VARIATIONS OF SOIL PROPERTIES AS INFLUENCED BY LAND USE AND SOIL DEPTH IN COASTAL PLAIN SANDS OF PORT HARCOURT, SOUTHERN NIGERIA.

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Abstract
Assessment of the variation of soil properties as influenced by land use types and soil depth was carried out in the Teaching and Research Farm, Rivers State University, Port Harcourt. Two land use types (plantain plantation and cassava cultivated land) were identified as mapping units. One modal profile pit of 2x2x2m each was dug in each of the land use type. Soil samples were taken systematically from each pedon at various depths and horizons identified. Soil morphological properties such as colour, structure, consistence, drainage and root abundance were determined in the field. Soil colour ranged from dark brow to yellowish brown, structure ranged from friable to sub-angular blocky. Bulk density has mean value of 1.71gcm^3 in Pedon 1 and 1.84gcm^{3}inPedon 2, mean total porosity is 33.13 and 28.26 in pedon 1 and 2 respectively. Textural class varied from sand to sandy clay loam. Soil reactions (pH) varied from 5.03 to 6.25 in pedon 1 and 5.07 t0 6.12 in pedon 2. Organic carbon varied from 3.78 – 15. 78g/kg in pedon 1 and in pedon 2 and 12.04g/kg – 12.73g/kg. Mean total nitrogen varied from 0.27 – 1.28g/kg and 1.04 and 1.10g/kg in pedon 1 and 2 respectively. Available phosphorus varied from 6.05 – 10.61g/kg in pedon 1 and 7.33 – 8.49g/kg n pedon 2. ECEC also varied from 3.650 – 10.156cmol/kg in pedon 1 and 4.925 – 5.457cmol/kg in pedon 2, while base saturation varied from 95.62 – 99.21% and 79.48 – 79.48% in pedon 1 and 2. Exchangeable Calcium was low to high (2.64 -7.76cmol/kg), Magnesium was low to moderate (0.82 – 2.29cmol/kg), potassium was very low in both pedons (0.003 – 0.21cmol/k and sodium was also very low in both pedons (0.009 – 0.014cmol/kg)). The two land use types under study has serious influence on soil properties as indicated by the low level of some nutrient element. Therefore, strict measure should be adopted to replenish lost nutrient in soils of the study area to enhance the soil productive capacity.

Keywords: variations, soil properties, land use, Port Harcourt, Southern Nigeria

INTRODUCTION

Land use types play an important role as one of the factor that influences pedogenesis and at the same time, dictate the distributions of soils and their inherent properties on a landscape (Nsor and Adesemuyi, 2016). Information on land use changes or variations among soil properties as influenced by land use is important for sustainable agricultural production (Peter and Anthony, 2017). Land use types and cropping systems plays an important role in agriculture and environmental management especially with regards to soil properties in term of soil fertility and soil quality (Douglas and Peter, 2016) Land use which is the use to which a piece of land is put to, determine the best that such soils can be effectively managed to enhance agricultural sustainability. Different land use system adversely affect soils on which they are practiced and greatly influenced the morphological, physical chemical and biological properties of such soils. Therefore, knowledge of land use which is also the application of human control in a systematic manner in order to boost its productive capacity is very imperative. Soil physical properties deteriorate with changes in land use especially from forest to arable land. Continuous cropping also lead to erosion and leaching of soil nutrients which in turn, adversely affect the physical and chemical properties of the soil (Onweremadu and Peter, 2016). Under natural conditions, soil physical and chemical properties rarely deteriorate but structural deterioration may occur along tracks regularly use by foraging animals. Soil structure is affected by intensity of land use and this has effect on the distribution of microbial biomass as well as microbial processes within the soil aggregate systems Mbagawa and Auerswald (1999). Land use also influenced structural stability more than intrinsic soil properties and percolation stability of soil also increase with an increase in organic matter content of the soils. The variations in soil properties should be monitored and quantified so as to understand the effects of land use and management systems on soils.

Justification

The consequences of inappropriate land use are land degradation and soil quality deterioration through loss of vegetative cover, reduced infiltration capacity, low soil organic matter content, low fertility status and so on. Hence, the changes in soil properties are usually influenced by the type of land use.

Therefore, the main objective of this study is to access the variations in soil properties as influenced by land use in a coastal plain sand of Port Harcourt.

MATERIALS AND METHODS

Site Location

The study was conducted at the Teaching and Research Farm, Rivers state university, Port Harcourt, Rivers State. It is located between 4°8′59′′N latitudes 6°10′90′′ at elevation of 25m above sea level.

