0-20	5.00	4.89	0.40	0.10	0.05	0.39	0.94	1.20	0.20	1.44	2.38	50.4	39.0	2.91	0.03	15.8
AB	20-40	6.65	6.55	0.25	0.08	0.14	0.44	0.91	0.50	1.70	1.68	2.59	17.3	35.0	1.76	0.02	16.0
Bt1	40-60	5.12	5.10	0.43	0.23	0.11	0.33	1.00	0.20	1.80	1.80	2.90	6.89	38.0	0.79	0.02	16.1
Bt2	60-80	5.09	5.00	0.41	0.06	0.06	0.42	0.95	1.90	0.20	2.16	3.11	61.7	31.0	0.93	0.01	12.5
Bt3	80-100	5.16	5.12	0.45	0.18	0.05	0.40	1.08	2.20	0.20	2.40	3.48	62.0	31.0	0.59	0.08	16.1
	Mean	5.40	5.31	0.39	0.13	0.08	0.40	1.00	1.20	0.80	1.90	2.89	39.6	35.0	1.40	0.03	15.3
						Terrace (0-3 % slope)											
A	0-20	7.35	5.21	0.42	0.05	0.22	0.33	1.02	0.20	0.20	0.24	1.26	15.8	81.0	2.76	0.03	14.0
AB	20-50	5.86	5.79	0.43	0.23	0.32	0.45	1.43	2.40	0.80	23.2	4.67	51.4	31.0	0.66	0.02	15.4
Bt1	50-70	5.94	5.90	0.26	0.13	0.52	0.52	1.43	1.00	0.80	0.24	1.67	59.8	86.0	1.17	0.02	16.1
Bt2	70-90	5.91	5.82	0.19	0.06	0.08	0.35	0.68	1.50	0.20	0.84	1.52	98.6	45.0	1.14	0.02	13.3
Bt3	90-150	5.17	5.10	0.76	0.16	0.39	0.44	1.75	3.10	0.20	3.36	5.11	61.6	34.0	1.07	0.01	14.7
	Mean	6.04	5.56	0.41	0.13	0.31	0.42	1.26	1.64	0.50	5.58	2.85	57.4	55.0	1.36	0.02	14.7

OM = Organic matter, Avail. P= Available phosphorus, ECEC= effective cation exchange capacity, TEB=Total exchangeable bases, TEA=Total exchangeable acidity. Units – Ca, Mg, K, Na, TEB = Cmol/kg, Al. Sat, OM, TN = %

Table 3: Variability in the Physical Properties of Soils

Soil Property	Sand (%)	Silt (%)	Clay (%)	BD (g/cm^3)	MC (%)	Total Porosity	SCR
	Backswamp (0-1 % slope)						
Grand Mean	52.84	12.4	34.74	1.42	21.37	46.4	0.39
CV (%)	34.3	34.3	39.7	8.9	32.5	9.5	40.1
	Terrace (0-3 % slope)						
Grand Mean	62.24	5.4	32.36	1.41	16.63	49.4	0.26
CV (%)	21.7	48.3	32.4	8.5	36.0	11.1	120

CV= coefficient of variation, BD= Bulk density, MC= Moisture content, SCR= Silt clay ratio

Table 4: Selected Physical Properties

Samples	Bulk Density (g/cm^3)	MC (%)	Total Porosity (%)
	Surface Samples Backswamp		
SS_1	1.10	32.03	58.0
SS_2	1.18	29.22	56.0
SS_3	1.42	26.83	44.0
SS_4	1.12	33.74	58.0
SS_5	1.83	22.53	50.0
Mean	1.33	28.87	53.8
	Surface Sample Terrace		
SS_1	1.54	10.85	42.0
SS_2	1.34	18.42	49.0
SS_3	1.48	11.66	44.0
SS_4	1.37	7.22	48.0
SS_5	1.60	15.03	40.0
Mean	1.47	12.64	44.6

SS1 – SS5 Surface Samples 1-5, MC = Moisture Content.

