Pedological and Geotechnical Properties of Soils formed on Coastal Plain Sand of Imo State, Nigeria

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***Abstract*: The study investigated pedological and geotechnical soil properties and classified soils derived from Coastal Plain Sand (Benin formation) in Imo State, Nigeria. In siting the profile pit, free soil survey technique was used. Three profile pits were investigated. Hand held Global Positioning System (GPS) Receiver was used to geo-referenced the profile pits. FAO guidelines were also used to describe the profile pits. From each horizon of the profile, we collected soil samples starting from the deepest horizon upwards. Soil samples were also collected at a depth of 100 – 200cm geotechnical studies. For standard routine analysis, soil samples were dried in the open air and sieved. For soil data analysis, the mean and percentage coefficient of variation were used. Colour of the soils ranged from 2.5YR to 5YR with clay content 103.2-199.2g/kg, silt content 10-60g/kg and sand content 760.8-876.8g/kg. The bulk density ranged from 1.18 to 1.58Mg/m^3 and Porosity, 404-555g/kg. The soils were acidic with pH range 4.2-5.6. Organic matter content ranged from 1.40-2.33g/kg with TEB, 1.11-3.97cmol/kg, Available Phosphorous, 16.87-11.69mg/kg and TEA, 0.40-2.56 Cmol/kg. Results of geotechnical properties revealed maximum dry density (≥1.7mg/m^3), shear strength (≥93KN/m^2), angle of internal friction (≥26.6^0), and ultimate bearing capacity (≥363KN/m^2). The soils were classified under USDA Taxonomy as Typic Hapludult and WRB as Nitic Acrisols. Under USCS, Obinze and Mgbirichi were classified as Clayey Sand (SC) and Umuagwo as Silty Sands (SM).**

***Keywords*- Geotechnical properties, soil, lithologic, coastal plain sand, classification.**

I. INTRODUCTION

Soil health describe the fitness of soil for a particular purpose. Soil's suitability for various uses man can put them is highly dependent on their properties. Soil quality and health assessment has been inspired by the growing consciousness that soil as a very important constituent of the earth's biosphere, contributes greatly in food and fiber production fiber and also in maintaining the quality of the universal environment [1]. Soils like every other natural resources cannot be utilized in a proper manner if there is no comprehensive knowledge of the soil properties [2]. Almost all the construction and agricultural endeavors of mankind are concerned with soil behaviour; either the soil is used as planting material or structures are placed on it. [3] stated that soil properties influence the designs, construction and stability of structures like buildings, bridges, roads, dams and canals which are directly by soil. Agronomist most times do not take into cognizance, the physical composition of the soil but rather prefers to focus on its chemistry and yield potentials aspect. Better crop growth and stability of farms over natural and manmade environmental factors are significantly controlled by soil physical properties.

Geotechnical properties are characteristics that determine the load bearing capacity of soil, both for agricultural and civil engineering projects. In intensive farming, the use of heavy machinery without proper track wheel can exert stress on the soil profile which may exceed the internal strength of the soil, thereby causing soil deformation. Pedology looks at soil from the point of its origin, and environment surrounding the soil. This involves formation, morphology, chemistry and classification of soils. Classifications reveal how soils of different region relate. Geotechnical and Pedological soil properties are very necessary in land use planning. [4] reported that soil degradation and collapse of farm structures are on increase on soils derived from different lithological materials. Moreover, most farmers don't have good knowledge of both the pedological and geotechnical properties of their soils.

Determining the pedological and geotechnical properties of soils and also classifying them is one of the major ways that can help to predict secure and healthy environmentally friendly measures while ensuring better crop growth for sustainable development in our society.

II. MATERIALS AND METHODS

A. Description of Study Area

This investigation was carried out in Imo State, Nigeria, at three different locations underlain by coastal plain sand. Imo State is located within Latitude 4^{0}45'N and 7^{0}15'N and Longitude 6^{0}50'E and 7^{0}25'E. Imo River and other rivers such as Otamiri River are the major hydrology governing the study area. The geomorphology of the study area are generally lowland less than 60m above sea level. It has seasonal rainfall amount of 1,200mm to 2,700mm, mean annual temperature of range 26^{0}C to 32^{0}C and relative humidity that is high (above 80%) during the rainy season. The soil has isohyperthermic soil temperature regime. Imo State falls under agro-ecological zone of tropical rain forest and is expected to have original vegetation of rainforest, but this vegetation has been drastically altered by anthropogenic activities with variety of plant types like cassava (*Manihot spp*), maize (*Zea mays*), yam (*Dioscorea species*), ube (Dacryodes edulis), mango (Mangifera spp.) plantain (*Musa spp*), oil palm (E*leais* *guineesis*), etc. The major socio economic activities in the area include agriculture, cottage industries, sand mining and other activities. The total land area used as cultivated land is about 70% . Cassava and yam based cropping systems predominate with oil palm forming major plantation crop. Land clearing method majorly used involves slash and burn techniques. Fertility regeneration method involves the use of bush fallow. Soils of the study areas are on flat topography (0-1%)

