PROPERTIES AND CLASSIFICATION OF EROSION PRONE SOILS OF UKPOR, NNEWI SOUTH L.G.A ANAMBRA STATE NIGERIA

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ABSTRACT

The study characterized and classified some erosion prone soils of Ukpor Nnewi in Anambra State. Three profile pits were sited along toposequence based on the slope of the area. Soil samples were collected from profile pits to determine the physical and chemical properties of the soils, according to USDA guidelines and FAO/UNESCO. Soil samples were subjected to routine analysis. The chemical properties of the soil were extremely acidic, very low in organic matter, exchangeable bases and C.E.C. taxonomically, the Soil were classified as Halpludalfs and correlated to FAO/UNESCO soil legend as Hapic Lixisols. At the higher level of classification the soils were classified as typic Hapludalfs (USDA) and Haplic Lixisols FAO/UNESCO.

Keywords: Degradation, Soil Erosion, Anambra, Tropical soils.

INTRODUCTION

Soil degradation is a major threat facing many agricultural soils in west Africa. This is as a result of high annual rainfall, leaching, high soil acidity, deforestation, and poor management culture obtained in the area. The obvious effect of these ranges from landslide, soil fertility depletion, loss of biodiversity and soil erosion putting agricultural ecosystem at a risk. FAO (1979) report reviews that between 5 and 7 million hectares of land world-wide are lost annually through soil degradation, according to this studies if the current rate of soil erosion in the world continues, close to one third of the world's arable land will be destroyed.

In Nigeria, the threat of soil erosion has left many towns and communities completely ruined of their soils. The study area is not an exception, as different kinds of soil erosion occur; ranging from inter-rill to gully erosion. The situation has led to low crop yields and other problems associated with soil erosion, such as the cutting of access roads, farm lands and destruction of buildings in most cases. Based on the above, the study aimed at characterizing and classifying soils of Ukpor-Nnewi, Anambra state using USM soil taxonomy and FAO/NUESCO.

Materials And Methods

Umuoham in Ukpor is about $1^{1/2}$ km from the headquarter complex of Nnewi South (about 5km from Nnewi town). The landform area comes under the low lands. The plains and lowlands include the following landform region: Niger Anambra lowlands (covered by alluvium deposits), lower Niger plains and Mamu River plains. These plains and lowlands has great rolling topography, generally below 122m above sea level. The Awka-Orlu uplands extend to this area. It has a humid tropical climate with annual rainfall ranging from 1,750 to 2,500mm and annual temperature range of 28 ^{0}C to 34 ^{0}C. The area has typical tropical lowland rainforest vegetation characterized by many plant types with the dominant of oil palm trees. Agriculture, hunting, and cottage industries are the main source of livelihood. Agriculture is dominated by manual operation on the farmland.

Field Studies

Transect soil sampling was used in locating and digging profile pits along the slope. Profile pits were dug along toposequence and were described using USDA (1999) and correlated to revised FAO/UNESCO (1988). Soil samples were collected based on horizon differentiation. Soil samples were air-dried, sieved using 2.mm aperture. Core samples were collected for bulk density determination.

Laboratory Analysis

Particle size distribution was determined by hydrometer method, (Boyoucous 1965). Bulk density was obtained by core procedure (Blake, 1965). Soil pH was measured electrometrically using glass electrode pH meter in a soil-liquid ratio of 1:2.5 (Hendershot et al, 1993). Percentage organic carbon was determined by the (Walkey-Black wet oxidation method 1934 as modified by Allison (1965). Total nitrogen was determined by Microkjeldahl distillation method (Bremner and

Mulvaney, 1982). Base saturation was calculated. Exchangeable acidity was gotten by a method described by (Mclean 1982). Available phosphorous by Bray, No. 1 method using spectrophotometer.

Soil Classification

Statistics

Soil data collected were analyzed using Tables and charts to present the data.

