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Research Article

EVALUATION OF ERODIBILITY STATUS OF SOILS IN SOME AREAS OF IMO AND ABIA STATES OF NIGERIA

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ABSTRACT

In this study, the erodibility indices and some soil properties of some cassava farms in selected areas of Abia and Imo States were investigated. This study involves taking measurements of some soil parameters such as permeability, soil texture and particle size analysis from which the erodibility indices were compared. Results showed that soils of the areas are very sandy. The results showed that Isiukwuato with index of 72 has the highest erodibility index. The results also showed that Arondizuogu with index of 34 has the least erodibility index. The results revealed that soil erodibility (k) values varied from 34 to 72. Nkporo has the highest sand content, Inyishie has the least silt content. The result indicates that there were respectively strong inverse relationship between clay and silt contents and erodibility index. On the other hand, sand, organic matter and moisture contents as well as soil permeability has significantly high positive correlation with soil erodibility and it can be concluded that particle size distribution is a major finger print on the erodibility index of soil in the study area. It is recommended that safe cultural practices like crop rotation, matching and adoption of organic farming techniques be incorporated into farming communities of Abia and Imo States in order to stem the advances of erosion in the study area.

KEYWORDS: Erodibility, indices, soil, sand

INTRODUCTION

Soil erosion refers to the detachment and transportation of soil particles by water, wind or gravity (1). Water and wind are the major driving forces of erosion. The steady and slow processes that occur in nature such as geomorphologic processes cause non-destructive type of erosion, and this type is not detrimental to man's well-being and is wholly beyond his control (11). Erosion due to man's activity such as deforestation, leveling and cultivation results in accelerated erosion. Erosion is triggered by a combination of factors such as steep slopes, climate (e.g. long dry periods followed by heavy rainfall) and cover patterns (e.g. sparse vegetation and ecological disasters (e.g. forest fire) (2). Some intrinsic features of a soil can also subject it to erosion (e.g. a thin layer of topsoil, salty texture or low organic matter content). Erosion that has gone past the rill stage and developed into deep gullies are generally irreversible. Soil moved by erosion carries nutrients, pesticides and other harmful chemicals into rivers, streams and groundwater resources leading to pollution and siltation of surface water bodies as well as cause drastic reduction of water volume and eventual siltation and drying up of rivers, water reservoirs and dams (2). Taking steps to preserve the quantity of global soil resources should require no justification. Our future ability to feed ourselves and to live in an unpolluted environment depend our ability to understand and to reduce the rates at which our soils are currently eroding. USLE (the universal soil loss equation) is the most widely

used model for prediction of water erosion hazards and planning of soil conservation measures. It was adopted in 1958 by the soil conservation service in the USA to make long-term assessments of soil losses under different cropping systems and land management practices. On the basis of a considerable experience with more than 10,000 plots, 20 years later an updated equation was formulated in which k, the soil erodibility factor, is expressed as the average soil loss per unit of applied external force of energy. USLE namograph (19) was applicable to tropical soils that have kaolinite as the dominant clay mineral, but less applicable where vertisols dominante (15). In order to improve USLE, the revised universal soil loss equation (RUSLE) was developed, which is more adaptable to tropical climates easier than other existing models. Although RUSLE is an empirically based model, developed to predict water erosion in temperate climates, it is more diverse and includes data bases unavailable when the USLE was developed (15).
Although a great deal of research has been done on soil erodibility, there are still several obstacles restricting the research of soil erodibility. Many erosion studies have concentrated on disturbed, homogenized “agricultural” soils and gentile slopes where natural soil profile features have been homogenized thus suppressing some important properties and processes in geomorphology and hydrology (12, 6 and 3). The problem of soil erosion especially in the south-eastern part of Nigeria is enormous. This problem is affecting the development because infrastructure such as houses, roads and many others are being destroyed yearly and this in turn constitutes an environmental menace. To effectively tackle this problem, there is a need to evaluate those factors of soil that affect erosion.