B. Field Study

A reconnaissance visit was first made with the aid of geology map and free survey technique was used for sampling at the sites. A profile pit was excavated at each location and described according to FAO guidelines for soil description [5] and genetic horizons guided soil sample collection from the bottom layer to the topmost layer with colour, softness, presence of macro fauna and presence root being the criteria for delineation.

Table 1. Co-ordinates, Elevations and Slope Features of Study Sites

Study Sites	Co-ordinates	Elevations	Slope features
Obinze	$5^0 25' 31''$N, $6^0 58' 35''$E	59m	Plain
Mgbirichi	$5^0 21' 23''$N, $6^0 57' 8''$E	56m	Plain
Umuagwo	$5^0 18' 26''$N, $6^0 57' 8''$E	49m	Plain

(Global Positioning Systems, GPS Receiver, Garmin Ltd, Kansas)

C. Laboratory Analysis

The soil samples collected were initially dried in the open air after which they were pulverized to reduce the effect of clods. The samples for grain size analysis and shear strength determination were separated out. Samples for compaction test were sieved with 4.75 mm sieve while soil samples for Atterberg limits test were sieved with 425μm sieve. The soil samples for soil routine fertility analysis were sieved using the 2mm sieve. The soil samples were subjected to various physical and chemical soil routine laboratory analyses; the results of which were used for evaluation and classification of the sites. Some of the geotechnical properties studied in this work includes; compaction characteristics, grain size distribution, Atterberg limit tests, shear strength and soil bearing capacity. In the compaction test, the wet and dry densities, the optimum moisture content (OMC) and the maximum dry densities (MDD) of the soil samples were determined. Grain size distribution analysis was done by passing the soil samples through sieves of various sizes and the grains of soils retained in each sieve were weighed. The fines where determined using Hydrometer method. Shear Strength, angle of internal friction and the cohesion were determined by the method of shear box test [6]. The Ultimate Bearing Capacity was determined utilizing the general bearing capacity equation given by Terzaghi and Meyerhof [7]. Atterberg limits were determined using Cassagrande method and plasticity index (PI) was calculated as liquid limit minus plastic limit in accordance to clause 4.5 and 5.3 part 2 of BS 1377 and BS 1990, respectively [8]. The coefficient of linear extensibility (COLE) was calculated as described by [9].

D. Soil Classification and Data Presentation

Soil samples were subjected to classification based on their morphological, physical, chemical and geotechnical properties according to USDA Soil Taxonomy, World Reference Base (W.R.B.) and Unified Soil Classification System (USCS). Mean and Coefficient of Variation was use to analyze soil data [10].

III. RESULTS AND DISCUSSION

Results of the morphological, physical, chemical and geotechnical properties of the soils studied were shown in table 2,3,4 and 5 respectively.

Table 3. The Physical Properties of the Soils

Pedon ID	Depth (cm)	Horizon Designation	Sand (g/kg)	Silt (g/kg)	Clay (g/kg)	Silt:Clay Ratio	Textural Class	Moisture Content (g/kg)	Porosity (g/kg)	Bulk density (Mg/m^3)
			Obinze							
O1	0-20	A	860.8	20	119.2	0.17	Loamy sand	135	464	1.42
O2	20-50	AB	876.8	20	103.2	0.19	Loamy sand	126	441	1.48
O3	50-130	Bt_1	820.8	20	159.2	0.13	Sandy loam	137	404	1.58
O4	130-180	Bt_2	780.8	60	159.2	0.38	Sandy loam	120	407	1.57
O5	180-210	Bt_3	780.8	50	179.2	0.27	Sandy loam	123	419	1.54
		Mean	822	34	144	0.23		128.2	427	1.52
		CV	5.7	57.3	21.9	43.5		5.8	5.9	4.4
		CV Ranking	*	***	**	***		*	*	*
			Mgbirichi							
M1	0-25	A	810.8	50	139.2	0.36	Sandy loam	111	555	1.18
M2	25-60	AB	780.8	40	179.2	0.22	Sandy loam	114	494	1.34

