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A REVIEW OF SOIL ERODIBILITY
Case Study of UGBOJU Settlement of OTURKPO Local Government Area of Benue State Nigeria

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ABSTRACT

Soil sample from different areas of Ugboju settlement of Oturkpo local government area of Benue State comprising of Ogobia, Ondor and Ogoli were studied for their susceptibility to erosion. The main objective of the study was to determine the soil properties in relation to erodibility.

Fifteen Erosion sites, five each from the three communities were studied and soil samples collected from identified Erosion sites. Soil sampling and analysis constituted the primary data sources while secondary data were obtained from meteorological station of the Nigerian Air force, Technical air command, Makurdi.

The core chemical properties of the soils were PH, organic matter and So4, CI, Co3 Ions. Bulk density was found to range between 1.46g/cm³ to 2.85g/cm³, moisture content ranged from 1.4% to 18.4%, permeability of the soil samples was observed to be between 4.4 x 10^{-3} to 0.6 x 10^{-1} while porosity ranged from 10% to 37%. Specific gravity was found to have an average value of 2.7g/cm³, and shear strength was highest at 194.0 kpa and lowest at 5.1kpa.

Indices of Erodibility like Dispersion ratio (DR) modified clay ratio (MCR), Erosion ratio (ER) and water stable aggregates (WSA) were calculated Based on these results, some of the areas under consideration had poor moderate and high erodibility.

It is therefore recommended that control measures should be carried out on areas belonging to high and very high erodibility class, while areas belonging to low and moderate erodibility class should begin to introduce erosion preventive measures to avoid further degradation of the soil.

KEYWORDS: *Erosion ratio, Dispersion ratio, Modified ratio, Water stable aggregates etc*

INTRODUCTION

1.1 Background of the Study:-

In Nigeria where agricultural production is crucial to development, the livelihood of the majority of the population depends on this naturally abundant resource. Agricultural land use in Nigeria often results in the degradation of natural soil fertility and reduced productivity. Soil degradation under farming sometimes brings about soil erosion, sedimentation and leaching.

Soil erosion by general description is the loosening, removal and transport of soil material from one place to another (detachment, transportation and deposition). Because of this life threatening disaster to the lives of the residents,agricultural and general economics of these areas prone to erosion,this study became neccssary to see how possible suggestions could be made through scientific approach to avert this threat.

1.2 Area of study:-

Oturkpo is largely made up of Adoaka and Ugboju settlement Areas. The areas under study will be from three different places in Ugboju settlement (Ogobia,Ondor and Ogoli). With 95% of its populace comprising of Idoma-speaking people. Inhabitants of this area are mainly preoccupied with subsistence farming and trading.

Oturkpo Local Government Area of Benue State lie between latitude $6^{o}45'$ and $7^{o}15'$ North of the equator and longitude $7^{o}30'$ and 8'00 East. The Local Government Area is bounded by Kogi State in the West. Otukpo bounds Okpokwu and Ohimini from the East.

1.3 Statement of Problem:-

The erosion problem in Oturkpo local government Area of Benue State has developed over the years and come to the notice of local, state, national and international agencies like World Bank. Much ecological fund has been put in by these authorities to cob the devastation caused by this menace.

Soil erosion in Ugboju settlement of Oturkpo local government area of Benue State has resulted to:

i. Collapse of buildings
ii. Blockage and damage of sewage lines
iii. Damage to public water supply lines
iv. Washing away of township roads.
v. Washing away of farm lands
vi. Loss of lives and properties

1.4 Aim and objectives of the study:-

The main aim of this work is to determine the Erodibility of soils in Ugboju settlement of Oturkpo local government area of Benue state. The specific objectives include:

(i) To investigate the various soil properties and how they influence erodibility of soils in this area.
(ii) To provide indices for the determination of erodibility of soils of this area.
(iii) To predict soil losses by erosion under the same environmental condition.
(iv) To give recommendations for future occurrence.