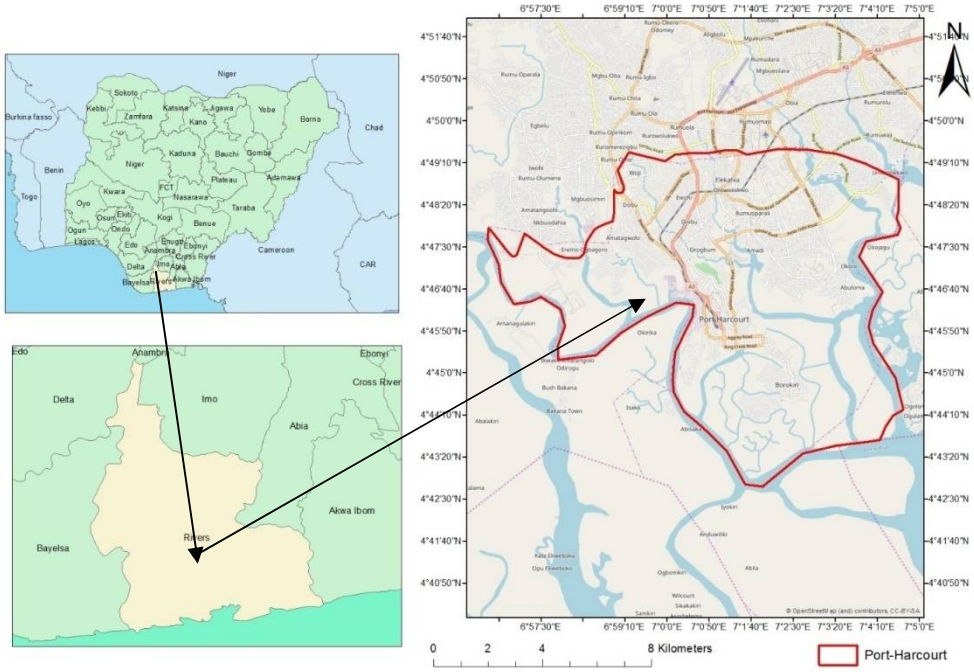

Fig 1 MAP OF PORTHARCOURT

Soil in this study area is a coastal plain sand of marine deposits. Generally, the vegetation of the study has been greatly altered by the impact of continuous cropping and land cultivation. Some secondary vegetation and fallow land covered by grass such as *Panicum maximum* are prominent. The vegetation of the study area has been greatly affected by anthropogenic activities resulting to depleted vegetation due to increase in population and urbanization.

Climate of The Study Area

The study area has an average rainfall of 2000mm-3000mm in a bimodal form and a peak in September and period of low precipitation in early August usually call August break (Peter and Ayolagha, 2012). The monthly temperature in the study area ranges from 26^{o}c - 35^{o}c and relative humidity 80% - 83% depending on the season of the year.

Field Study

The field work was carried out in July 2018. A reconnaissance visit was made to the study location to identify the land use types and to obtain relevant information about the study site. Two major land use types as revealed as Plantain plantation and Cassava Farm were identified. One profile each was dug in each of the land use type. Geographical coordinates and elevation of the profile points in each mapping units were taken using Geographical Positioning System (GPS). Two modal profile pits measuring 2x2x2m were dug and described comprehensively using FAO/USS (2008). Soil samples were collected at various depths and horizons in each of the pedon from bottom to top to avoid contamination. Soil morphological characteristics such as soil colour, texture, structures, drainage, consistency and root outcrop were identified in situ. Each profile was sampled according to natural color of the horizon from bottom to top. The color of the various horizon was determined using Munsell color chart (Munsellcolour Co 1992). Each horizon from bottom to top were sampled using hand trowel and put into a well labeled polythene bags. Core's sampler were used to collect core samples from each profile for bulk density determination. The soil samples were collected, bagged and labeled to show their profile number, depth and horizon designations. The collected soil samples from the various profiles were taken to the laboratory, where they were air dried, grounded, sieved with 2mm sieve and labeled for laboratory analysis.

Laboratory analysis

Soil samples for determination of physical and chemical properties from different pedons across land use types were air-dried, grind and sieved with 2mm sieve, labeled and stored for laboratory analysis. Soil reactions (pH) was determined by with distil water at 1:1 soil to water ratio. Organic carbon was also determined by Walkey and Black (1934), Total nitrogen by micro kjeldahl method, Available phosphorous was determined by Bray 1 testing using 0.003N NH_4F IN 0.025N HCl as the extractant (Bray and Kurtz 1945) and potassium was also determined by the extraction with normal NH_4OAC at a soil solution ration of 1:10.