M3	60-110	BA	770.8	30	199.2	0.15	Sandy loam	125	441	1.48
M4	110-140	Bg	820.8	40	139.2	0.29	Sandy loam	142	419	1.54
M5	140-200	Bt$_1$	760.8	40	199.2	0.2	Sandy loam	164	411	1.56
		Mean	788.8	40	171.2	0.24		131.2	464	1.42
		CV	3.2	17.7	17.7	33.6		16.8	13.0	11.2
		CV Ranking	*	**	**	**		**	*	*
			Umuagwo							
P1	0-25	A	860.8	20	119.2	0.17	Loamy Sand	103	521	1.27
P2	25-35	AB	840.8	20	139.2	0.14	Sandy loam	84	413	1.55
P3	35-95	Bt$_1$	790.8	10	199.2	0.05	Sandy loam	142	419	1.54
P4	95-150	Bt$_g$	836.8	20	143.2	0.14	Sandy loam	156	407	1.57
P5	150-220	Bt$_2$	790.8	29	189.2	0.15	Sandy loam	157	441	1.48
		Mean	824	19.8	158	0.13		128.4	440.2	1.48
		CV	3.8	34	21.8	35.7		25.8	10.7	8.3
		CV Ranking	*	**	**	***		**	*	*

CV-Coefficient of Variation, *- Low variation, **- Medium Variation, ***- High Variation

Table 2. Morphological Properties of Soils Studied

Pedon ID	Depth (cm)	Horizon	Moist Colour	Textural Class	Structure	Consistency
			Coastal Plain Sand (Obinze)			
O1	0-20	A	2.5YR$^{2.5}/_{1}$	Loamy sand	1crc	Friable
O2	20-50	AB	2.5YR$^{3}/_{2}$	Loamy sand	1crm	Friable
O3	50-130	Bt$_1$	2.5YR$^{4}/_{4}$	Sandy loam	1bk	Firm
O4	130-180	Bt$_2$	2.5YR$^{4}/_{8}$	Sandy loam	2bk	Firm
O5	180-210	Bt$_3$	2.5YR$^{5}/_{6}$	Sandy loam	2bk	Firm
			Coastal Plain Sand (Mgbirichi)			
M1	0-25	A	2.5YR$^{3}/_{2}$	Sandy loam	1crm	Friable
M2	25-60	AB	2.5YR$^{5}/_{3}$	Sandy loam	1crm	Firm
M3	60-110	BA	2.5YR$^{5}/_{6}$	Sandy loam	1bkm	Firm
M4	110-140	Bt$_g$	2.5YR$^{6}/_{6}$	Sandy loam	2bkm	Friable
M5	140-200	Bt$_1$	2.5YR$^{6}/_{6}$	Sandy loam	2bkf	Firm
			Coastal Plain Sand (Umuagwo)			
P1	0-25	A	5YR$^{3}/_{3}$	Loamy Sand	1crm	Friable
P2	25-35	AB	2.5YR$^{5}/_{4}$	Loamy Sand	1crm	Friable
P3	35-95	Bt$_1$	2.5YR$^{3}/_{6}$	Sandy loam	2bkm	Firm
P4	95-150	Bt$_g$	2.5YR$^{4}/_{6}$	Sandy loam	2bkm	Firm
P5	150-220	Bt$_2$	2.5YR$^{6}/_{6}$	Sandy loam	2bkm	Firm

Structure; 0- structureless, 1- weak, 2- moderate, 3- strong, gr- granular, cr- crumb, bk- blocky, ms- massive, f- fine, m- medium, c- coarse. Consistency; v- very, e- extremely.

