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SOIL ERODIBILITY ASSESSMENT IN SELECTED PART OF EKWUSIGO LOCAL GOVERNMENT AREA ANAMBRA STATE SOUTH-EASTERN NIGERIA

Ruth Oghenerukevwe Eyankware[1], Moses Oghenenyoreme Eyankware[2], and Solomon Chukwuedum Effam[2]

[1]Department of Geography and Meteorology, Faculty of Environmental Science, Enugu State University of Science and Technology, Enugu State, Nigeria

[2]Department of Geology, Faculty of Science Ebonyi State University, Abakaliki P.M.B 053 Ebonyi State, Nigeria

ABSTRACT: Erosion related problems has been on the increase in some part of Ekwusigo local government area and its environs in particular and southestern Nigeria at large for some decades now and all past attempts at solving the problem have proved ineffective and thus constituting risk to the people living in such area or erosion prone area. The research was embarked upon to assess the erodibility of soil over different parent materials in selected part of study area. Soil samples were collected from profile pits dugs in three different locations namely: Egbema, Nza and Ifite Oraifite. A total of fifteen soil samples in all comprising five samples from each profile pit with a depth of 2m and according to the clarity of the different horizons was collected. The samples were air dried, crushed and sieved in 2mm before subjected to test in the laboratory for both physical and chemical. Sand fraction in all the three locations showed porosity below 50%, the ECEC were found to be low likewise the organic content and the $_{P}H$ in the three locations. The properties exhibited by this soil indicate that the soil has been subjected to high rate of weathering and leaching they are easily detachable and transported by runoff, hence there stability is low.

KEYWORDS: vulnerability, soil erosion, chemical parameters, Physical parameters and Moisture Content.

1 BACKGROUND INFORMATION

Adinna (2001) defines erosion as the gradual or forceful removal of weathered rock from the point of weathering. It is an inevitable natural process in sedimentary and often metamorphic rock formations, which is necessary for the formation of the medium for crop production and plant growth. Soil erosion as a denudation process involves the three stages of rock decay (decomposition), transportation and deposition (aggradations). Soil erosion is a well-known environmental problem in southeastern Nigeria. It is the removal of soil particles from surface of the earth, transportation and deposition of the particles by the action of wind, heat, and water. Soil erosion encompasses all activities by water in all forms (rain, flood, ice, sea) resulting in soil erosion. Socio-economic problems caused by soil erosion include removal of nutrients from soil leading to low farm produce, destruction of farms, it also resulting in collapse of buildings. Soil erosion by water is a continuing, long-term problem related to south-eastern part of Nigeria forming a threat to infrastructure and agricultural production (Grove, 1951; Ofomata, 1964; Idike, 1992). Gully erosion in Anambra state, South East Nigeria has continued to pose a challenge to Geoscientist and other environmental scientist. The menace has taken its toll on the socioeconomic well being of the people living in the study area, such that lands used for agricultural and industrial purposes, ancestral homes, crops, livestock and other infrastructure are lost to the hazard at alarming rate. Soils of south eastern Nigeria have high erodibility and are classed as structurally unstable (Idowu and Oluwatosin, 2008). Therefore erosion forms a major type of soil degradation in the area. According to Lal et al, (1994), the susceptibility of soil to erosion depends on soil properties which may include the soil texture, structure, organic matter, oxides of irons and aluminium and predominantly clay minerals there are also the topographic factors which influences soil loss.

Different types of erosions, such as sheet, rill and gully, are pervasive in Anambra. However, gully erosion constitutes the most significant threat to the survival of individuals and communities. Human activities, such as bush burning, deforestation, improper farm practices, and, more importantly, construction activities (building of roads, houses, industries), that undermine natural landscape or drainage systems account for much of the erosion menace plaguing the States. A number of researchers have investigated the magnitude of erosion in various parts of Anambra State (Obiadi. I. I et al,(2011), Chuks Okpala-Okaka, (2010), Ndukwe Chiemelu et al.,(2013) and Eze, et al,(2012) but detail study of erosion and its effect has not been carried out.

1.1 Statement Of Problem

As a matter of fact, erosion is natural and inevitable process. It becomes serious when the process is accelerated by human activities and it relate exceed the three hold value equivalent to the count, balancing and compensating rate new soil formation this depletes soil productivity and causes soil degradation, On the effect of erosion, agriculturally speaking both erosion and sedimentation affect soil productivity by decrease the rooting depth and depleting nutrient and water reserves. The adverse effect of erosion on the economy of south-eastern Nigeria became more prominent through drastic reduction in availability of cultivated land for agriculture. About 54% of the cultivated lands in Anambra state are affected by either sheet, rill and gully erosion. The following research questions would be answered after this study:

- What are the parameters required for assessing erodibility of soil in the study area.
- What are the measures for erosion control in the area of the study area.

1.2 Scope Of Study

The scope of the study area is based on the assessment of erodibility of soil formed over three different parent materials in Ekwusigo local government of Anambra state. Soil samples were collected from profile pit dugs in three different location namely Egbema, Ifiite Oraifite and Nza. The soils samples were analyzed to get the physical and chemical properties of erodibility of soil in the study area using laboratory test analysis

1.3 Aim And Objectives Of Study

The aim is to determine the presence and extent of erosion of the three different parent materials. To achieve the above aim, the following objectives were required:

- To investigate the vulnerability of soil on the study area.
- To relate erodibility of soils to some selected soil properties.
- To suggests improved management practices that will improve agricultural productivity and reduced the incidence of erosion.

1.4 Research Hypothesis

Ho: There is no significant differences in the erodibility of the soils which the three parent materials.