The aim of this research was to determine the erodibility status of soils in some areas of Imo and Abia States to know their susceptibility to erosion and proffer suitable techniques in controlling the growing menace of soil erosion in the area. The research was focused on estimate the erodibility status using regression equation and correlating the data generated from the analysis of the physiochemical properties of the soil to erodibility index.

METHODOLOGY

Study Area

The study area which comprises of Abia and Imo State is located between latitude $40^0 40^1$ and $80^0 15^1$N and longitudes $6^0 40^1$ and $8^0 15^1$E (5). The major geological formations include alluvium, coastal plains sand (Benin formation), shale (Bendel Ameki formation), lower coal measures (Nsukka formation) and false-bedded sandstones (14). The study area is dominated by plains and lowlands (13). Abia and Imo State have humid climate, with wet season lasting for 9 months (10). The vegetation of the study area is dominated by forest (7) and soils were predominantly sand. The sandy nature of the soil reflects the parent materials from which they were formed which is coastal plain sand (4, 18). Farming is a major socio-economic activity. Farm location (Table 1) was measured using global positioning system (GPS). The farm delineation were the located at Abiriba,Akwette,Amamba,Atta,Arochukwu,Arondizugo,Bende,Iho,Ihube,Inyishi,iIkuano.Isiukwauato,Item,Mbieri,Nkporo,Ogwa,Ohafia,Oguta,Okeikpe,Orodo,Owerri,Owerri nta Ukwa,Umuahia and Uturu.

Soil Sample collection and Analysis

On each farm, a transect was run transect (Figure 1) was run to capture the morphology of the farm as it affects soil conservation. Soil samples collected from all section of the farm were bulked to form composite soil samples per location, which were later air-dried and sieved using 2mm mesh sieve for laboratory determinations. Soil samples were collected at random positions at meter distance apart. Four quadruple samples at 15meters depth except in fallow land where triplicate soil laboratory

Standards methods were employed to analyze the collected soil samples for water stable aggregates, mean weight diameter, particle size analysis, steady state infiltration rate, saturated hydraulic conductivity and soil organic carbon.