1.5 Scope of the work:-

This research involves studies on properties of soil in Ogobia,Ondor and Ogoli area of Ugboju settlement of Oturkpo Local Government Area of Benue state. Five (5) undisturbed soil samples each were collected at profile dept of 1.7m in 5 different parts of the 3 areas (labelled A-E) making a total of 15 soil samples and subjected to laboratory analyses in the civil and Agricultural and Environmental Engineering Department of the University of Agriculture Makurdi to determine the hydrological, mechanical, chemical and engineering properties of the soil and how they influence the susceptibility of these soils to erosion. SSPS software package was used for the statistical analysis.

2.0 LITERATURE REVIEW

2.1. Soil :-

Soil is a mixture of minerals, organic matter, gases, liquids and a myriad of organisms that can support plant life. It is a natural body that exists as part of the pedosphere and it performs four important functions: it is a medium for plant growth; it is a modifier of the atmosphere; and it is a habitat for other organisms.

Soil is considered the "skin of the earth" with interfaces between the lithosphere, hydrosphere, atmosphere, and biosphere. Soil consists of a solid phase (minerals and organic matter) as well as a porous phase that holds gases and water. Accordingly, soils are often treated as a three-state system.

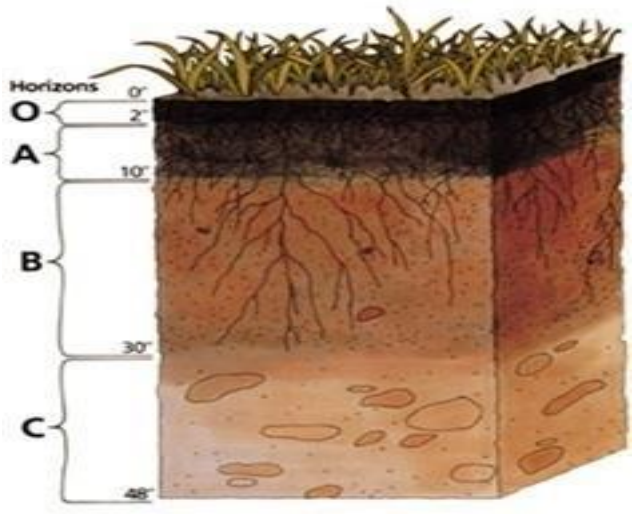


FIG.2.0 Soil profile

2.2 Soil Erodibility:-

Soil erodibility refers to soil resistance against detachment and transport of particles and aggregates. Erodibility is a function of soil texture, aggregate stability, shear strength, infiltration capacity, organic and chemical contents (Morgan, 2001). Generally, soils with faster -infiltration rates, higher levels of organic matter and improved structure have a greater resistance to erosion (Wall et al, 1987)

Soil with relatively low erodibility factor may show signs of serious erosion. Yet soil could be highly erodible and suffer little erosion (Nyakatawa et al, 2001). This is because soil erosion is a function of many factors as stated in the Universal Soil Loss Equation (USLE). These factors include rainfall factor (R), soil erodibility factor (K), slope length (LS), crop factor (C), and conservation practice factor (P). This is represented in the Universal Soil Loss Equation as:

A = RKLSCP ---------- (2.0)

Soil Erodibility indices (K_m) can be evaluated by calculating average annual values from measured soil losses (AM) for n consecutive years

($n \geq 6$) for each soil with field plots for soil erosion studies as

$$km = \sum_{i=1}^{n} \frac{Ami}{niRiLs} \text{ ---------- (2.1)}$$

Where A_m = Average annual values from measured Soil losses

n = Number of years for each Soil with field plots for Soil Erosion Studies.