Total Exchangeable Bases (TEB): In the backswamp (Pedon 1), Ca varies with depth ranging from concentration of 0.4 cmol/kg at the surface and greater concentrations of 0.43 to 0.45 cmol/kg down the, horizon. This may be attributed to leaching of nutrients down depth because · of water action. Total amount of Ca in backswamp was lower when compared with that of terrace and this may be attributed to organic matter accumulation on terrace soils resulting from movement and deposition of particles down slope. Mg^{2+}, K^{+} and Na^{+} were low in all the horizons with some accumulating in Bt, and AB horizon and may be due to illuviation of basic cations in the lower horizons or excess leaching down the horizons causing the accumulation (Donahue et al., 1990). In Terrace (Pedon 2), Ca^{2+} concentration was high at the surface horizon, A and AB due to accumulation of organic matter at the surface and decreased down the profile due to leaching (Table 2). Also, Mg, K, Na also had more accumulation on AB and Bt_1 horizons and decreased down the profile. However the low TEB in Backswamp can be as a result of high leaching rate characteristics of the humid tropics or presence of acidic cations. Ca, Mg and K varied moderately to highly at the

Table 5: Variability in the Chemical Properties

Soil Properties	pH (H_2o)	pH (0.1 N KCl)	Ca	Mg	K	Na	TEB	Al^{3+}	H^{+}	TEA	ECEC	Al Sat	BS	OM	TN	Avai P (mg/kg)
Grand Mean	5.40	5.13	0.39	0.13	0.08	0.40	1.00	1.80	0.80	1.90	2.89	58.0	35.0	1.40	0.03	15.3
CV (%)	12.9	13.0	20.5	55.5	49.8	10.5	8.80	28.0	98	20.8	14.9	11.4	12.0	32.5	96.1	10.1
Grand Mean	6.04	5.56	0.13	0.31	0.42	1.26	2.76	0.5	2.85	2.85	56.5	55.2	0.80	0.02	14.7	15.3
CV (%)	13.2	6.04	53.4	59.0	54.6	18.6	33	18	69	178	66	12.8	47.0	59.5	42.2	7.5

CV= Coefficient of variation, TEB= Total exchangeable bases, Avail. P= Available phosphorus

Table 6: Correlation Matrix Showing the Relationship among some Soil Physical and Chemical Properties

	Al^3	Avail P	BS	Ca	Bulk D	Clay	ECEC	Mg	OM	TEB	TN	pH (1NKCl
Al^3	1											
Avail P.	-0.0803	1										
BS	-0.4649	0.347	1									
Ca	0.8228*	-0.022	0.07	1								
Bulk D	-04466	0.595	0.90*	-0.1	1							
Clay	0.6492*	-0.500	-0.50	0.58	-0.7908*	1						
ECEC	0.9519	0.0339	-0.4	0.73*	-0.28340	0.397	1					
Mg	0.5253	0.643*	-0.3	0.21	0.038909	-0.15	0.70	1				
OM	-0.682*	0.2054	0.95*	-0.2	0.8567*	-0.63	-0.60	-1.0	1			
TEB	0.9064*	0.1166	-0.1	0.85*	-0.04595	0.321	1.00	0.60	-0.3	1		
TN	-0.2177	0.603*	-0.1	-0.3	-0.05149	0.022	-0.30	0.2	-0.3	-0.13	1	
pH 1NKCl	0.43637	0.0635	-0.6	-0.1	-0.22771	-0.16	0.60	0.7	-0.6	-0.59	0.46	1

*= significant at 0.05 probability, TEB= Total exchangeable bases, Avail. P= Available phosphorus, BS= Base saturation, ECEC= Effective cation exchange capacity, Bulk D = Bulk density