Figure 1: Erosion Stake

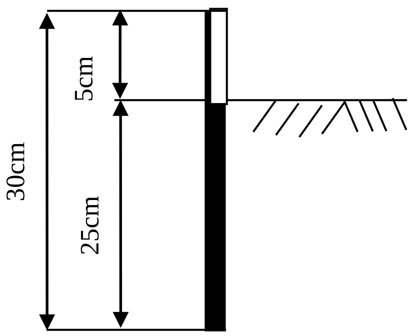


Figure 2: Location Map of the Study Area

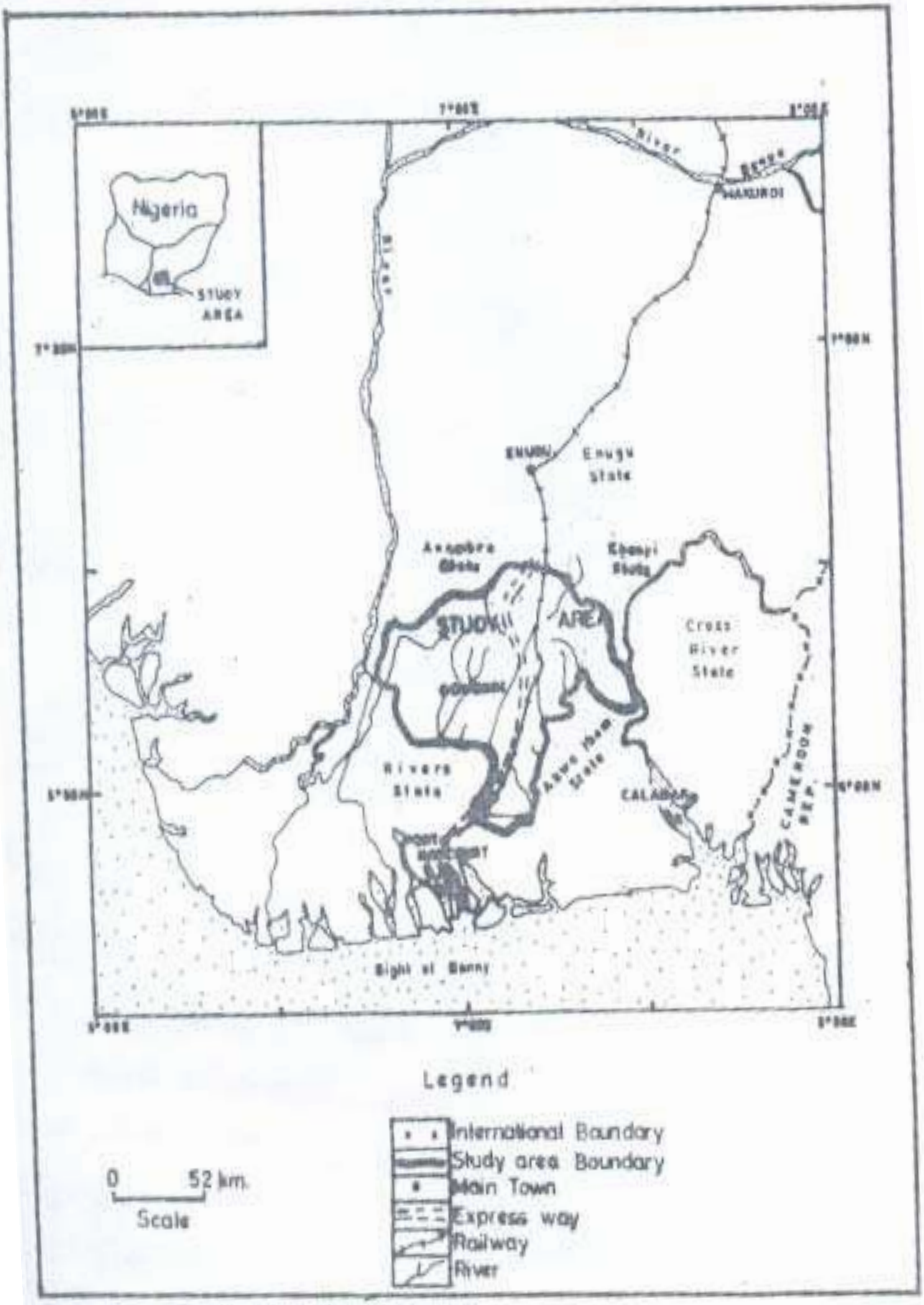


Fig. 1 Location map of the study area

Table 1: The Latitude and Longitude of the Sampling Points

Station	Latitude	Longitude
Umuahia	$5^{\circ}31^{1}$	$7^{\circ}29^{1}$
Owerri	$5^{\circ}29^{1}$	$7^{\circ}03^{1}$
Owerrinta	$5^{\circ}18^{1}$	$7^{\circ}17^{1}$
Ogwa	$5^{\circ}38^{1}$	$7^{\circ}05^{1}$
Bendel	$5^{\circ}33^{1}$	$6^{\circ}39^{1}$
Oguta	$5^{\circ}43^{1}$	$7^{\circ}48^{1}$
Okeikpe	$4^{\circ}53^{1}$	$7^{\circ}20^{1}$
Ohafia	$5^{\circ}38^{1}$	$7^{\circ}49^{1}$
Uturu	$5^{\circ}49^{1}$	$7^{\circ}27^{1}$
Abiriba	$5^{\circ}41^{1}$	$7^{\circ}44^{1}$
Arochukwu	$5^{\circ}23^{1}$	$7^{\circ}55^{1}$
Arondizuogu	$5^{\circ}53^{1}$	$7^{\circ}11^{1}$
Atta	$5^{\circ}36^{1}$	$7^{\circ}08^{1}$
Orodo	$5^{\circ}38^{1}$	$7^{\circ}03^{1}$
Item	$5^{\circ}45^{1}$	$7^{\circ}09^{1}$
Akwaette	$4^{\circ}53^{1}$	$7^{\circ}21^{1}$
Amaba	$5^{\circ}42^{1}$	$7^{\circ}33^{1}$
Nkporo	$5^{\circ}46^{1}$	$7^{\circ}16^{1}$
Ukwa	$4^{\circ}53^{1}$	$7^{\circ}15^{1}$
Isikwuato	$5^{\circ}55^{1}$	$7^{\circ}31^{1}$
Ikwuano	$5^{\circ}27^{1}$	$7^{\circ}33^{1}$
Ihu	$5^{\circ}35^{1}$	$7^{\circ}06^{1}$