Table 4 Chemical Properties of Soils Underlain by Coastal Plain Sand

Pedon ID	Depth (cm)	pH (H_2O)	O.C.	O.M.	Total N	Avai.P (mg/kg)	Al^{3+}	H^+	TEA	Ca	Mg	Na	K	TEB	ECEC	Al Sat	BS
			→	(g/kg)	←			→	(Cmol/Kg)	←						→ (g/kg) ←	
						Obinze											
O1	0-20	5.1	1.35	2.33	0.117	13.79	-	0.44	0.44	0.82	0.25	0.11	0.8	1.98	2.42	-	81.8
O2	20-50	4.3	0.99	1.71	0.086	14.00	-	0.72	0.72	0.56	0.31	0.14	0.1	1.11	1.83	-	60.7
O3	50-130	4.8	0.87	1.50	0.075	12.60	0.40	0.68	1.08	0.77	0.83	0.09	0.6	2.29	3.37	11.8	68.0
O4	130-180	4.4	0.83	1.43	0.072	15.19	0.92	0.06	0.98	0.51	0.40	0.11	2.0	3.02	4.00	23	75.5
O5	180-210	5.1	0.81	1.40	0.070	13.93	0.60	0.80	1.40	0.83	0.78	0.13	1.1	2.84	4.24	14.2	67.0
	Mean	4.7	0.97	1.67	0.08	13.9	0.64	0.54	0.92	0.70	0.51	0.12	0.92	2.3	3.2	16.3	70.6
	CV	8.0	23.1	23.1	23.2	6.6	41.0	55.6	39.4	21.7	52.8	16.8	76.6	33.8	32.4	36.1	11.6
	Ranking	*	**	**	**	*	***	***	***	**	***	**	***	**	**	**	*
						Mgbirichi											
M1	0-25	5.3	1.33	2.29	0.115	14.63	0.64	0.80	1.44	0.88	0.56	0.07	0.2	1.75	3.19	20.1	54.8
M2	25-60	4.2	1.07	1.84	0.092	12.95	1.32	1.00	2.32	0.56	0.82	0.09	0.1	1.57	3.89	33.9	40.4
M3	60-110	4.3	0.97	1.97	0.099	12.48	1.44	0.68	2.12	0.40	0.13	0.09	1.0	1.62	3.74	38.5	43.3
M4	110-140	4.8	0.85	1.47	0.074	12.39	1.48	1.08	2.56	0.40	0.18	0.19	3.2	3.97	6.53	22.7	60.8
M5	140-200	4.8	0.87	1.50	0.075	12.53	1.80	0.52	2.32	0.56	0.53	0.12	2.2	3.41	5.73	31.4	59.5
	Mean	4.68	1.02	1.8	0.09	13.0	1.34	0.82	2.15	0.56	0.44	0.11	1.34	2.5	4.6	29.3	51.8
	CV	9.5	19.2	18.9	18.9	7.2	32	28.1	19.9	35	64.7	42.1	99.8	46.2	31.1	26.3	18.1
	Ranking	*	**	**	**	*	**	**	**	**	***	***	***	***	**	**	**
						Umuagwo											
P1	0-25	5.6	1.27	2.18	0.109	16.87	-	1.04	1.04	0.83	0.50	0.05	0.6	1.98	3.02	-	65.6
P2	25-35	4.8	1.01	1.74	0.087	13.44	0.48	0.72	1.20	0.85	0.43	0.12	1.8	3.20	4.40	10.9	72.7
P3	35-95	4.2	0.97	1.67	0.084	13.44	0.64	1.60	2.24	0.50	0.06	0.08	1.9	2.54	4.78	13.4	53.1
P4	95-150	4.4	0.97	1.67	0.084	12.32	1.04	0.84	1.88	0.31	0.14	0.12	2.3	2.87	4.75	21.9	60.4
P5	150-220	4.8	0.85	1.46	0.073	11.69	1.01	0.72	1.73	0.62	0.29	0.13	2.4	3.44	5.17	19.5	66.5
	Mean	4.76	1.01	1.74	0.09	13.6	0.79	0.98	1.61	0.62	0.28	0.1	1.8	2.8	4.4	16.4	66.7
	CV	11.3	15.3	15.2	15.1	14.8	34.9	37.4	30.5	36.6	65.6	33.9	39.9	20.4	18.8	31.3	11.5
	Ranking	*	**	**	**	*	**	***	**	***	***	**	***	**	**	**	*

O.C- organic carbon, O.M- organic matter, N-nitrogen, P-phosphurus, TEA-Total Exchangeable Acidity, TEB- Total Exchangeable Base, ECEC- Effective Cation Exchangeable Capacity, Al Sat – Aluminium Saturation, BS-Base Saturation

Table 5: Geotechnical Properties of Soil

Site location	LL (%)	PL (%)	PI (%)	LS (%)	MDD (Mg/m^3)	OMC (%)	Grain size Distribution (%)				COLE	VS	τ (KN/m^2)	$Ø^0$	C (KN/m^2)	q_{ult} (KN/m^2)
							Sand	Clay	Silt	Gravel						
Obinze	31.5	17.6	13.9	6	1.78	14	80	14	6	-	0.06	19.1	95.80	27.3	4.0	415.1
Mgbirichi	35.0	19.6	15.5	7	1.75	14.0	80	18	2	-	0.06	19.1	96.40	27.2	5.0	428.0
Umuagwo	40.8	27.1	13.7	6	1.70	14.4	80	15	5	-	0.06	19.1	93.00	26.6	4.0	363.0