Where LS is the topographic factor estimating the influence of the plots and calculated as:

$$LS = \left[\frac{\lambda}{22.13}\right]^{n} (0.065 + 0.045S - 0.0065S^2) \text{ ---------- (2.2)}$$

Where λ = Plots lengths

S = Slope

Profile particle fractions of sizes finer than 0.002mm and from 0.1 to 0.002mm needed for evaluating the term M, was calculated following the procedure developed by Rousseau (1997). The term b was determined from the routine soil morphological descriptions and the values of the term c were based on pedotransfer function (Rousseva, 2002)

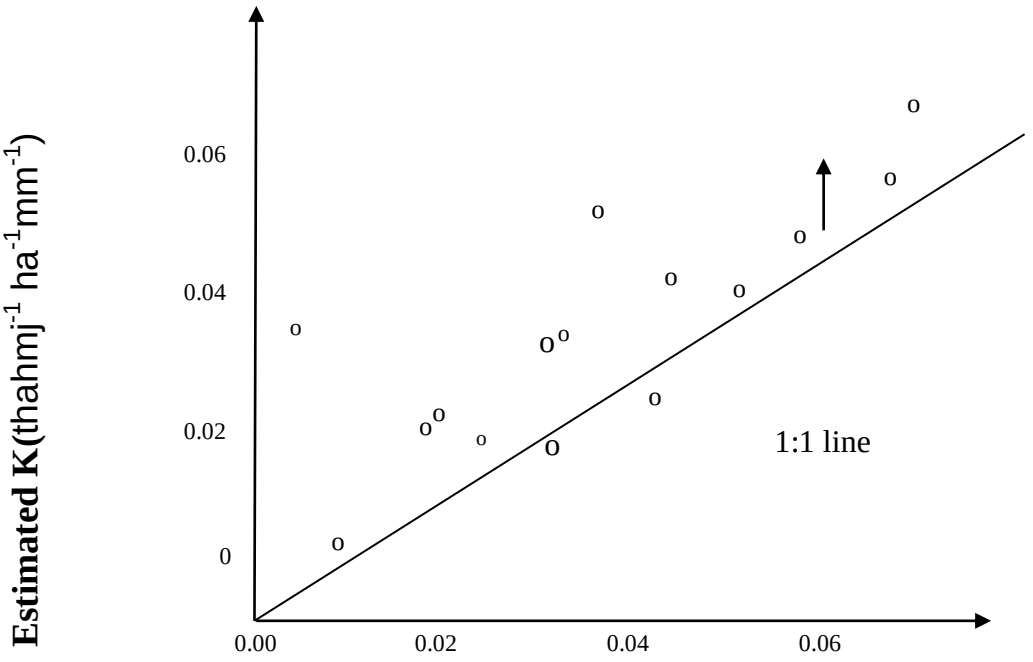
The soil erodibility nomograph (Wishmeier et al, 1971) was validated to enable calculations of the k – factor from routine outputs to the national soil survey. The measured values of K_m were compared to the estimates calculated by the analytical expression of the soil erodibility nomograph.

$K_m = 1.77 \times 10^{-6} M^{1.14} (12 - a) + 0.043 (b - 2) + 0.033 (4-c)$ ---------- (2.3)

Where:

M = soil texture parameter,
a = organic matter content,
b = soil structure class and
c = profile permeability class

The average annual values of K measured for field plots on Dystric - cambisol, Dystric planosol. 3 Haplic Kastonozems and 12 chromic luvisols varied from 0.005 to 0.060 t ha h mj^{-1} ha^{-1}mm^{-1}. The plot on fig. 1 illustrates the results of the validation test for the soil erodibility nomograph. The mean measured K was 0.025 t ha h mj^{-1}ha^{-1}mm^{-1} while the mean difference between the measured and the estimated values was 0.001 t ha h mj^{-1} ha^{-1}mm^{-1} with a standard deviation 0.003 t ha h mj^{-1} ha^{-1}mm^{-1}. The coefficient of determination between measured and estimated K – factors was 0.976. Thus it can be concluded that the soil erodibility nomograph expressed in equation (4) enables realistic evaluation of the k factor for the studied soils.



Measured K (t ha h mj^{-1} ha^{-1} mm^{-1})

FIG.2.1 Soil erodibility (K) estimated by equation 4.0 versus measured ones.