Nonographic Estimation of Soil Erodibility

For this study the use of regression equations describing the relationship between k and soil physicochemical properties was adopted. The nomograph developed by (19) expressing the relationship between k and soil properties is based on the following equation.

$$K = 2.77M^{1.14}(10^{-7})(12-\alpha) + 4.28(10^{-3})(\beta-2) + 3.29(10^{-3})(\gamma-3) \quad (1)$$

where m = (% silt – veryfine sand) (100-%clay)

α = organic matter %)

β = structure code (very fine granular =1, fine granular = 2 coarse granular = 3, blocky platy or massive = 4)

ϒ = permeability class (rapid = 1, moderate to rapid = 2, moderate = 3, slow to moderate = 4, slow = 5, very slow = 6). The soil erodibility is normally classified into the following groups; very high > 0.45, high = 0.35-0.45 moderate = 0.25-0.35, low to very low = < 0.2 based on classes of values for erodibility (2). For determination of K using the nomograph, the grain size distribution, organic content, structure and permeability class of the soil would have to be known. Correlation analysis was also performed to determine the relationship between the physicochemical properties and erodibility.

RESULTS

Higher organic carbon of some part of the study area could be a response to the density of predominant vegetation as (7) had previously classified the site into dense rain forest (south) and sparse forest (north). In particle size distribution, sand-sized fractions predominated followed by clay content. This is consistent with report of (8) while silt-sized particles were lower in content (9). The clayey nature (Table 2) of soils from Arondizuoge, Bendel, Nkporo and Arochukwu is attributable to shale parent material from where they were derived. Pearson correlation analysis results showed significant correlations among erodibility indices and certain soil properties such as clay and sand fraction of soils (-0.633 and 0.504) (Figures 3, 4, 5, 6, 7 and 8). The results showed that Isiukwuato with index of 72 has the highest erodibility index. The results also showed that Arondizuogu with index of 34 has the least erodibility index. The results revealed that soil erodibility (k) values varied from 34 to 72. Nkporo has the highest sand content; Inyishie has the least silt content. When (16) evaluated soil erodibility using natural rainfall and by nomographic charts in sub-mountainous tract of Purfab area of India, the results revealed that soil erodibility (k) values varied from 0.33 to 0.67 under natural rainfall conditions; 0.13 to 0.34 for farms. The result (Figures 3 and 4) indicates that there were respectively strong inverse relationship between clay and silt contents and erodibility index. This suggests that increases in clay and silt lead to decrease in soil erodibilty and this is not in harmony with sustainable crop production since clay minerals play important role in soil fertility status of a given location. On the other hand, sand, organic matter and moisture contents as well as soil permeability (Figures 5, 6, 7 and 8) has significantly high positive correlation with soil erodibility. More so, with over 60 percent of the geology being coastal plain sands, fluvial, alluvium, incrustine marine deposit locations, organic matter was higher in Mbaitolu than Ikeduru .