Results And Discussion

Results of physical and chemical properties of the soils samples studied are shown on (Table 1 and 2) below and are represented by profiles. EGB/uk/01, EGB/uk/02, EGB/uk/03. The soils are generally sandy clay loam to sandy loam. Well drained in all the Pedons, this could be as a result of the influence of parent materials, which is sandy in texture. The clay content of the soils were generally low to medium, ranging between 4 and 26.26% in all the pedons. This could be as a result of the transportation of clay and other finer materials on the top soil by serious sheet erosion and leaching observed in the study area. Silt content were very low in all the profiles, ranging between 2 and 6%. In most cases the values did not follow a definite trend, showing little fluctuations within depths of all the pedons.

Sand values are high ranging between 70 and 82%, the highest value 82% as were observed in the three pedons could be attributed to the parent material which are highly leached followed by the continuous action of soil erosion which gave rise to the washing away of clay and silt contents of the soil leaving the sand content. This were as a result of excessive leaching that occurs overtime in the area, while the lowest values of 69.7% were recorded in pedon EGB/uk/03 which is on a toe slope. The value did not follow a defined trend within the profile. Bulk density of the samples were generally high, ranging between 1.45-1.64g/cm^3 and there was an increase with depths of these values. Clifford Tafangenyasha et al (2010) revealed that high bulk density in a soil sample could be as a result of soil degradation such as compaction of soil through tillage operation, use of tractor on the farmland and high rate of leaching among others.

Soil chemical properties of the three profile pits were extremely acidic in 1N KCl as shown in (Table 1). The $_P$H value ranges between 3.67-4.63, this values make a low pH rating which is as a result of excessive leaching and over cropping. Organic carbon values range between 0.25-0.87%, decreasing with depths except for EGB/uk/03 where there is no variation as such with depth. Results shows that in all the samples the total nitrogen values were very low to low ranging between 0.028-0.0126% and there was a significant decrease with depth in all the pedon with EGB/uk/03, recording the highest value of 0.126%. The exchangeable sodium were generally very low ranging between 0.148-0.618 Cmol(+)kg^{-1} in all the profiles. Pedon EGB/uk/03 recorded the highest values of sodium than the other two pedons. Exchangeable potassium were also low with values ranging from 0.041-0.113 Cmol(+)kg^{-1}.

Exchangeable calcium and magnesium were very low ranging from 2.00-4.80 Cmol(+)kg^{-1} and 1.20-3.20 Cmol(+) kg,$^{-1}$ respectively with some variation based on depths.

Exchangeable aluminum values are moderate ranging between 0.20-1.36 Cmol(+)kg^{-1}. Higher values are recorded in pedons EGB/uk/01 and EGB/uk/03 between 0.92-1.38 Cmol(+)$^{-1,}$ respectively while EGB/uk/02 has a low value of 0.16 Cmol(+)kg^{-1} Value for cation exchange capacity are extremely low, ranging between 3.604-9.691 Cmol(+)kg^{-1}, though there were some fluctuation with depth in all the profiles studied. Base saturation were generally high to very high with values between 77.89-96.72%. Finally, available phosphorus were low between 1.60-15.30 ppm P. and the lowest of the values was found in the second horizon of pedon EGB/uk/02.

Table 1: Physical and Chemical Properties of Soils

Samples	Horizon	Depth (cm)	Sand	Silt %	Clay	Bulk density	Textural class
EGB 01	A_P	0-12	82	4.00	14.2		S.L
	A_B	12-34	82	2.00	16.2	1.53	S.L
	B_1	34-49	80	4.00	16.2		S.L
	2_B	49-95	76	6.00	18.2		S.L
	3_B	95.114	74	6.00	20.2	1.68	S.L
	B_C	114-194	72	4.00	24.2	1.59	S.C.L
EGB 02	A_P	0-22	82	4.00	14.2		S.L
	A_B	22-43	82	4.00	14.3	1.45	S.L
	$2B_1$	43.60	80	4.00	16.2	1.60	S.L
	2_B	60-82	78	6.00	16.2		S.L
	B_C	82-130	74	4.00	22.2		S.C.L
EGB 02	A_P	0-10	82	2.00	16.2		S.L
	A_B	10-24	80	4.00	16.2	1.58	S.L
	B	24-40	78	4.00	18.2		S.L
	2_B	40-58	74	6.00	20.2	1.64	S.C.L
	B_T	58-78	72	4.00	24.2		S.C.L
	B_C	78-120	70	4.00	26.2		S.C.L