Table 2.0: Classification of Erodibility Class at different ranges of K

Group	K - Factor	Nature of Soil	Erodibility Class
I	0.0 – 0.10	Permeable well drain soil having stony substrata	Low
II	0.11 – 0.17	Well drain soils in sandy graded free material	Moderate
III	0.18 – 0.28	Poorly graved moderately fine and textured soil	High
IV	Above 0.28	Poorly graded silt or very sandy soil, well and moderately drain soil	Very high

Source: Chouliaras (2000)

4.0 RESULTS AND DISCUSSION

4.1.0 Soil samples:-

Five soil samples were collected from areas where erosion was observed in five different areas in each of the 3 communities making up the study area.

The soil samples were prepared and analysed to know the particle size distribution of the soil, the chemical properties as well as the physical properties of soils in the study area. The texture and colour of the soil samples were also observed. Results obtained from the moisture content test of the soil samples in the study area showed that most of the soils from the various areas making up the study zone have low moisture content ranging from 4.1% to 18.4% with Ogobia having the least percentage of moisture content.

The porosity of soils from the study area ranges from 2% to 40%. The highest porosity percentage observed at site B(Ondor) with 40% and the lowest at site A&C (Ogobia) with 2%. There seems to be a negative correlation between Bulk density and Porosity this could be attributed to compactness of the soil particles which reduces number of voids through which water can pass through. The specific gravity (Gs) of a substance is defined as the ratio of its mass in air to the mass of an equal volume of water at reference temperature of $4^{o}c$. The specific gravity test carried out on the soil samples showed the results ranging from $2.43g/cm^3$ to $2.83\ g/cm^3$ with an average of $2.7\ g/cm^3$. This value is comparatively low to that of soils like loamy soils which have very stable aggregates and are less susceptible to erosion. Results from the particle size analysis showed that most of the soil samples were more of silty sand that is, having a diameter of 0.06mm to 2.0mm. An observation of the results of the unconfined strength of the soil samples from the study area indicates values as low as 6.2kpa and as high as 194.0kpa. The clay content had the highest being 22% and lowest 0%.

Results obtained from the calculation of the dispersion ratio (DR) showed values of DR ranging from 0.52 to 0.74 with average value of 0.58. While the lowest value of 0.52 was found in soil samples from site E(Ogoli) and site B(Ondor) the highest value was found from site D(Ogobia).

5.0 CONCLUSION AND RECOMMENDATIONS

This study looked at the various soil properties in relation to their degree of influence on soil's susceptibility to erosion. The parameters studied include: grain size, specific gravity, permeability, porosity, shear strength, bulk density, moisture content and pH. Results from this analysis showed that:

i. Most of the soil samples were predominantly of sand and silt making the soil to be classified as silty sand soil.
ii. Permeability results showed that the soils were highly permeable. High permeability reduces the shear strength of the soil particles making them vulnerable to the shear stress of water.
iii. The shear strength of the soil samples in some area was averagely low, this suggest that the resistance of the soils from these area was low. Results of the moisture content and clay content were also found to be low which also is an indication that the soil is loose, has little or no binding properties to make the soil particles cohesive and less vulnerable to the forces of erosion.
iv. Dispersion Ratio (DR), Modified Clay Ratio (MCR) and Erosion Ratio (ER) where high , while Water Stable Aggregates (WSA) which can offer resistance to the shearing force of water was low which suggests that soils from the study area are vulnerable to erosion even though at various degree of susceptibility.
v. Erodibility factor (K) was determined and Annual soil losses in this areas where predicted with areas like siteA(Ogobia), having the highest value of erodobility factor (K) of (0.32) and the highest predicted soil loss of (65 Ton/Ha /Yr) while areas like siteA & B (Ogoli) and siteB(Ondor) had the lowest (K) values and predicted soil loses respectively
vi. A strong positive correlation was found to exist between soil loss, Dispersion Ratio, Modified Clay Ratio, while a negative correlation existed between soil loss, ER and WSA

5.2 Recommendations:-

(i) Control measures should be put in place in areas that are highly susceptible to erosion to avoid more soil loss and further development of gullies.
(ii) Deforestation should be discouraged in this area as removing this natural soil cover which also provides organic matter and cohesion of soil particles leaves the soil exposed as most of the soils in that area are sandy and silty;
(iii) Further studies are recommended to compare erodibility from different land uses; to know which land use

can ameliorate land degradation most.

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