Figure 3: Relationship between clay content of soils and erodibility index in farmlands in Imo and Abia States

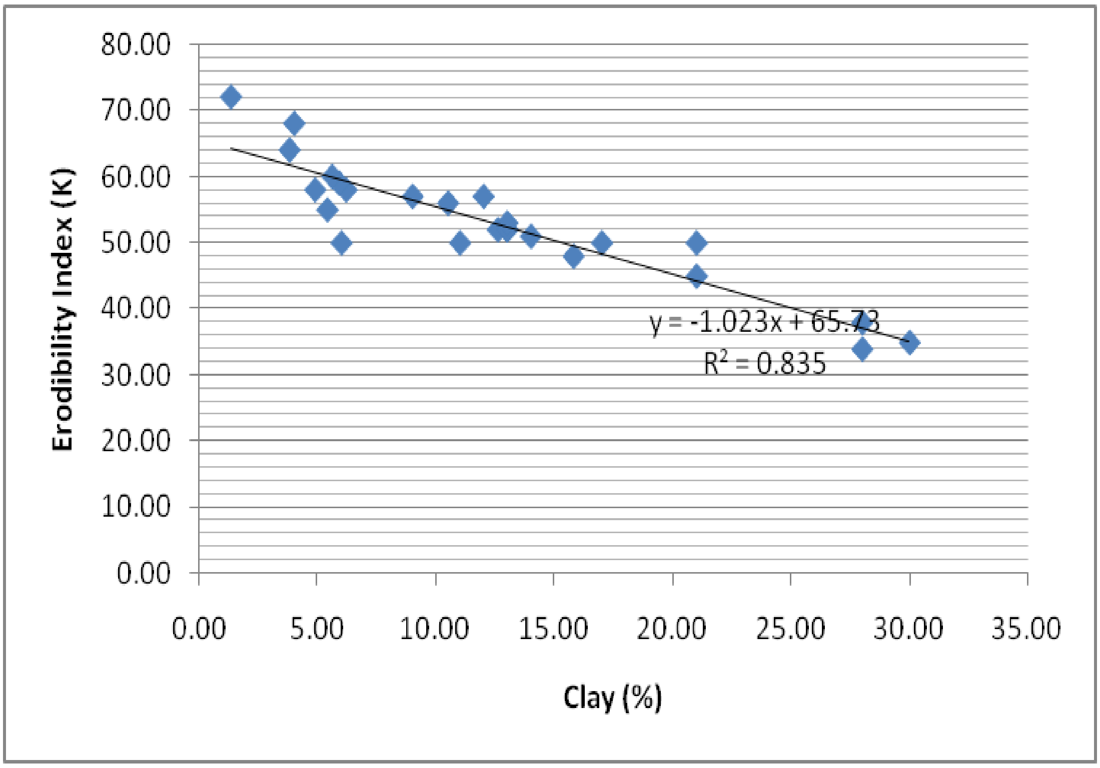


Table 2: Results of Analysis of Soil Physical Properties

LOCATION	Clay (%)	Silt (%)	Sand (%)	Organic Matter (%)	Moisture Content (%)	Permeability	Erodibility Index (K)
Abiriba	13.00	4.00	83.00	0.120	10.00	3.04	52.00
Akwette	12.00	3.00	85.00	0.211	16.10	3.61	57.00
Amamba	6.20	2.00	92.00	0.210	19.80	3.21	58.00
Atta	5.90	4.60	90.00	1.150	20.00	3.00	59.00
Arochukwu	28.00	21.00	48.00	0.019	5.00	1.07	38.00
Arondizugo	28.00	10.00	54.00	0.210	8.00	3.01	34.00
Bende	5.40	7.00	38.00	0.196	14.00	3.01	55.00
Iho	5.60	12.40	86.00	1.300	11.80	4.67	60.00
Ihube	14.00	8.00	78.00	0.106	7.00	2.00	51.00
Inyishii	3.80	1.00	94.80	1.700	19.80	4.53	64.00
Ikuano	4.88	1.60	80.80	0.670	14.60	4.05	58.00
Isiukwauato	1.33	2.90	95.80	1.620	22.50	5.78	72.00