Table 7: Ranking of Soil Properties According to Wilding, 1985

Properties	CV (%) Backswamp	Ranking	CV (%) Terrace	Ranking
Chemical Properties				
pH (H_20)	12.9	Low	13.2	Low
pH (0.1N K Cl)	13.0	Low	6.04	Low
Ca^{2+}	20.5	Moderate	53.4	High
Mg^{2+}	55.5	High	59.0	High
K^+	49.5	High	54.6	High
Na^+	10.5	Low	18.6	Moderate
TEB	8.8	Low	33.0	Moderate
ECEC	14.9	Low	66.0	High
Al Sat.	11.4	Low	12.8	Low
BS	12.0	Low	47.0	High
OM	49.5	High	59.6	High
TN	96.1	High	42.2	High
Avai. P	10.1	Low	7.5	Low
Physical Properties				
Sand	34.3	Moderate	21.7	Moderate
Silt	34.3	Moderate	32.4	Moderate
Clay	39.7	High	32.4	Moderate
BD	8.9	Low	8.5	Low
MC	32.5	Moderate	36.0	High
Porosity	8.5	Low	11.1	Low
SCR	40.1	Moderate	1.20	Low

CV = Coefficient of Variation

Backswamp and Terrace soils while Na varied lowly to moderately when subjected to Wilding (1985) variability model. Also, TEB and ECEC varied lowly at the Backswamp and moderately highly at the Terrace soils (Tables 5, 7). Calcium has a positive significant relationship ($P \leq 5$) with ECEC and TEB at the investigated soils (Table 6)

Total Exchangeable Acidity (TEA): The total exchangeable acidity were moderate in Backswamp and high in terrace in all profile units (Table 2) with Terrace higher than Backswamp and this contributes to the pH obtained from the profile pit. Avail. P^+ ions react with water to form H^+ ions. For this reason, Al^{3+} and H^+ together are considered acid cations because $A1^{3+}$ is the cation of a weak base $AI(OH_3)$. It has a strong tendency to hydrolyze, splitting the water molecules into H^+ and OH^- ions. The aluminum combines with the OH^- ion, leaving the H^+ to lower the pH of the soil solution. This aluminum hydrolysis reaction which follows the displacement by H^+ ions of aluminum in minerals may be responsible for much of the acidity in very acid soils (Brady & Weil, 2002).

Effective Cation Exchange Capacity (ECEC): There was low ECEC Backswamp but high in Terrace from the results in Table 2. This low ECEC could be as a result of low levels of organic matter, intense leaching of cations obtained from fluvial deposits and predominance of kaolinitic clay in the soil. The low ECEC is in Constance with results of soils containing high proportion of kaolinitic clays (Igwe *et aI,* 2002). It has also been reported that soils low in organic matter are low in ECEC hence soils of the tropics with high predominance of sesquioxide and kaolinites have low fertility (Foth, 1990). Base saturation of the soil studied has a fairly good result for Backswamp and a better result for Terrace. Lower percent base saturation at the upper slope class may also indicate that the exchangeable cations which are mostly soluble, moved down the slope by agents of soil erosion and are deposited on the Terrace region because it is the zone of reduced moisture movement.

Organic matter content recorded highest in Terrace (59.5 %) relative to Backswamp (32.5 %) (Table 2) and this may be due to movement of soluble organic matter down the slope and might be the reason for the higher organic matter in the terrace region. The moderate organic matter in backswarnp may be due to nutrient loss through leaching, erosion and movement of alluvial, materials down slope reducing decomposition and accumulation of nutrients. The nitrogen content was found to be greatest in the Backswamp (96.1 %) and Terrace (42.2 %). The moderate nitrogen in the other profile (Terrace) may be partially attributed to the predominantly sand texture of the soil. It has been discovered that the rate of organic matter and nitrogen contents of the soils depends principally on soil texture as influenced by parent material (Ezedinma *et al,* 1989; Brady & Weil, 2002). There is a decrease in the phosphorus value at Terrace when compared with Backswamp. The phosphorus obtained had no definite trend of concentration. It increases and decreases down the profile pit. The low available phosphorus in the soil may be attributed to the fixation of phosphorus by iron and aluminum (sexquioxide) under drained and acidic conditions in the soil (Akpanidiok *et al.,*1996). Also percentages of phosphorus deposited by fluvial processes are trapped and retained in clay colloids thus greater percentage of phosphorus concentration in the Backswamp region.

