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EFFECTS OF FLUVO – MARINE DEPOSITS ON SOME SOIL CHARACTERISTICS IN THE NIGER DELTA REGION OF NIGERIA

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ABSTRACT
The study was conducted in Warri – North Local Government Areas of Delta State, to evaluate the effects of Fluvo-marine deposits on some soil's physico-chemical properties. Four locations that are largely influenced by fluvomarine deposits induced by coastal erosion were selected for the study. These locations were Ajagbodudu, Ubatere, Koko – West and Ugbogelete. Soil samples were randomly collected from pre-determined depths of 0 – 15 and 15 – 30 cm mini-pits and analyzed for their physical and chemical properties. The results showed that the soils are dominated, by silty loam and silty clay loam fractions with mean values greater than 50%. The mean bulk density, particle density, total porosity and saturated hydraulic conductivity are in this order 1.99 gcm^{-3}, 2.48 gcm^{-3} 19.3% and 2.21 cm/sec. The soils are generally acidic with a mean pH value of 4.9. The organic matter and total nitrogen contents were moderate with mean values of 2.10% and 0.43%. Available phosphorus was low with a mean value of 5.72 $mgkg^{-1}$. The exchangeable cations Ca (5.62 $cmolkg^{-1}$), Mg (1.35 $cmolkg^{-1}$), and K (0.30 $cmolkg^{-1}$) were all moderate, while Na was relatively high 5.17 $cmolkg^{-1}$. The exchange acidity and electrical conductivity were high with mean values of 4.68 $cmolkg^{-1}$ and 6.27 dsm^{-1} indicating high soluble salt contents and salinity of the soils.

KEYWORDS: Effects, Fluvo-Marine deposits, soil Characteristics, Warri – North, Delta State.

INTRODUCTION

Fluvo-marine deposits are common with soil areas whose physiography is along the fringes of Atlantic oceans and their estuaries. They are more of flooded soils resulting from deposits by tidal waves which most frequently hit the coastlines very severely thereby resulting to accelerated coastal erosion and the development of salt flats (Jimoh, 2001). In Warri-North local Government Areas of Delta State, most coastal towns are bounded by the Atlantic Ocean and greatly influenced by coastal flooding in most parts of the year, thereby resulting in massive deposition of fluvo-marine sediments across the soil surfaces. The areas are characterized by coastal saline mudflats that include the beach ridges and mangrove swamps that are watered by the maize of deltaic distributaries and partly by saline water at high tides (Chapman, 1997). Other common features associated with the environment include daily tidal influx, outflows, impaired drainage, a long rainy season, organic substrate and high acidic conditions (Egbuchua and Ojeifo, 2007). In most parts of the year, coastal flooding by waves and tides which are common phenomenon along the coastlines usually cause unbearable havoc leading to widening of creeks, estuaries and great loss of the ridge areas which recede at an average rate of about, 2.5m annually (Fubara, 1987). The terrain features consist mainly of low gradients, levees, back-swamps, sand-bars ox-bow lakes and cut-off channels (Apkamigbo *et al.*, 2001). Although, the study areas are not popular in food crop production but rather in artisinal fishing and International oil exploration and drilling hence, the few agricultural lands that are tormented by fluvo-marine deposits have not been quantitatively investigated and documented. This paper therefore is a report of investigation on the effects of fluvo-marine deposits induced by coastal flooding on soil characteristics in Warri – North Local Government of Delta State, Nigeria.

MATERIALS & METHODS

Study Areas

The study was conducted in Warri – North Local Government Area of Delta State of Nigeria. It lies essentially between latitude $4^0\ 50^1$ to $40\ 25^1$ North and longitude $6^0\ 11^1$ to $7^0\ 28^1$ E. The area occurs on coastal plains characterized by low gradient and subjected to intense flooding by tidal waves and seawater intrusions. The soils are derived from the older sedimentary rocks of the quaternary recent sediments. The area has high rainfall with a mean annual rainfall of about 2548.7 mm. The mean minimum temperature is about 23^0C. Relative humidity is high throughout the year (over 65%). The natural vegetation is typically of fresh water swamps.

Field Study

A semi – detailed survey was conducted at a scale of 1:25,000 using maps that show the geomorphology, topography and other physical features of the area. Identification observation was made in the four physiographic units identified as Ajagbodudu, Ubatere, Koko-west and Ugbogolete. Minipits measuring 70 x 70 x 85 cm length, width and depth were made

and composite soil samples collected from 0 – 15 and 15 – 30 cm depth for analysis.