Data analysis

Data generated from laboratory analysis were analyzed using Means Separation to ascertained variations that exist among the selected soil properties.

RESULTS AND DISCUSSIONS

Morphological Properties of Soil in the Study Area

Morphological properties of soil of the study are shown in Table 1. The table shows the colour (hue, chroma and value) when moist using Munsellcolour chart. Soil colour varied from very dark grayish brown 10YR 3/4 at depth 0 -21cm to Yellowish red (5YR 5/6) at a depth of 87-200cm in Pedon 1(Plantain Plantation) while in Pedon 2 (Cassava cultivated land) soil colour varied from very dark brown at depth 0-23cm to strong brown colour in the subsurface horizon at 80 -200cm depth. The brownish to dark brown of the upper horizons of the two Pedons could be as result of presence of organic matter. This in line with the findings of (Brady and Weil, 2002) who reported that dark brown colouration of soils at the surface horizon might be attributed to organic matter influence. The soils of the study area are well drained with macro pores. This also support the findings of (Baker et al 2004) who revealed that soil with high macro pores is an attribute of a well drain soil. The soils are also very deep looking at the depth which is greater than 100cm (>100cm) with presence of abundance roots at the surface horizon as a result of presence of Plantain plants and few perennial shrub and herbs. Consistence ranged from friable sandy loam to slightly hard sand clay loam. The soils boundaries in both Pedons (1 and 2) were clear and at some point diffused. Plants and animal activities were also observed at the surface horizon than the sub surface horizon.

Table 1: Morphological properties of the studied soils

Horizon	Depth (cm)	Colour (moist)	Structure	Consistency	Root	Boundary
PLANTAIN CULTIVATED LAND						
Ap	0-21	Very dark grayish brown 10YR ¾	2, c, m	Fr	Abt	Cs
Ab	21-34	Dark yellowish Brown 10YR 4/6	3, abk, vc	MFr	F	Cs
Ba	34-55	Strong Brown 10YR 5/8	2, cr, m	Mfr	F	Ds
Bt1	55-87	Reddish, Brown 10YR 5/8	1, cr, f	mVf1	Vf	Ds
Bt2	87-200	Yellowish Red 5YR 5/6 moist	3, abk, vc	mVfi	Vf	
CASSAVA CULTIVATED LAND						
Ap	0-23	Very dark brown 7.5YR 2.5/3	3, abk, vc	Fr	abt	Cs
Ab	23-80	Brown 7.5 YR 5/6	3, sbk, vc	Fr	M	Cs
Bt1	80-200	Strong brown 7.5 YR 4/4	3, bk, c	Vfi	Vf	Ds

Key:Structures= 1=weak, 2=moderate, 3=strong, cr= crumb, m =medium, abk=angular blocky, vc=very coarse, f =fine, c = coarse,Consistency: mFr =moderately friable, Vfi= very firm, fr= friable,Roots: Abt=abundant, f= few, Vf=very few,Boundary: Cs=clear smooth, Ds = diffuse smooth.

Physical Properties of Soils in the Study Area

Table 2 shows the results of the physical properties of soils in the study area. The results indicated that sand fractions decreased from 905.2 gkg^{-1}(surface horizon) to 765.2 gkg^{-1}(sub surface horizon) with a mean value of 823.2 gkg^{-1} in Pedon1 (Plantain Plantation). There was also a decrease in sand fraction from 885.2gkg^{-1} at surface horizon to 715.2$gkg^{-1}$and mean value of 801.9gkg^{-1} at sub surface horizon in Pedon 2 (Cassava cultivated land). The trend in the clay fraction was not the same as in the sand fraction. In the clay fraction, there was an increase from 34.8 gkg^{-1}at the surface horizon to 204.8 gkg^{-1} at the sub surface horizon with a mean value of 120.8 gkg^{-1}in Plantain Plantation while in Cassava Cultivated land, there was also an increase in clay fraction from 44.8 gkg^{-1} to 254.8gkg^{-1}. The increase in clay fraction down the depth of the profile in both Pedons was attributed to the process of eluviation and illuviation that might have taken place down the profile depth. The accumulation of clay down the profile favours water retention that may enhance the availability of water in the root zone of crop grown in soil of the study area (Onweremadu and Peter 2016). Silt had similar pattern of distribution as observed in the sand fraction, there was a decreased from 60 gkg^{-1} to 30 $gkg^{-1}$with a mean value of 56 gkg^{-1}in (Plantain Plantation) and also decreased from 70 $gkg^{-1}$to 30gkg^{-1} with a mean value of 53gkg^{-1} in (Cassava Cultivated land). Particle size distribution of soil in both Pedons shows that the sand fractions dominated all the horizons followed by clay and then silt. This observation is in line with the findings of (Akamigbo and Asadu, 1983) that the trend is similar in most soil of south eastern Nigeria. The textural class in