VS - Volumentric Shrinkage, τ – Shear strength, OMC – Optimum Moisture content, MDD – Maximum Dry Density, LS – Linear Shrinkage, PI- Plasticity Index, LL – Liquid Limit, PL-Plastic Limit, $Ø^0$- Angle of internal Friction, C- Cohesion, q_{ult}- Ultimate Bearing Capacity.

Table 6: Classifications of Soils.

Soil Location	USDA	WRB	USCS
Obinze	Typic Hapludult	Nitic Acrisols	Clayey Sand (SC)
Mgbirichi	Typic Hapludult	Nitic Acrisols	Clayey Sand (SC)
Umuagwo	Typic Hapludult	Nitic Acrisols	Silty Sand (SM)

A. Morphological properties

The soils in the study sites were characterized with the presence of dark colour at the surface horizon in all pedons. [11] and [12] stated that dark soil colour is related to high organic matter content of the soil. Dark brown or black soil colour is usually associated to soil organic matter and is important for both soil classification purposes and for good thermal properties, which promote biological processes [13]. Soils were characterized with reddish colouration. These colours indicate a relatively high amount of iron oxide, which may be due to the parent material and the atmospheric condition prevailing in the area. The soils structural development ranges from structureless to moderate crumb and blocky ped. The consistency ranges from friable to firm down the profile. These can be attributed to textures of these soils.

B. Physical properties

Sand-sized particles dominated other primary particles in the study sites. The parent material could be the reason for the higher sand values of the area. Sand fraction generally decreased down the profile with mean as follows; 822g/kg at Obinze, 788.8g/kg at Mgbirichi and 824g/kg at Umuagwo. Clay contents had irregular distribution, but were observed to increase with depth. [14] described this as clay migration by lessivage to produce the process of illuviation. Mean clay contents recorded were; 144.2g/kg at Obinze, 171.2g/kg at Mgbirichi and 158g/kg at Umuagwo. Texture of the area varied between sand, loamy sand and sandy loam. The variation in texture reflected the parent materials. Texture has a profound influence on many soil properties and it affects the suitability of a soil for most uses [15]. Soil texture affects soil characteristics, fertility, water, ability of soil to hold nutrient and plant root movement

Bulk densities of the soils of the study area increased down the profile and this could be attributed to the facts that there is less organic matter present in the sub-surface horizons. [16] reported that low soil organic matter was responsible for increased bulk density in cultivated soils of Southeastern Nigeria. Results on bulk densities were less than the critical limits for root restriction (1.75 – 1.85 gcm^{-3}) [17]. Moisture content increased as depth increased. The percentage porosity was high in the top soil of all pedons which could be due to the presence of organic matter. Porosity also declined down the profile due to the clay content which enters into the soil pores and blocks them thereby reducing the total porosity [18]. It was observed that the higher the bulk density, the smaller the porosity.

C. Chemical Properties

pH in water ranges from: 4.2 to 5.6. The degree of leaching, nature of the parent material, dominant clay mineralogy and intensity of microbial activities going on within the soils are likely factors affecting the pH of the soil. According to [19], pH range of 5.6 to 6.5 provides the most satisfactory plant nutrient levels for most crops. Low pH values recorded in soils (<6) could be due to the dominance of Al^{++} and H^{+} ions in the soil exchange complex [17]. Generally, organic carbon contents which translate into organic matter content decreased with soil as soil depth increases. The surface horizons of the soils studied have the highest proportion of organic matter because most of the organic residues are deposited and incorporated on the soil surface and this could be explained by their dark colour and considerable low bulk density of these horizons. Total nitrogen ranging from 0.07g/kg to 0.11g/kg were obtained across the soils studied. When compared with the critical value of 0.15% (1.5g/kg), total nitrogen across the studied soils were rated low [20]. [21] also reported critical level of 2% (20 gkg-1) in soils of southeastern Nigeria and [19] reported the range of 0.1 – 0.2% of total N to be low in soils of the tropics. This could be due to soil reaction, temperature and rainfall pattern of the area. The values of available P contents of the soils were rated low because they falls between the critical levels of 10 – 16 mgkg-1 [22]. Low level of available P indicates that P may be chemically bound as phosphates of Fe and Al owing to the observed acidity of the soil of the study area [23]. Total exchangeable bases (TEB) ranged from 1.11-3.97Meq/100g. This may be due to intense leaching (sandy nature), weathering (heavy tropical rainfall) and ferrolysis, hence low inherent fertility status with regards to the major nutrients.