Table 2: Chemical Properties of Soil

% O.M Depth (cm)	TOTAL N (%)	AVAILABLE (PPM)	Na^+	K^+	Mg^{++} (meq/100 g soil)	Ca^{++} (meq/100 g soil)	EA	CEC	% B-S	pH (INKCL)	O.C (%)
1.17	0.070	7.80	0.191	0.067	1.60	2.40	3.95	0.68	82.23	3.95	0.68
1.06	0028	2.00	0.165	0.067	1.20	1.60	3.88	0.61	80.81	3.88	0.61
0.94	0.056	6.10	0.165	0.067	1.20	2.00	3.81	0.55	85.97	3.81	0.55
0.87	0.056	7.10	0.148	0.046	3.20	2.80	4.63	0.51	92.25	4.63	0.51
0.51	0.070	8.20	0.183	0.056	1.60	3.20	3.62	0.29	85.71	3.62	0.29
0.44	.028	2.20	0.191	0.041	0.40	1.20	3.80	0.25	77.89	3.80	0.25
1.01	0.056	4.30	0.218	0.092	1.60	2.40	3.67	0.59	95.57	3.67	0.59
0.92	0.056	6.60	0.235	0.061	1.60	4.00	4.20	0.53	96.72	4.20	0.53
0.76	0.070	9.20	0.226	0.180	2.40	2.80	4.60	0.44	94.60	4.60	0.44
0.55	0.028	1.60	0.165	0.051	1.06	2.00	4.45	0.32	92.26	4.45	0.32
0.46	0.028	2.50	0.210	0.082	1.60	2.40	4.28	0.27	96.41	4.28	0.27
1.49	0.126	15.30	0.218	0.113	3.20	4.80	4.00	0.87	85.97	4.00	0.87
1.38	0.084	8.80	0.618	0.056	2.80	4.80	3.80	0.80	91.18	3.80	0.80
1.29	0.070	4.80	1.057	0.061	0.20	2.40	4.60	0.75	94.09	4.60	0.75
1.10	0.070	7.40	0.148	0.056	1.20	2.00	4.60	0.64	94.45	4.60	0.64
0.83	0.056	6.20	0.165	0.061	1.60	2.00	4.15	0.48	92.28	4.15	0.48
0.48	0.042	5.50	0.210	0.087	1.20	2.80	0.28	4.577	93.88	4.00	0.28

Soil Classification

The soils investigated were classified using the USDA soil taxonomy (1999) and correlated to the revised FAO/UNESCO soil map of the world legend (1988). Physio-chemical and climatic data were used for the classification (as shown on table 3 below). They were classified down to the sub group level of generalization.

Table 3: Soil Classification

PEDONS	*LOCATION*	*CLASSIFICATION*
1) EGB/uk/01	Egbu, ungwu Umuohoama Ukpor	Typic Hapludalf (USDA) and Hapic Lixisols (FAO/UNESCO)
2) EGB/uk/02	Egbu, ungwu Umuohoama Ukpor	Typic Hapludalf (USDA) and Hapic Lixisols (FAO/UNESCO)
3) EGB/uk/02	Egbu, ungwu Umuohoama Ukpor	Typic Hapludalf (USDA) and HapicLlixisols (FAO/UNESCO)

Discussion

Physical Properties

The soil in the project area are deep, porous and well drained with moist munsell colour ranging from dark reddish brown (5YR 3/3) and yellowish (5YR 4/6) to reddish brown (5YR 4/4). This could be attributed to the nature of parent materials, which is derived from the weathered false-bedded sand stones, which are sandy in nature, and the oxidation of the iron liberated during weathering. The particle size analysis shows that the pedons have coarse texture over medium texture, i.e. sandy loam over sandy clay loam. This agrees with the observation made by (Akamigbo and Asadu, (1986), which reveals that soil texture of the Southeastern Nigeria are related to their parent materials. This soil has heavier coarse materials, which accumulated after lighter materials have been leached out and transported by over land flow.