Pedons varied from sand to sandy loam in Plantain Plantation and sand to sandy clay loam in Cassava Cultivated land. Bulk density varied from 1.89 gcm^{-3} to 1.54 gcm^{-3} in Plantain Plantation while in Cassava Cultivated land, it varied from 2.09 to 1.63 gcm^{-3}. The trend contradicts the findings of (Aki et al, 2017) who reported that soil bulk density increases with soil depth, this contradiction must be attributed to mechanical impediment caused by farm machinery working on the farm. This also resulted in poor root penetration and aeration despite the fact that the soils of the study area are well drained ultimate weathered soils (Ultisols). It also affected the total porosity at the surface horizons which varied from 26.17% to 39.84% with a mean value of 33.13% in Plantain Plantation while in Cassava Cultivated land, it varied

from 18.36% to 36.33% with a mean value of 28.26%.

Table 2: Effects of land use types on physical properties of the studied soils

Location	Depth (cm)	Sand →	Clay (gkg^{-1})	Silt ←	TC	BD (gcm^{-3})	TP (%)
PLANTAIN CULTIVATED LAND							
Ap	0-21	905.2	34.8	60	S	1.89	26.17
Ab	21-34	825.2	104.8	70	LS	1.89	26.17
Ba	34-55	835.2	94.8	70	S	1.63	36.33
Bt1	55-87	785.2	164.8	50	SL	1.61	37.11
Bt2	87-200	765.2	204.8	30	SL	1.54	39.84
	Mean	**823.2**	**120.8**	**56**		**1.71**	**33.13**
CASSAVA CULTIVATED LAND							
Ap	0-23	885.2	44.8	70	S	2.09	18.36
Ab	23-80	805.2	134.8	60	LS	1.79	30.08
Bt1	80-200	715.2	254.8	30	SCL	1.63	36.33
	Mean	**801.9**	**144.8**	**53**		**1.84**	**28.26**

Key: TC=textural class, S=sand, LS=loamy sand, SL= sandy loam, SCL= sandy clay loam, BD=bulk density, TP=total porosity.

Chemical Properties of Soils in the Study Area

Table 3 shows the chemical properties of soils in the study area. The results revealed that soil pH decreased down the profile from 6.25 to 5.93 in Plantain Plantation but there was an increase down the profile from 5.07 to 6.9 in Cassava Cultivated land. Soil acidity ranged from strongly acid to slightly acidic in both Pedons. Organic matter varied from 15.82gkg^{-1} to 3.78 gkg^{-1} with a mean value of 12.52gkg^{-1} in Plantain Plantation while in Cassava Cultivated land, organic matter content of the soil ranged from 12.73 $gkg^{-1}$to 8.11gkg^{1} in the AB horizon. Plantain Plantation had more organic matter (15.82gkg^{-1}) at the surface horizon than that of Cassava Cultivated land (12.73 gkg^{-1}), this might be attributed to the present of litters from harvested plantain plants that decayed and returned more organic materials to the surface soil. Total nitrogen varied from 1.28gkg^{-1} to 0.27gkg^{-1} in Plantain Plantation and varied from 1.10 gkg^{1} to 1.04 gkg^{-1}. However, the rating of total nitrogen in both Pedons belongs to the medium class which in line with the report of (Landon 1991). Generally, total nitrogen content of soils in the study area were very low to moderate. The available Phosphorus content of the soils in the study area varied from 10.61$mgkg^{-1}$ to 6.05 $mgkg^{-1}$in Plantain Plantation and varied from 8.49$mgkg^{-1}$ to 7.33$mgkg^{-1}$in Cassava Cultivated land. There were variations in soil available Phosphorus content due to the degree of soil distribution and fixation in the study area. Exchangeable calcium and Magnesium content of soils in the study area also varied from 7.76 $cmolkg^{1}$to 2.64 $cmolkg^{1}$ and 2.29$cmolkg^{-1}$ to 0.82$cmolkg^{-1}$in Plantain Plantation respectively while in Cassava Cultivated land, exchangeable Calcium and Magnesium varied from 3.2cmol/kg to 3.26$cmolkg^{-1}$and 1.12$cmolkg^{-1}$to 1.49cmol/kg respectively. Generally, exchangeable calcium content of the soils in the study area were higher than that of magnesium in both pedons, although exchangeable calcium rating according to (Douglas and Peter 2016) were considered to varied from low to higher, while magnesium was moderate in both pedons. The exchangeable Potassium and Sodium ranged from 0.012 $cmolkg^{-1}$to 0.020$cmolkg^{-1}$ and 0.014$cmolkg^{-1}$ to 0.010$cmolkg^{-1}$ in Plantain Plantation but varied from 0.007cmol/kg to 0.004$cmolkg^{-1}$and 0.010$cmolkg^{-1}$to 0.011$cmolkg^{-1}$in Cassava Cultivated land respectively. Exchangeable Potassium and Sodium were generally very low in both pedons of the study area when compared to available standard ratings interpretation Guide for Evaluating Analytical data. The total exchangeable acidity (TEA) varied from 0.08 $cmolkg^{-1}$ to 0.16 $cmolkg^{-1}$ in Plantain Plantation and 1.12 $cmolkg^{-1}$ to 0.16 $cmolkg^{-1}$ in Cassava Cultivated land. The ECEC value also varied from 10.156 $cmolkg^{-1}$ to 3.490 $cmolkg^{-1}$ in Plantain Plantation while in Cassava Cultivated land ECEC varied from 4.925 and 5.454 $cmolkg^{-1}$ to 4.925 $cmolkg^{-1}$. The base Saturation rated high to very high for both Pedons which varied from 99.21% to 95.62% and 79.48% to 96.75%. It was also observed that there were high percent base saturation at the sub surface horizon. This might be attributed to leaching of soluble base down the profile level.