Hi: There is significant difference in the erodibility of soils within the three parent materials.

1.5 Justification Of Study

- This study will produce documentation on the assessment of soil in three different parent materials.
- The result of research will aid in the identification of soils that are easily erodible.
- It enables the hazards and problems of erodible soil in the area to be avoided at the early stage of planning.
- The study will identify the three parent materials and their erodibility potentials.

1.6 Literature Review

Soil erosion with its numerous forms of occurrence in varying degree has been identified as the major impendent of agricultural productivity in most part of the world. The south-eastern Nigeria is not an exemption in this trend where gully have taken catastrophic dimension threatening farmlands, streams and even entire human settlement thereby hindering increased agricultural output. Following the ordinary definition of the world gully (i.e. an erosion channel too deep to be crossed by a wheeled vehicle), the gullies in Anambra State in particular and South East Nigeria would modestly be described as catastrophic. With many of them having depth and width exceeding tens of kilometres, they would better be called canyon (Okagbue and Ezechi, 1988). Several workers have attributed the development of gullies in Anambra State to the influence of human activities on natural and geologic processes while others suggested that gullies are linked with concentrated runoff processes. Nwajide and Hogue (1979) attributed the causes of gullies to the combination of physical, biotic and anthropogenic factors. Egboka and Nwankwor (1982) are of the opinion that gullies are caused by hydrogeological, hydrogeochemical and geotechnical properties of the rocks in the affected area. Okagbue (1986), Uma and Onuoha (1986) are in agreement with Nwajide and Hogue on the causes of gullies in South Eastern Nigeria. South-eastern Nigeria is dominated by acidic soils as in all humid regions that records very high rainfall of up to 200mm and above annually. The soils are formed from mostly sandstones and are variably classified as ferralitic soil, dystic, Nitossis (EC), organic matter, base saturation, both available and total phosphorous then acidity dominates and makes the soil susceptible to erosion Enmezor et al (1981). On the other hand they have high exchangeable Al, which leads to low $_{P}$H that rarely exceed 6.0 hence a net negative charge. These acidic soils are mostly coarse textured with low specific surface areas, they poses waek structure ranging from weak crumb, crumb to granular for the first 2m (Babalola et al 1981).

1.7 Study Area

The study was carried out in Ekwusigo local government area of Anambra state, Nigeria at three different location namely: Egbema, Ifitie Oraifite and Nza. It geographically bounded between longitude $6^{0}50^{I}$E and $6^{0}55^{I}$E, latitude $5^{0}22^{I}$N and $5^{0}57^{I}$N and bounded by Nnewi north at the north and Idemili at the north, Ihiala local government in the south, Nnewi south local government in the east and Ogbaru local government at the west as shown in **Fig.1**