3.1 Taxonomic Classification of Soils

The soils of the study were classified using USDA soil Taxonomy System of Soil Survey Staff (2003) and correlated with World Reference Base classification system (FAO 1998). The two pedons had argillic [Btl horizons as a result of clay movement down depth and low silt/clay ratio indicating advanced stage of weathering (Table 1). Pedon 1 had mean percentage base saturation of 35 % and as such Ultisols. The soil in pedon 1 has an aquic moisture regime and isohyperthermic temperature regime hence the suborder Aqualt it also belongs to the great group, Kandiaquult. Pedon 2 had base saturation above 50 % hence Alfisols. The soil has an Udic moisture regime and isohyperthermic temperature regime hence it belongs to the sub order Udalf and it to the great group of the soil Kandiudalf. They do not have any lithic, paralithic contact within 150 cm of the mineral soil surface. So pedon 1 or the Backswamp soils belong to the great group of Kandiaqualts and sub group of Typic kandiaquults (Gleyic Acrisols). While pedon 2, the Terrace soils belong to the great group Kandiudalfs and sub group of Typic Kandiudalfs (Haplic Luvisols).

4.0 Conclusion

The results have shown that differences in the physiological land units can impact on soil properties by changing moisture and organic content in the soil, these changes have great implication on management of the soil for sustainable crop production and environmental conservation.Fluvial soils are generally suitable for roots and tuber crops especially at the backswamp region because of the clay content. Other parts of fluvisols are suitable for other food crops such as vegetables, sugarcane and other annuals. Fluvial soils are also necessary for other by-products that have resulted from alluvial deposits such as coal, gravels and other sedimentary deposits, and other type of soils such as soils that can be used in place of cement. Also fluvisols can also be used for pond making for fishing and other economic purposes especially in Backswamp since they have the tendency to retain flood water.

References

Akpan-Idiok, A.U. Opuwaribo E.E. & Longanathan, P. (1996). Available phosphorus status of selected soils of the Niger Delta and their relationship with iron and other soil characteristics. *Delta Agric* 3 :99-105.

Allexandratos, l.R. (1996). A handbook for soil survey and agricultural land evaluation in the tropics and subtropics

Borlaug, E. & Dowsell, R.R (1997). Fluvial processes. *Geographic Magazine* 55,12-17.

Boul, S.N, Meyer.W.R & Tuner, B.I. (1994). Environmental Consequences, Changes in land uses and land cover. A Calabar perspective Cambridge University press Cambridge:,

Brady, N.C and Weil, R.R (1999). The natur and properties of soils 12th ed. New Jersey Prentice

Hall Upper Saddle,

Brady, N.C. & Well, R,R. (2002). The nature and properties of soils. 13th ed. Prentice Hall, 27-32, 200-204.

Bridges, E.M (1996). *World soil*. Cambridge University Press.

Christensen, F.N. (1996). Fluvial sorting and alluvial sedimentation in the tropics, Baltimore Maryland 295-300. John Hopkins Press .

Davidson, H. (1995). Ecosystem function and agricultural development. *Metheilungen* 74, 35-40.

Donahue, R.L. Miller, R.W & Schickbuna, J.E. (1990). *An introduction to soil and plant growth.* 5th ed. Limited Prentice Hall of India, Private New Delhi:.

Ezedinma, F.O.C, You Oewei, A. & Onazi, O.E. (1989). Introduction to tropical agriculture 4th ed. Longman group Ltd.