Laboratory Analysis

Soil samples collected were air – dried at room temperature of 25–27^{0}C, crushed and sieved using a 2mm sieve mesh and analyzed for some soil physical and chemical characteristics. The physical characteristics determined include; the particle-size size distribution using the Bouyocous Hydrometer method (Bouyoucous 1951). The bulk density was by Core-methods and Particle density by Pyconometer methods (Blake and Hartge 1986). Total porosity was calculated from particle and bulk densities using the relationship as established by Vomocil, (1965). Hydraulic conductivity was determined using the modified Klute (1965) constant head methods in which undisturbed core samples were collected and slowly saturated for forty-eight hours and conductivity measured. The soil pH was determined potentio metrically in a 1.1 soil / water ratio, Organic carbon was by Walkley and Black method (Nelson and Sommers, 1982). Total Nitrogen was by Micro Kjeldahl digestion method (Bremner 1996). Available phosphorus was by Bray and Kurtz No1 method (Bray and Kurtz 1945). The exchangeable cations (Ca, Mg and K) were extracted with 1 N NH_40AC at pH 7 and the amount in the extracts measured with flame-photometer for Na and K, while Ca and Mg were measured using Atomic Absorption Spectro-photometer. Exchangeable acidity was determined by titration method, while the electrical conductivity was determined in a soil/water suspension at 25^{0}C using an electrical conductivity meter. The ECEC was calculated as the sum of total exchangeable bases and exchange acidity.

RESULTS & DISCUSSION

Physical Properties

The results of some physical properties of the soils are presented in Tables 1 and 2.

Particle Size Distribution

The particle – size distribution which describes the relative percentage of sand silt and clay (Table 1) showed that silt was the dominant soil fractions with a mean value of 51.25% across the pedons. This was followed by clay 31.23%; and sand 17.46% respectively. The high silt content could be attributed to sediments brought to the soil surfaces by tidal waves from the sea, and could also be responsible for the fine texture nature of the soils.

TABLE 1: Some Physical Properties of Fluvo-marine deposits on soils of Warri North Local Government area of Delta State

Location	Horizon	Soil depth (cm)	Sand (%)	Silt (%)	Clay (%)	Silt/clay ratio	Texture
Ajagbodudu	Ap	0 – 15	19.4	62.1	18.5	3.30	Silt loam
	Bw	15 – 30	20.4	53.6	26.0	2.06	Silt loam
Ubatere	Ap	0 – 15	5.4	56.1	38.5	1.46	Silt loam
	Bw	15 – 30	7.5	44.0	48.5	0.91	Silt loam
Koko-West	Ap	0 – 15	29.6	56.3	14.1	3.99	Silt loam
	Bw	15 – 30	25.4	48.1	26.5	1.82	Silt loam
Ugbogelete	Ap	0 – 15	18.6	44.3	37.1	1.19	Silty clay loam
	Bw	15 – 30	13.4	46.0	40.6	1.13	Silty clay
Mean values:			17.46	51.25	31.23	1.98	

TABLE 2: Bulk density, Particle density, Porosity and Hydraulic conductivity of Fluvo-marine deposits on soils of Warri – North Local Government Area of Delta State, Nigeria

Location	Horizon	Soil depth (cm)	Bulk density (gcm^{-3})	Particle density (gcm^{-3})	Porosity (%)	Hydraulic conductivity cm/sec
Ajagbodudu	Ap	0 – 15	1.45	2.18	27.0	2.67
	Bw	15 – 30	2.45	2.61	6.90	2.45
Ubatere	Ap	0 – 15	1.47	2.35	37.45	3.05
	Bw	15 – 30	2.21	2.47	10.53	2.48
Koko-West	Ap	0 – 15	1.75	2.49	29.72	2.15
	Bw	15 – 30	2.42	2.57	5.84	1.28
Ugbogelete	Ap	0 – 15	1.73	2.58	32.95	1.88
	Bw	15 – 30	2.51	2.62	4.20	1.75
Mean values:			1.99	2.48	19.33	2.21

This finding agrees with the reports of Ayolagha 2001 and, Egbuchua and Ojeifo, 2007). The clay fraction was found to be irregularly distributed and stratified down the mini-pits and also increased with depth. This suggests different periods of deposition of sediments and clay illuviation by process of lessivage or argillation. The soils are dominantly silty loam (Ajagodudu and Koko-West) and silty clay loam (Ubatere and Ugbogelete) respectively. The silt/clay ratio's has a mean value of 1.98 (Table 1) implying that the soils are made up of young parent materials with low degree of weathering.

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TABLE 3: Some chemical properties of Fluvo-marine deposits on soils of Warri – North Local Government area of Delta State, Nigeria.

Locations	Hori.	Depth (cm)	pH (H_20)	Org. C %	Total N %	Avail. P ($mgkg^{-1}$)	Ca.	Mg.	K.	Na.	E.A	EC. dsm^{-1}	ECEC $Cmolkg^{-1}$
							→		$Cmolkg^{-1}$	←			
Ajagbodudu	Ap	0–15	5.3	3.71	0.53	5.48	5.21	1.54	0.27	4.87	4.60	6.75	16.49
	Bw	15-30	4.6	5.56	0.42	5.32	4.34	0.75	0.21	5.24	4.95	5.32	15.46
Ubatere	Ap	0–15	5.7	4.12	0.48	8.24	6.14	1.57	0.31	4.76	4.75	6.81	17.53
	Bw	15-30	4.8	5.61	0.35	7.15	5.84	0.84	0.25	4.86	4.87	5.91	16.66
Koko-West	Ap	0–15	5.2	4.65	0.41	3.78	5.85	1.67	0.45	5.25	4.16	6.95	17.40
	Bw	15-30	4.3	0.58	0.31	4.21	5.46	1.49	0.24	5.73	4.76	5.34	16.68
Ugbogelete	Ap	0–15	4.87	0.81	0.52	6.14	6.38	1.76	0.38	5.28	4.38	7.14	18.18
	Bw	15-30	4.32	0.71	0.39	5.47	5.74	1.21	0.31	5.37	4.95	5.94	17.58
Mean values			4.9	2.10	0.43	5.72	5.62	1.35	0.30	5.17	4.68	6.27	16.99