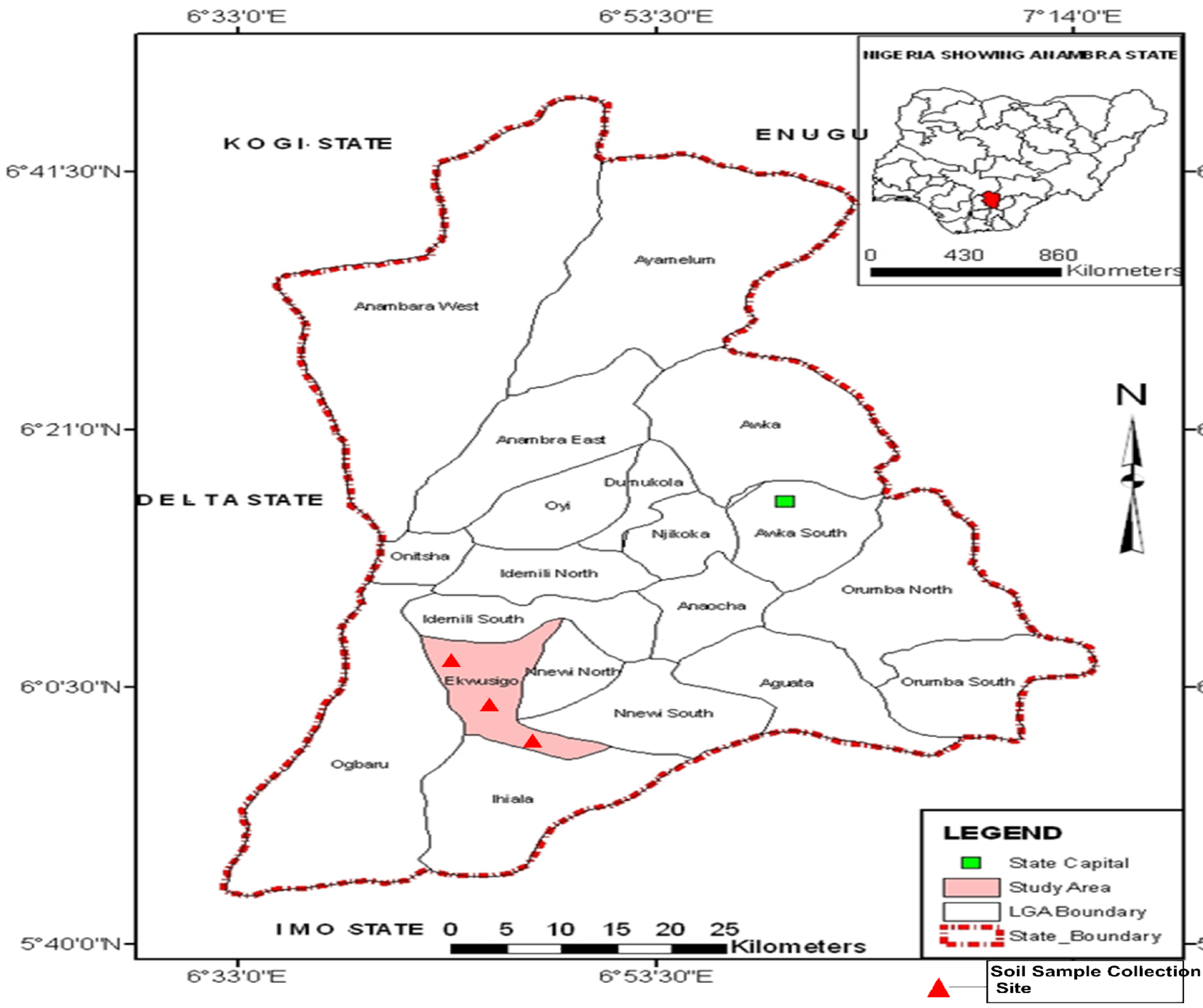

Fig. 1 Map of Anambra State Showing the Study Area. Source: (Joel et al, 2012.)

2 Soil And Geology Of The Study Area

The soils are lateritic in nature and derived from the underlying Sandstone and Shale units. The soils derived from Shales on lower slopes where drainage is poor. There is dark reddish brown clayey at the surface and a strongly mottled light grey and red soil. It varies from reddish to brownish and it is underlain by yellowish, dark red sandy clay in the lower horizons. The thickness varies from a few centimetres to more than 10m. The soils are well drained and weakly consolidated in most part of the study area. The study area falls within the Ogwashi-Asaba Formation which is Oligocene to Miocene in age, it lithology consists of alteration of clayey shale with seam lignite.

3 Research Methodology

Material used in the study are topographic map covering Ekwusigo, shovel that was used for digging the profile pit, steel tape for taking measurement of different horizons and annual soil colour chart for describing the colour of various soil samples in the horizon. Other materials are polyethene used for storing soil samples and a field note for recording the data collected from the field.

3.1 Preliminary Field Study

One profile pit each was dug on the three different locations to a depth of 2m. Soil samples were according to clear horizon differentiation. A total of fifteen (15) samples, comprising of five (5) from each profile pits were collected in polythene bags and labelled both inside and outside. The samples use air dried at room temperature crushed and sieved in a 2mm sieve for determination of physical and chemical property in the laboratory. Soil samples were analyzed at the federal university of science and technology Owerri, Imo state, department of soil science laboratory.

3.2 Laboratory Procedure

3.2.1 Determination Of Physical Properties Of Soil

Bulk density: It was determined using the core sample (Blake 1964) and calculated from:

$\rho_b = M_s/V_t$

Where

ρ_b =Bulk Density (g/cm^3)

M_s=Mass of oven- dried sample (g)

V_t = Total Soil Volume (same as v of core) cm3.

Moisture Content: It was determined gravimetrically, by first over drying representative soil samples, collected from each horizon, at a temperature of 1050c until a constant weight is obtained. Then calculation was done from this formula

$$Mc(\%) = \frac{W_s - D_s * 100}{D_s}$$

Where M_c = Moisture Content, W_s = Wet Sample and D_s = Dried Sample.

Clay Ratio (Boyoucos, 1935)

This was calculated as follows:

$$\frac{\text{Sand (\%)}}{\text{Silt (\%)} + \text{Clay (\%)}}$$

Porosity (F)

It was calculated using density values, thus

$$F = 1 - \frac{Bd}{Ps}$$

Where

F = Porosity

Bd= Bulk Density

Ps = Particle Density (2.56 cm^3).

❖ **Particle Size Distribution**

This was determined using the hydrometer method describing Boyoucos (1935). Textural class was determined using soil textural triangle.

❖ **Shear Strength**

It was calculated using;

$TE = C + \sqrt{n} \tan\emptyset (KN/M^{-2})$

Where

√n = Maximum x Normal stress

C = cohesion

tanØ = Angle of Internal Friction.

- **Aggregate Stability**

It was determined using the percent mean weight diameter.

Where

W1 = mi/mt

X_1 = Mean diameter range of aggregate

m_1 = Soil sample in the respective sieve after oven dry

m_t = Total weight of initial material (samples)

DATA PRESENTATION AND ANALYSIS

The results data obtained for purpose of this study are shown in tables, graph and histogram. Statistical analyses were summarized using four measures: mean range, standard deviation and the coefficient of variation. The measurements used in summarizing the data are expressed as follows

Mean

$$(x) = \frac{\sum x}{N}$$

Where:

X = Arithmetic Mean, $\sum x$ =Total Measurement and N = Total measurement.

Standard Deviation

$$SD = \frac{\sqrt{\sum f(x-x)^2}}{\sum f}$$

Where: SD = Standard Deviation, $\sum f$ = Total numbers of items and $(x\text{-}x)^2$

The coefficient of variation is determined by relating standard deviation to the mean, this express the standard deviation to the mean, this expressed the standard deviation as a percentage of the mean.