The results shows that the clay content are generally very low ranging between 14.26-26.26% and increasing with depth in all pedons (Table 1). This could be as a result of the soil which is prone to intense leaching and erosion. The percentage silt content of the pedons is very low but without a definite trend showing fluctuations within the depths of pedons (Sancheze 1976) indicated that low silt content of soil reveals the degree of leaching the soil has undergone or exposed to and the parent material. This could be traceable to severe sheet and gully erosion, resulting to lots of nutrient losses.

Finally, the bulk densities of the pedons are moderate ranging between 1.45-1.64mg/m^3 in all the pedons (Table 1). Generally the bulk densities tend to increase with depth. The moderate level of the bulk densities could be as a result of high agricultural activities, which may give rise to the soil structural degradation if the bulk densities get higher.

Chemical Properties

From the general overview, the soil is found to be extremely acidic in $_P$H 1N KCl. High acidity has been recorded in many eroded soils (Akamigbo and Igwe, 1990). The basic element which usually influence aggregation have been lost when soil reaction is in the strongly extremely acidity range (Akamigbo and Igwe, 1990). This condition could be responsible for the high aluminium saturation and very low calcium and magnesium of the soil when they are as low as 1.20-0.40 Cmol(+)kg^{-1}, respectively. The implication being that a large quantity of time could be required to increase the soil $_P$H, crops that can not strive in low pH will be grown in the area. The low to very low level of the organic matter content is the situation in the humid tropics due to rapid mineralization of organic matter by high temperature. Another possible effect could be as a result of high leaching and severe sheet erosion, which are evident in the area. Tillage operations and the depletion of nutrients elements by very high concentration of arable farming could be another cause of low organic matter content in the area.

The low level of exchangeable bases in the soil is an indication of heavy leaching of soil nutrients. The leaching of calcium and magnesium is largely responsible for the development of acidity in the soil. High leaching rate is favoured by high rainfall, coupled with porous nature of the soils due to its texture and the parent materials. Also, the cation exchange capacity (CEC) and the effective acidity are both very low. (King and Juo, 1981) referred to these soils as low activity clay (LAC) soils, probably as a result to their low (CEC). The soils are composed of mainly 1:1 Lattice Clay Minerals, particular kaolinites (Akamigbo and Igwe, 1990).

The moderate to high base Saturation of the soils as shown in (Table 1) could be attributed to properties inherited from the parent materials. The percentage sodium of the soil is very low, this trend is common with soils in high rainfall belts such as the study area, and sodium are exposed to high rate of leaching in the area. The moderate to high value of available phosphorus recorded in all the soils could be attributed to strong weathering. Study by

(Enwezor, 1977) shows low available phosphorous content of soil are caused by weathering and low pH values of soil. This is also evident in the study area. The parent materials of these soils could as well be poor in phosphorous.
The soils were classified down to the subgroup level of generalization, morphological and physio-chemical properties of the soils. The soils are mostly Hapludalfs (USDA) and correlated to FAO/UNESCO (1988). At the higher level of classification the soils were classified as typic Hapludalfs (USDA) and Haphic Lixisols (FAO/UNESCO).

Conclusion

The study reveals that the soils are deep (114-194 cm), acidic (pH 4.60), low in organic matter and exchangeable bases as well as highly erodible. The soils are generally classified at the subgroup level as Typic Hapludalfs (USDA) and Hapic Lixisols (FAO/UNESCO). There is need to employ some conservation practice to ensure a sustainable land use practice especially for agricultural purposes, practices like crop rotation cover cropping, agroforestry and mixed farming system. Should be adapted. It is also important to create road side drains during road construction followed by proper planning to avoid blocking of natural drains which lead to excessive runoff/soil erosion.

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