Van Wambeke (1962), reported that silt/clay ratio above 0.15 is of young parent material while soils with silt/clay ratio below 0.15 indicates old parent material. The results of the bulk and particle densities (Table 2); showed that the mean location values of 1.99 gm^{-3} 2.48 gcm^{-1} are moderate. This could be attributed to low content of organic matter, less aggregation and compaction due to constant influence of tidal waves. The implication of these includes poor soil aeration, retarded root growth and decrease in transmisivity of water within soil matrix (Egbuchua and Ojeifo, 2007). The mean location value of particle density which was lower than $2.65gcm^{-3}$ as established by Donahue *et al.* (1990), implied that the mineral and chemical compositions as well as the crystal structure in the flooded environment caused by Fluvo-marine deposits are likely to altered. Total porosity and hydraulic conductivity were low (19.33% and 2.21 cm/sec) due to constant inundation of the (Table 2). These could be attributed to high sodium content, low organic matter and, low soil aggregate stability which are generally influenced by flooding. The same observations have been reported by Ayolagha (2007), Egbuchua and Ojeifo (2007). The implication of low hydraulic conductivity in the study areas is that the soils are prone to extensive surface water logging, crusting and coldness on drying. The same observations have been variously reported by Coughlan *et al.* (1987) and Adeoye *et al.* (1988) on some wetland sols of tropical origins.

Chemical Properties

The results of some chemical properties are presented in Table 3.

Soil pH: The results show that the mean pH value across the mapping units is 4.9 indicating acidic condition of the soils. Akpan-idiok and Esu (2001) have attributed such acidic condition to the content of pyretic materials (FeS_2) which undergo oxidation to Fe^{+++} and H_2SO_4 to cause extreme soil acidity. It could also be associated to the redox products of ferrolysis that are common in slowly permeable soils.

Organic Carbon: The mean values of organic carbon (2.10%) are regarded as low. This could be attributed to regular flushing of the surface soil by tidal waves.

Total Nitrogen: The mean values of total nitrogen 0.43% are low and tend to decrease with depth. The low value could be as a result of low organic matter content of the soils which has direct relationship with total nitrogen.

Available Phosphorus: The mean values of 5.72 $mgkg^{-1}$ are low. This could be attributed to excessive flooding that is common in the environment, strong acidic condition, low organic matter content of the soils and low phosphate potentials of the parent material Egbuchua and Ojeifo (2007) Akamigbo *et al* have also attributed it to high fixation rate of phosphates by sesquoxides in the soils.

Exchangeable Cations: The mean values of exchangeable cations (Table 3) are generally moderate. This could be attributed to frequent supply of basic cations by flood water or soluable salts in sea water that flood the environment on a constant basis. The sodium (Na^+) ion content was exceptionally high which could possibly result in salinity of the soils. Salinity is generally known to have an adverse effect on non-tolerant crop species by direct toxicities of Na^+ - ions and associated ionic inbalance in the soils (Van Menscoort *et al* 1985). The moderate to high Na^+ content is a major limitation since the soils disperse easily when saturated with water and blow away when the soils are dry. The same observations have been reported by Akamigbo *et al* (2001) and Egbuchua and Ojiefo (2007).

Exchange Acidity: The exchangeable acidity across the mapping units (Table 3) are high with a mean value of 4.68 $cmolkg^{-1}$. The rise in the level of exchangeable acidity is a reflection of low pH of the soil which may have indirect negative fertility effects on the soils.

Electrical Conductivity: The values of electrical conductivity are presented in Table 3. The locations mean value of 6.27 dsm^{-1} depicts that the soils are saline in nature and are influenced by tidal salt water containing soluable bases (Higashi and Shinagawa 1989). The effective cation exchange capacity (ECEC) across the mapping units are moderate with a mean location value of 16.99 $cmolkg^{-1}$. This is due to low content of organic carbon and clay which are the essential colloidal materials for cation exchange and absorption in the soil. The same observation have been reported by Akinbola (2001)' Ayolagha (2001) and Egbuchua and Ojeifo (2007).

CONCLUSION

Fluvo – marine deposits are associated with soil environment located on the fringes of ocean and major rivers. Warri North Local Government Area of Delta State is one of such an environment. The results of the study showed that soil texture was greatly influenced as silty clay and silty clay loam were the dominant fractions of the soils due to sediment accumulation resulting from tidal waves. High acidity, low organic carbon and nitrogen contents, low phosphrous and moderate to high basic cations were greatly influenced in the study. The sodium (Na+ - ion) and electrical conductivity of the soils were negativity affected resulting to salinity problems of the soils. High exchange acidity of the soils have indirect negative fertility effects on the soils.

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