Where

$$CV = \frac{SD \times 100}{X}$$

Table 1 – 6 shows information obtained from soil data laboratory analysis. While (Table.1) shows analysis of the variable

4 RESULTS AND DISCUSSION

TABLE.1. ANALYSIS OF THE VARIABLE TABLE

	SOURCE OF VARIATION	SUM OF SQUARES	DEGREE OF FREEDOM	VARIANCE ESTIMATE	F-CAL	F 0.05	F 0.01	CONCLUSION
Sand	Between Group Within Total	412.16 1101.26 1513.42	2 12 14	206.08 91.77	2.25	3.89	6.93	Not Significant
Silt	Between Group Within Group Total	595.8 390.4 986.2	2 12 14	297.6 32.5	94	3.83	6.93	Significant
Clay	Between Group Within Group Total	409.2 503 913.0	2 12 14	204.5 41.9	4.9	3.89	6.93	Probably Significant
Sand	Between Group Within Group Total	727.3 1558.8 2286.1	2 12 14	363.7 129.9	2.8	3.89	6.93	Not Significant
Silt	Between Group Within Group Total	114.35 130.3 244.65	2 12 14	57.18 10.85	5.27	3.89	6.93	Probably Significant
Clay	Between Group Within Group Total	1051.0 1065.3 2.116	2 12 14	525.5 88.8	5.9	3.89	6.93	Probably Significant
Pr	Between Group Within Group Total	241.3 181.7 423.0	2 12 14	120.7 15.14	7.9	3.89	6.93	Significant
St/Cr	Between Group Within Group Total	9.39 46.91 56.30	2 12 14	4.69 3.91	1.2	3.89	6.93	Not Significant
AS	Between Group Within Group Total	3853.1 8266.2 12119.3	2 12 14	1926.6 688.8	2.8	3.89	6.93	Not Significant
IR	Between Group Within Group Total	3949.0 14916.4 8865.4	2 12 14	1974.5 1243.0	4.7	3.89	6.93	Not Significant
SS	Between Group Within Group Total	428.90 196.2 925.10	2 12 14	214.45 24.71	8.6	3.89	6.93	Not Significant
OC	Between Group Within Group Total	3.1 16.5 19.60	2 12 14	1.5 1.3	1.1	3.89	6.93	Not Significant
OM	Between Group Within Group Total	30.4 50.7 81.1	2 12 14	15.2 4.23	3.6	3.89	6.93	Not Significant
TEB	Between Group Within Group Total	7.71 9.40 17.1	2 12 14	3.85 1.6	2.4	3.89	6.93	Not Significant
ECEC	Between Group Within Group Total	46.2 70.5 116.7	2 12 14	23.1 5.86	3.9	3.89	6.93	Not Significant
$_pH$	Between Group Within Group Total	0.10 0.39 0.49	2 12 14	0.05 0.03	1.7	3.89	6.93	Not Significant

TABLE. 2 SHOWING STATISTICAL DESCRIPTION OF PHYSICAL PROPERITIES OF THE SOIL AT EGBEMA

SITE NO.1 EGBEMA	DEPTH	Bd (gcm)	Mc(%)	Porosity(%)	Sand(%)	Clay(%)	Silt(%)	Sand(%)	Clay(%)	Silt(%)	Textural Class	Silt/Clay ratio	Infiltration Ratio (%)	Aggreagate Stability(%)	Shear strength (KN/M^2)
A_P	0-15	1.52	12	42.64	93.7	2.2	4.1	86.08	4.92	9	S	1.83	50	49	109
A_B	15-57	1.49	11.21	43.77	90.2	6.6	3.2	89.66	4.54	5.8	S	1.28	54	47	95
B_{t1}	57-89	1.42	11.82	46.42	91.4	10.6	6.2	90.11	2.5	7.39	S	2.96	52	43	101
B_{t2}	89-105	1.39	13.52	47.55	83.68	11.6	7.72	75.94	12.43	11.63	SL	0.94	47	45	81
Bt_3	105-124	1.47	13.72	44.53	80.68	5.79	2.81	71.8	16.8	11.4	SL	0.68	41	42	72
Max		1.52	13.72	47.55	93.7	11.6	7.72	90.11	16.8	11.63		2.96	54	49	109
Min		1.39	12	42.64	80.68	2.2	3.2	71.8	2.5	5.8		0.69	41	42	72
Range		0.13	2.52	4.91	13.02	9.4	4.91	18.31	9.93	5.6		2.96	13	7	37
Mean		1.468	12.45	44.982	87.932	7.358	4.086	82.718	82.718	9.044		1.538	48.8	45.8	91.6
STDEV		0.071		1.783	4.922	3.409	2.99	7.472	7.472	2.18		0.808	5.562	5.562	13.412
COVAR	4.86		27.91	3.964	5.598 46.62		62.16	9.033	9.033	24.20		52.47	11.169	11.169 14.642	

TABLE.3 SHOWING STATISTICAL DESCRIPTION OF PHYSICAL PROPERITIES OF THE SOIL AT NZA

SITE NO.2 NZA	DEPTH	Bd (gcm)	Mc (%)	Porosity (%)	Sand (%)	Clay (%)	Silt (%)	Sand (%)	Clay (%)	Silt (%)	Textural Class	Silt/Clay ratio	Infiltration Ratio (%)	Aggregate Stability (%)	Shear strength (KN/M^2)
A_P	0-16	1.68	11.2	36.6	92	2.5	5.5	85.22	8.22	6.56	SL	0.8	46	42	102
A_B	16-45	1.62	11.7	38.87	93.6	3.2	3.3	84.1	7.99	7.91	S	0.9	44	42	92
B_{t1}	45-71	1.52	12.01	42.64	91.22	3.3	5.48	90.02	4.3	5.68	SCL	1.31	40	43	90
B_{t2}	71-94	1.41	12.51	46.79	83.1	9.7	7.1	75.25	13.2	11.55	SL	0.88	39	41	81
Bt_3	94-118	1.57	12.9	40.75	81.18	8.7	10.12	72.5	15.8	11.7	SL	0.74	39	40	71
Max		1.68	12.9	46.76	93.6	9.8	10.12	90.02	15.8	11.7		1.31	46	43	102
Min		1.41	11.2	36.6	81.6	2.5	3.3	72.25	4.3	5.68		0.74	39	40	71
Range		0.27	1.7	10.19	12	7.3	6.82	17.97	11.5	6.02		0.54	7	3	49.6
Mean		1.56	12.06	41.13	88.22	27.5	6.3	81.418	9.9	8.68		0.926	41.6	41.6	87.2
STDEV		0.223	1.029	3.465	5.059	3.095	2.261	6.529	4.084	2.507		0.200	2.872	1.019	10.5
COVAR		14.29	8.008	8.425	5.736	56.27	35.89	8.012	41.234	28.88		21.51	6.904	2.449	12.04