Ezedinma, F.O.C. & Onazi, O.C. (1999). Introduction to tropical Agriculture . 5th ed. Longman group ltd, 43-46 .

FAO/UNESCO (1988). Soil map of the world, 1:5,000,000 Vo1.2 Legend sheet and memors, Paris

FAO (Food and Agriculture Organization). (1988). Guidelines for Soil Description (2nd ed]. Rome: Food and Agriculture Organization of the United Nations.

FAO(Food and Agricultural Organization) (1998). *Guidelines for soil profile description.* Rome.

Foth, H.D. (1990). Fundamental of *soil sctence*. B= edition. John Wiley and sons Inc. New 13ed York.

Gee, G.W. & Bauder, J.W. (1986). Particle size analysis. In A Klute. (ed) *Methods of soil analysis, part 1. Agronomy. Vol.9 American Society of Agronomy,* Madison, Wilsconsin: 383-411.

Grossman R.B., & Reinsch, T.G., (2002). Bulk density and linea extensibility, In; Dane JH ,Topp GC (eds). Methods of Soil analysis, Part 4. Physical methods. Soil Science Society of America Book series N0. 5 ASA and SSSA Madison, WI.2002, 201-228.

Hendershot, W.H. & Lalande, H D (1993). Soil Reaction and Exchangeable Acidity. In: M.R. Carter, (ed) *Soil sampling and methods of analysis.* Canadian *society of soil science*, Lewis Publishers, London, 141-145.

Igwe, C.A., Akamigbo, F.D.R & Mbagwu, J.S.C (2002). Soil moisture retention characteristics in relation to erodibility and texture of: some soils of South Eastern Nigeria. *E. Africa Agric. Journal*. 68;17-21.

Montgomerry, W. (2002). Tropical soils and survey. Cambridge: Cambridge University Press.

Nelson, S.R. & Sommers, L.E. (1982). Phosphorus. In Miller, R.H & Keeney, D.R (eds), *Methods of soil analysis* part 2 Madison, Wisconsin: America society Agronomy, 1572.

Ofomata, G.E.K (1975)., Landform regions. In: G.E.K Ofornata, (ed) *Nigeria in maps: Eastern state*. Benin Ethiope Publishers, Nigeria, 33-34.

Ojanuga, A.G. (1996). Wetland soils of Nigeria status of knowledge and potentials monograph No.2 Soil Science Society of Nigeria.

Olsen, S. R. & Sommers, L. E.,(1982). Phosphorus in: methods of soil analysis. R. HMiller & D. R. Keeney (eds). Maidson, W. I: AmericalSciety of Agronomy, 1572.

Orajaka, S.O. (1975). Geology; In: G.E.K of ornata (ed). *Nigeria in maps*: Eastern states. Ethiope Publishing House Benin 5-7

Scholes, R.J., Datal & Singer, S. (1994). Soil physics and fertility: the effect of water, temperature and texture. In; P.L Kloorner, & M.J Swift, (eds). *The biological management of tropical soil fertility,* Wiley _ aye Publication, 171-136.

Smith, C.W, Johnson, M.A. & Loentz, S. (1998). Assessing the compaction susceptibility of south African. Soil II: soil properties affecting compatibility and compressibility. *Soil and tillage research*, 43,356-357.

Soil Survey Staff (1975). Soil taxonomy: A basic system of soil surveys USDA Agric. Handbook 436. US Government printing office. Washington D.C. 754. Spatial variability: its documentation, accommodation and implication to soil surveys. In: *Soil Spatial Variability* (Eds D.R. Nielsen, & J. Bouma). Wageningen, Pudoc Press, the Netherlands:

Soil Survey Staff (1996), Soil quality information sheet; soil quality indicators Aggregate stability National Soil Survey Center in collaboration with NRCS, USDA and the national Soil Tilth. Laboratory, ARS, USDA.