Item	17.00	4.50	80.00	0.114	4.30	2.20	50.00
Mbieri	12.60	9.20	78.20	0.150	12.40	2.10	52.00
Nkporo	30.00	22.00	60.00	0.215	12.00	3.20	35.00
Ogwa	15.80	8.00	76.20	0.021	4.50	2.50	48.00
Ohafia	21.00	5.00	74.00	0.116	5.00	2.03	50.00
Oguta	9.00	2.60	87.00	0.211	13.40	3.61	57.00
Okeikpe	13.00	4.00	83.00	0.200	12.30	3.01	52.00
Orodo	10.50	9.30	80.20	0.151	8.40	2.40	56.00
Owerri	11.00	10.50	84.00	0.210	6.80	2.80	50.00
Owerrinta	6.00	8.00	86.00	0.120	10.00	4.01	50.00
Ukwa	4.00	1.50	97.12	0.321	20.00	4.21	68.00
Umuahia	21.00	10.40	72.00	0.215	7.50	1.09	45.00
Uturu	13.00	12.40	82.00	0.184	8.00	3.00	53.00

Figure 4: Relationship between silt content of soils and erodibility index in farmlands in Imo and Abia States

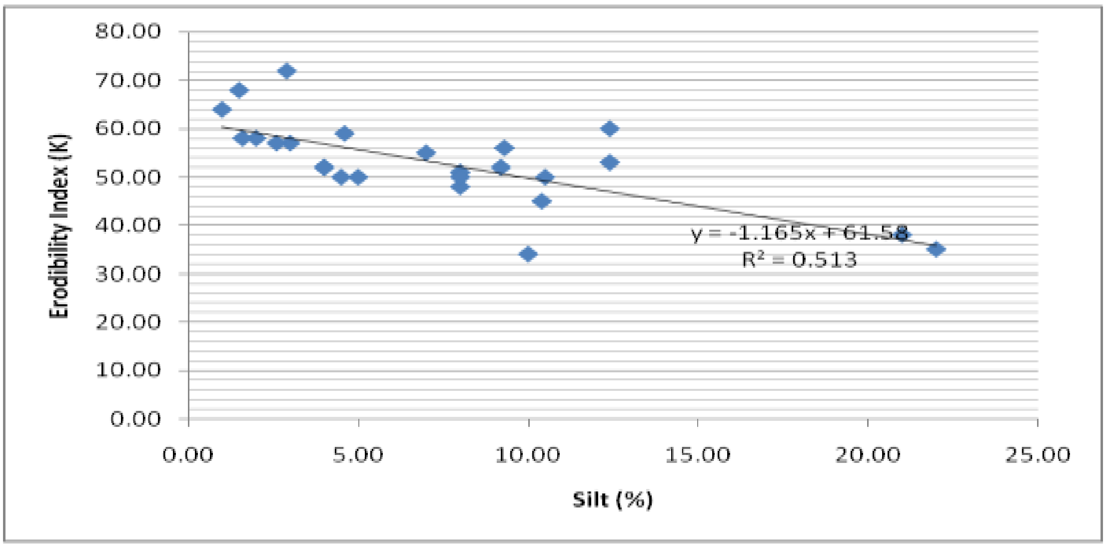


Figure 5: Relationship between sand content of soils and erodibility index in farmlands in Imo and Abia States