TABLE. 4 SHOWING STATISTICAL DESCRIPTION OF PHYSICAL PROPERITIES OF THE SOIL AT ORAIFITE

SITE NO.3 Ifite	DEPTH	Bd (gcm)	Mc (%)	Porosity (%)	Sand (%)	Clay (%)	Silt (%)	Sand (%)	Silt (%)	Clay (%)	Textural Class	Silt/Clay ratio	Infiltration Ratio (%)	Aggregate Stability (%)	Shear strength (KN/M^2)
A_P	0-19	1.47	12.02	44.53	90.8	7.2	2	88.24	8.04	3.72	SCL	0.46	56	57	117
A_B	19-42	1.42	12.25	46.42	90.2	5.1	4.7	87.77	9.04	3.19	SL	0.35	52	55	108
B_{t1}	42-69	1.42	11.9	64.42	87.8	7.4	4.8	90.2	7.05	2.73	S	0.39	50	49	102
B_{t2}	69-91	1.41	13.52	46.79	86.77	7.4	5.83	85.2	7.6	7.2	CL	0.94	48	46	96
Bt_3	91-115	1.39	14.55	47.55	85.25	6.2	8.55	86.44	7.55	6.01	S	0.8	45	41	81
Max		1.47	14.55	47.55	90.8	7.2	8.55	90.2	9.04	7.2		0.94	56	57	117
Min		1.39	12.02	44.53	85.25	5.1	2	85.2	7.05	2.73		0.35	48	41	81
Range		0.08	2.53	3.02	5.55	2.1	6.55	5	1.99	4.47		0.59	8	16	76
Mean		1.422	12.848	46.342	88.164	6.66	5.176	437.85	7.856	4.571		0.588	50.2	49.6	36
STDEV		0.026	0.598	0.996	2.081	0.898	2.111	1.692	0.6701	1.735		0.239	3.709	5.851	12.089
COVAR		1.831	4.959	2.149	2.360	13.48	40.78	1.932	8.529	37.96		40.51	7.388	11.79	11.993

TABLE. 5. SHOWING STATISTICAL DESCRIPTION OF THE SOIL CHEMICAL CHARACTERTICS AT EGBEMA

SITE NO.1 HORIZON	Depth (cm)	O.C (%)	O.M (%)	pH	Na (mol/kg)	Mg^{2+} (mol/kg)	K^+ (mol/kg)	Ca^+ (mol/kg)	TEB (mol/kh)	$Al3^+$ (mol/kg)	H^+ (mol/kg)	E.A (mol/kg)	E.C.E.C (mol/kg)	N (%)	P(PPM)
A_P	0-15	1.04	1.79	5.06	0.15	0.09	0.48	0.19	0.91	0.66	0.24	0.9	1.81	0.21	25.1
A_B	15-57	1.01	1.74	5.2	0.12	0.1	0.42	0.12	0.76	0.42	0.51	0.93	1.69	0.18	20.22
B_{t1}	57-89	0.97	1.67	5.04	0.1	0.21	0.52	0.21	1.04	0.32	0.82	1.14	2.18	0.17	21.44
B_{t2}	89-105	0.99	1.71	5.01	0.14	0.32	0.48	0.24	1.18	0.45	0.62	0.07	2.25	0.13	20
Bt_3	105-124	0.95	1.64	4.9	0.13	0.2	0.52	0.18	1.03	0.31	0.51	0.82	1.85	0.1	19.02
Max		1.04	1.79	5.2	0.15	0.32	0.52	0.24	1.18	0.66	0.82	1.14	2.25	0.12	25.11
Min		0.95	1.64	4.9	0.1	0.09	0.42	0.12	0.76	0.31	0.24	0.82	1.69	0.13	19.02
Range		0.09	0.015	0.3	0.05	0.23	0.1	0.12	0.42	0.35	0.54	0.32	0.56	0.08	6.09
Mean		0.992	1.71	5.042	0.128	0.184	0.484	0.188	0.984	0.432	0.54	0.772	1.956	0.158	21.16
STDEV		0.031	0.058	1.100	0.0173	0.1043	0.0369	0.0405	0.1407	0.124	0.1877	0.1179	0.22	0.0395	2.119
COVAR		3.55	3.4038	1.983	13.308	56.68	7.624	21.543	14.299	28.70	34.76	12.13	11.247	25.00	10.015