Table 3 Effects of land use types on chemical properties of the studied soils

Location	Depth (cm)	pH (H_20)	OC gkg^{-1}	OM (gkg^{-1})	TN	AvP ($mgkg^{-1}$)	Ca	Mg	K	Na ($cmolkg^{-1}$)	TEA	TEB	ECEC	BS (%)
PLANTAIN CULTIVATED LAND														
Ap	0-21	6.246	9.18	15.82	1.28	10.61	7.76	2.29	0.012	0.014	0.08	10.076	10.156	99.21
Ab	21-34	5.204	8.78	15.13	1.09	9.94	4.081	1.01	0.016	0.010	0.8	5.117	5.917	86.48
Ba	34-55	5.331	8.38	14.45	1.20	9.86	4.44	2.02	0.014	0.016	0.25	6.490	6.740	96.29
Bt1	55-87	5.116	7.78	13.41	0.96	8.76	3.6	1.82	0.021	0.010	1.02	5.452	6.472	84.24
Bt2	87-200	5.93	2.15	3.78	0.27	6.05	2.64	0.82	0.020	0.010	0.16	3.490	3.650	95.62
	Mean	**5.565**	**7.25**	**12.52**	**0.96**	**9.04**	**4.50**	**1.592**	**0.017**	**0.012**	**0.462**	**6.125**	**6.587**	**92.37**
CASSAVA CULTIVATED LAND														
Ap	0-23	5.07	7.88	12.73	1.10	8.49	3.20	1.12	0.007	0.010	1.12	4.337	5.457	79.48
Ab	23-80	5.106	4.70	8.11	0.64	6.8	3.36	1.01	0.003	0.009	0.64	4.382	5.022	87.26
Bt1	80-200	6.116	6.98	12.04	1.04	7.33	3.26	1.49	0.004	0.011	0.16	4.765	4.925	96.75
	Mean	**5.431**	**6.52**	**10.96**	**0.93**	**7.54**	**3.27**	**1.21**	**0.005**	**0.010**	**0.64**	**4.495**	**5.135**	**87.83**

Key:OC=organic carbon, OM= organic matter, TN= total nitrogen,Avp=available phosphorus, TEA=total exchangeable acidity, TEB= total exchangeable bases, ECEC=effective cation exchange capacity, BS=base saturatio

CONCLUSION/RECOMMENDATION

The results from this study shows that land use types had significant influence on both soil morphological, physical and chemical properties such as pH, organic matter, total nitrogen, available phosphorus, exchangeable bases (Ca, Mg, K& Na), base saturation etc. The results showed that low level of organic carbon, Total Nitrogen, Available P and exchange bases were also observed. They ranged from very low to moderate and in some cases very high. In both land use types, some of the chemical properties when compared to available standard were below the threshold limit due to continual usage for crop production. There is also an indication that soils in the study area has been over used. It is recommended that farmer within the study area should adopt management practices that will encourage the use of organic manure such as cow dung and poultry droppings in order to build up the organic matter content of the soils**.**

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