Aluminum hydrolysis reactions, which follow the displacement by H+ ions of aluminum in minerals, may be responsible for the high values of total exchangeable acidity in the soils [15]. Effective cation exchange capacity (ECEC) increased down the profiles in all the pedons. This also ascertains that the soil formed from coastal plain sand is excessively leached which may be because the texture. Values less than 8-10 Meq/100g are stipulated as indicative minimum values in the top 30cm of soils for satisfactory crop production [24]. The mean base saturation percentage is less than 90% of which [28] noted that the strongest, healthiest and nutritious crops are grown in soils where percentage base saturation is above 90%, this provides luxury levels of nutrients to crop and soil life.

D. Geotechnical Properties of Soil

Results of geotechnical properties are presented in Table 5. According to the ranking of compressibility using liquid limit by [26], the soils revealed intermediate compressibility (35% - 50%). [15] noted that high porosity of clay floccules and the flake-like shape of clay particles give clayey soils much greater compressibility than sandy soils which resist compression once the particle is settled into tight parking arrangement. This is to say that these soils make excellent soil to bear foundation. Soils formed over coastal plain sand had generally lower plasticity index using plasticity classification according to [26]. He earlier noted that for a given soil, the plasticity index increases in proportion to the percentage of clay particles in the soil. The soils had PI less than 25%. Soils with plasticity index less 25% have low swelling potential [27].

Linear Shrinkage was observed to be between 6% to 7%. According to [28], soils with linear shrinkage 5-8 have marginal degree of expansion while soils with linear shrinkage > 8% have critical degree of expansion.

The maximum dry density of soils increases as optimum moisture content decreases. [26] noted that soils with high maximum dry density at low optimum moisture content is use in construction of civil engineering structures such as highways, embankments, dams, foundations, etc. No gravel was observed in the grain size distribution of the soil. This could be due to the intensity of weathering in the soil.

Shrink-Swell hazard rating by [9] revealed that the soil falls under moderate (COLE= 0.03-0.06) shrink-swell hazard rating. Shrink and swell rating help to indicate possibility of soil to crack foundation, cause even heavy retaining walls to collapse and difficult to work when they are wet. Volumetric shrinkage was also moderate (10-20) [9]. The soils had shear strength range of 93.0KN/m^2 to 96.40KN/m^2. The strength of soil describes the ultimate state of stress that it can sustain before it fails [29]. The Cohesive strength (cohesion) of the soil was 4.5KN/m^2. Cohesion is the resistance due to forces tending to hold the soil particle together in a solid mass [26]. The ultimate bearing capacity ranges from 363 KN/m^2 to 428 KN/m^2. Bearing capacity concept is one of the main steps for the safe and economic design of foundation [29] The soil must be capable of carrying the load from any farm structure placed upon it without a shear failure and with the resulting settlement being tolerate for that structure [30].

E. Soil classification

The soils of the study area were classified according to USDA soil taxonomy [17] and correlated with World Reference Base and Unified Soil Classification System (USCS). The mean annual soil temperature of the soils of the study areas were above 25^0C (isohyperthermic) and they have Udic moisture regime. The soils were classified using USDA soil taxonomy as Typic Hapludult and Nitic Acrisols under World Reference Base (WRB)

Under Unified Soil Classification System (USCS), soils were classified as Coarse-Grained because > 50% was retained on sieve No 200. They fall under Sands because more than 50% of the coarse fraction passed sieve No 4. They also fall within the row of Sands with fines because they have more than 12% fines.

From the Plasticity chart, Atterberg limits of Umuagwo fall below A-line while Atterberg limits of Obinze and Mgbirichi fall above A-line and PI > 7%. The group name for Umuagwo was classified SM (Silty Sands). Fines were classified as CL (low compressibility) at Mgbirichi and Obinze with group symbol SC (Clayey Sands).

IV. CONCLUSION

This study had characterized the soils underlain by coastal plain sands in Imo State, Nigeria. The morphological and physical characteristics, chemical composition and mineralogical properties suggest that sustainable crop production on these soils will require very careful management. However, the soils have a high bearing capacity and thus can support engineering structures.

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