TABLE. 6. SHOWING STATISTICAL DESCRIPTION OF THE SOIL CHEMICAL CHARACTERTICS AT NTA

SITE NO.2 HORIZON	Depth (cm)	O.C (%)	O. M (%)	pH	Na (mol/kg)	Mg^{2+} (mol/kg)	K^+ (mol/kg)	Ca^+ (mol/kg)	TEB (mol/kh)	Al^{3+} (mol/kg)	H^+ (mol/kg)	E.A (mol/kg)	E.C.E.C (mol/kg)	N (%)	P(PPM)
A_P	0-16	1.05	1.81	5.4	0.17	0.08	0.47	0.81	0.9	0.52	0.62	1.14	2.02	0.22	23.24
A_B	16-45	1.02	1.76	5.5	0.19	0.09	0.42	0.17	0.87	0.51	0.59	1.1	1.97	0.19	22.44
B_{t1}	45-71	0.94	1.62	5.3	0.14	0.07	0.45	0.15	0.81	0.42	0.62	1.04	1.85	1.85	22.82
B_{t2}	71-94	0.92	1.59	5.08	0.15	0.1	0.37	0.15	0.77	0.32	0.52	0.84	1.61	1.61	21.01
Bt_3	94-118	0.82	1.41	4.99	0.14	0.11	0.44	0.14	0.83	0.31	0.49	0.8	1.63	1.63	21.01
Max		1.05	1.81	5.5	0.19	0.11	0.47	0.18	0.9	0.52	0.26	1.14	2.04	2.04	23.24
Min		0.82	1.41	4.99	0.14	0.07	0.37	0.14	0.77	0.31	0.49	0.8	1.61	1.61	21.01
Range		0.23	0.4	0.51	0.05	0.04	0.1	0.04	0.13	0.21	0.13	0.34	0.43	0.43	2.23
Mean		0.95	1.638	5.254	0.158	0.09	0.43	0.158	0.836	0.416	0.568	0.984	1.82	1.82	22.12
STDEV		0.0811	0.139	0.193	0.023	0.014	0.034	0.015	0.046	0.097	0.053	0.139	0.178	0.178	0.909
COVAR		8.537	8.476	3.676	14.557	15.56	7.907	9.375	5.502	23.32	9.298	14.184	9.780	9.780	4.109

TABLE. 7. SHOWING STATISTICAL DESCRIPTION OF THE SOIL CHEMICAL CHARACTERTICS AT IFITE ORAIFITE

SITE NO.3 HORIZON	Depth (cm)	O.C (%)	O. M (%)	pH	Na (mol/kg)	Mg^{2+} (mol/kg)	K^+ (mol/kg)	Ca^+ (mol/kg)	TEB (mol/kh)	Al^{3+} (mol/kg)	H^+ (mol/kg)	E.A (mol/kg)	E.C.E.C (mol/kg)	N (%)	P (PPM)
A_P	0-19	1.06	1.83	5.51	0.19	0.09	0.61	0.2	1.28	0.67	0.52	1.19	2.47	0.23	26.2
A_B	19-42	1.03	1.78	5.32	0.15	0.1	0.71	0.19	1.15	0.59	0.42	1.01	2.16	0.21	21.2
B_{t1}	42-69	0.99	1.71	5.01	0.16	0.08	0.42	0.19	0.85	0.51	0.66	1.17	2.02	0.18	24.2
B_{t2}	69-91	0.85	1.47	4.92	0.15	0.12	0.51	0.16	0.94	0.42	0.67	1.09	2.03	0.17	20.1
Bt_3	91-115	0.62	1.07	4.92	0.14	0.13	0.41	0.17	0.85	0.45	0.7	1.15	2	0.15	20
Max		1.06	1.83	5.51	0.19	0.13	0.81	0.2	1.28	0.67	0.7	1.19	2.47	0.23	26.22
Min		0.62	1.07	4.92	0.14	0.08	0.41	0.16	0.85	0.42	0.42	1.01	2	0.15	20
Range		0.44	0.76	0.59	0.05	0.05	0.4	0.04	0.43	0.25	0.28	0.18	0.47	0.08	6
Mean		0.19	1.572	5.136	0.158	0.104	0.572	0.182	1.014	0.628	0.594	1.122	2.136	0.188	22.4
STDEV		0.159	0.279	0.24	0.017	0.019	0.163	0.015	0.369	0.092	0.059	0.069	0.179	0.029	2.5
COVAR		17.47	17.75	4.67	10.63	19.00	25.597	8.333	45.33	17.36	12.04	6.273	8.380	15.26	10.9

Where O.C = Organic Content, Organic Matter, TEB =Total Exchangeable Base, E.C.E.C =Effective Cation Exchange Capacity

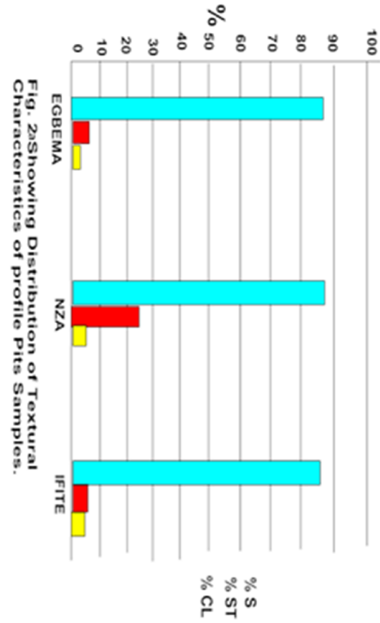

Fig. 2 Showing Distribution of Textural Characteristics of profile Pits Samples.

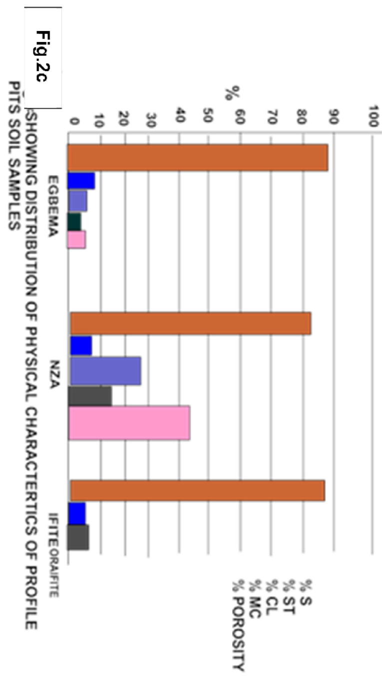

Fig.2c SHOWING DISTRIBUTION OF PHYSICAL CHARACTERTICS OF PROFILE PITS SOIL SAMPLES

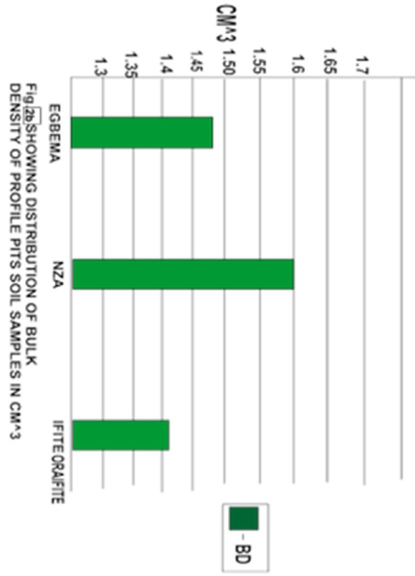

Fig 2a SHOWING DISTRIBUTION OF BULK DENSITY OF PROFILE PITS SOIL SAMPLES IN CM^3

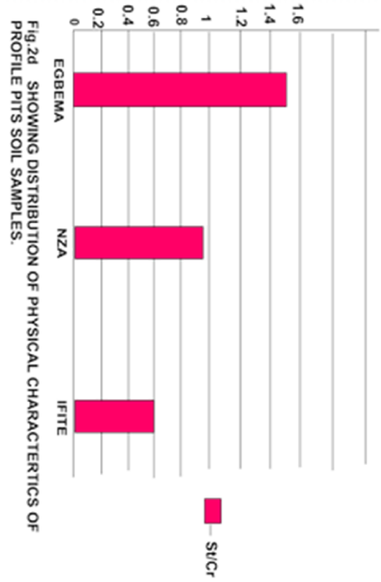

Fig.2d SHOWING DISTRIBUTION OF PHYSICAL CHARACTERTICS OF PROFILE PITS SOIL SAMPLES.

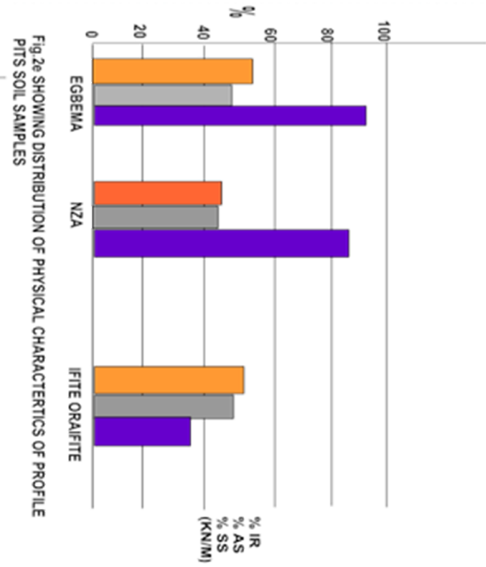

Fig.2e SHOWING DISTRIBUTION OF PHYSICAL CHARACTERTICS OF PROFILE PITS SOIL SAMPLES

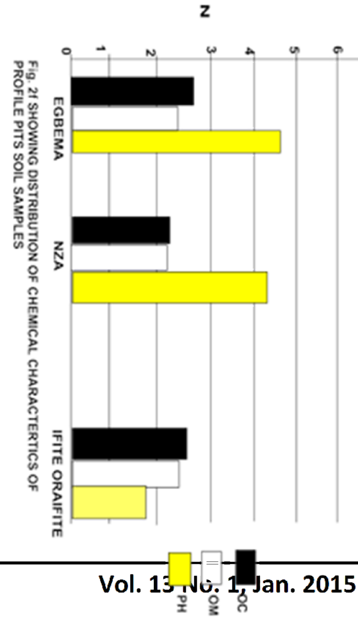

Fig. 2f SHOWING DISTRIBUTION OF CHEMICAL CHARACTERTICS OF PROFILE PITS SOIL SAMPLES

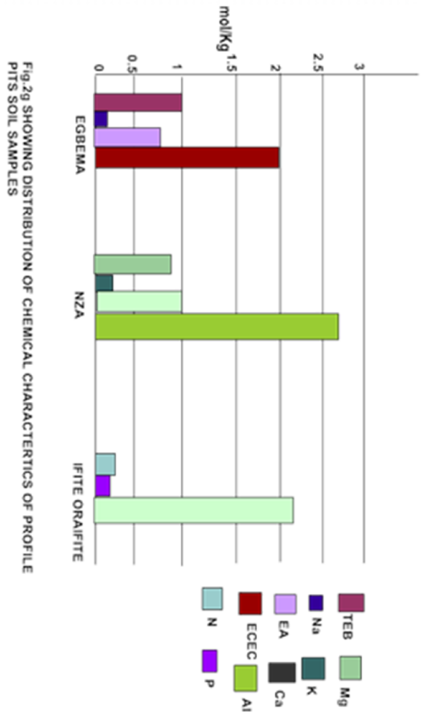

Fig.2g SHOWING DISTRIBUTION OF CHEMICAL CHARACTERTICS OF PROFILE PITS SOIL SAMPLES

4.1 Physical Properities

4.1.1 Bulk Density

There was slight increase in bulk density with in depth as observed in all three locations (profile pits). The mean bulk densities obtained are 1.45gcm^{-3}, 1.45gcm^{-3} and 1.42gcm^{-3} for Egbema, Nza and Ifitie Oraifite respectively as shown in (Table 3, 4 and 5). Nza has the highest bulk density which can be attributed to sand fraction which is as a result of high rainfall witnesses and its consequent leaching problem (Fig.2b).

4.1.2 Porosity

The mean porosity values are 44.982%, 41.13% and 46.342% for Egbema, Nza and Ifite Oraifite respectively. Porosity of less than 50% is not desirable so the poor porosity is attributed to high bulk density of soils of these locations (Table 3, 4 and 5) respectively.

4.1.3 Particle Size Distribution Of Sand

It revealed a dominance of sand fraction in all three locations through Ifite Oraifite has the greatest value. The mean value of sand is 82.718%, 81.418% and 437.85% for Egbema, Nza and Ifite Oraifite as shown in (Table 3, 4 and 5) respectively.

4.1.4 Moisture Content

The mean moisture content (%) obtained are 12.5%, 12.8% and 12.1% for Egbema, Nza and Ifite Oraifite respectively (Table 3, 4 and 5). Ifite Oraifite has the lowest value because of its poor structural stability as indicated by its highest sand content.

4.1.5 Clay Ratio

This is also known as mechanical ratio and according to Bouyouces(1935) a high clay ratio indicates a low structural stability. This is because it is ratio of sand over silt over silt plus clay. The mean clay ratio values obtained are 1.54, 0.93 and 0.58 for Egbema, Nza and Ifite Oraifite respectively (Table 3, 4 and 5).

4.2 Chemical Properties

4.2.1 $_{P}$H

The $_{P}$H mean values obtained are 5.042, 5.254 and 5.136 respectively for Egbema, Nza and Ifite Oraifite respectively (Table 6, 7 and 8). This indicates acidity rates very strongly acidic to strongly acidic. This is due to the constant leaching by rainfall which leaves the soil saturated with more Al^{3+} and H^{+} (Table 6, 7 and 8) respectively.

4.2.2 Organic Carbon

The mean value for organic carbon contained is 0.992, 0.95 and 0.19 % respectively for Egbema, Nza and Ifite Oraifite respectively. The low organic carbon content indicates low organic matter in all the three location as shown in (Table 6, 7 and 8) respectively.

4.2.3 Total Exchangeable Bases

The mean value are 0.98, 0.84and 0.81 mol/kg respectively for Egbema, Nza and Ifite Oraifite. The low value recorded was due to excessive rainfall and its consequent leaching action as shown in (Table 6, 7 and 8) respectively. Egbema has the highest value of total exchangeable base as shown in Fig.2g.

4.2.4 TOTAL EXCHANGEABLE ACIDITY

The mean exchangeable acidity values obtained are 0.984, 0.836 and 1.014 mol/kg respectively for Egbema, Nza and Ifite Oraifite respectively as shown in (Fig). This is quite higher than the exchangeable bases; hence there is a reason for the aciity nature of the soil as shown in (Table.5, 6 and 7) respectively.

4.2.5 EFFECTIVE CATION EXCHANGE CAPACITY

The mean values for ECEC are 2.96, 1.82 and 2.14 mol/kg respectively for Egbema, Nza and Ifite Oraifite as shown in (Table.). The ECEC of all the soils were of low values ranging from 1.96 – 2.14 which can be attributed to the low level of organic matter in these soils of the acid soils of southern Nigeria to the type of clay minerals found in the soils as shown in (Table.4, 5 and 6) respectively. Egbema has the highest effective cation exchange value as shown in Fig. 2g.

5 CONCLUSION

Result from the study revealed that soils formed over the afore mentioned soils are all erodible. This attributed to high annual rainfall amounting to 2000mm (Ofomata, 1964) which increase low structural stability as indicated by high sand fraction (%).This raises the dispersion ratio to above 15%. Soil PH, organic matter and effective exchangeable cation were all found to be low indicating that the soils are quite below their potential productivity level. There is also apparently low amount of cation as a result of low level of organic matter in the soil. The physical and chemical values of the soil influencing soil erodibility do not differ significantly. Since the soil charactertics are obtained from the same locality their properties are highly related. It was observed that soils in three areas are high in sand fraction and was generally low in clay content. It is therefore conclude from the above study that the relationship observed among the soils charactertics and soil erodibility could not have occurred by chance. Thus erodibility of soils is therefore significantly influenced by soil charactertics as shown in Table.1. From these observations one can conclude by saying that the erodibility of the soil in the study area is high.

6 RECOMMEDATIONS

Owing to the fact and considerations of the result of the study the following recommendations are hereby made:

- Practices such as mulching, alley cropping, minimum or zero tillage, cover cropping, crop rotation and high density, cropping which are all effective agronomic methods of controlling soil erosion should be practiced.
- Organic manure instead of fertilizer should be used during agronomic practices, this helps to stabilize the structure by improving the binding charactertics and compensating for soil nutrient loss, causes by high intensive rain and leaching
- Practices that will encourage vegetative cover on the surface should be applied and this will reduce surface runoff velocity, force of flow and transports capacity of flow, thereby encouraging sediment deposition. This practice is very important because of its high sand fraction (%) which indicates low aggregate stability, as it will reduce the direct current and impact of heavy rains with the soil surface.
- Finally from the statistical and laboratory analysis carried out, any factor that will increase the amount of sodium in the soil, increase soil $_{P}$H, decrease bulk density, decrease organic carbon and moisture content should be avoided. Mechanical structures can also be put in place to help silt trapping and vegetation establishment properly constructed drainage facilities should be built in the study area.

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