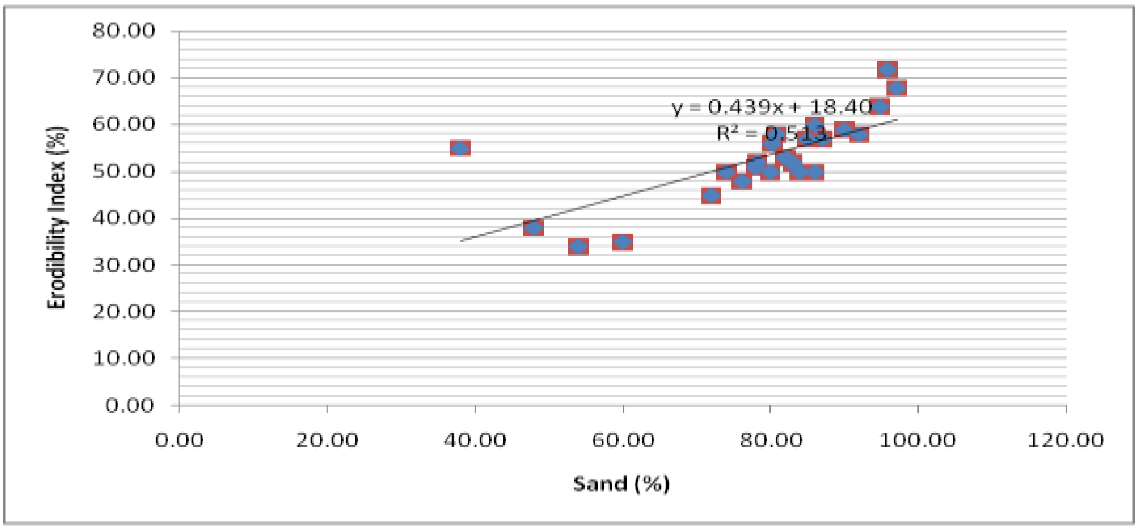


Figure 6: Relationship between Organic Matter content of soils and erodibility index in farmlands in Imo and Abia States

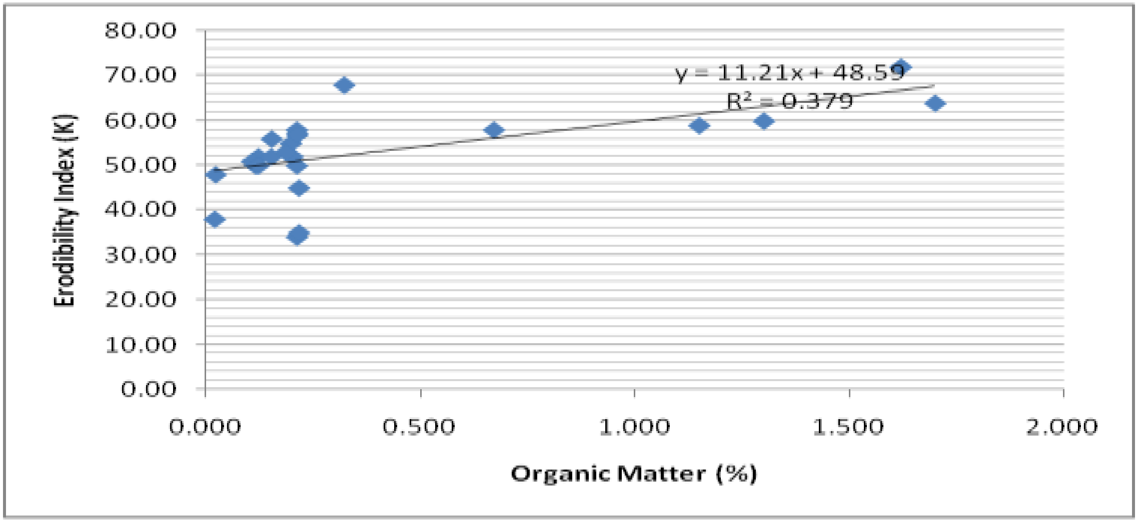


Figure 7: Relationship between Sand Content of soils and erodibility index in farmlands in Imo and Abia States

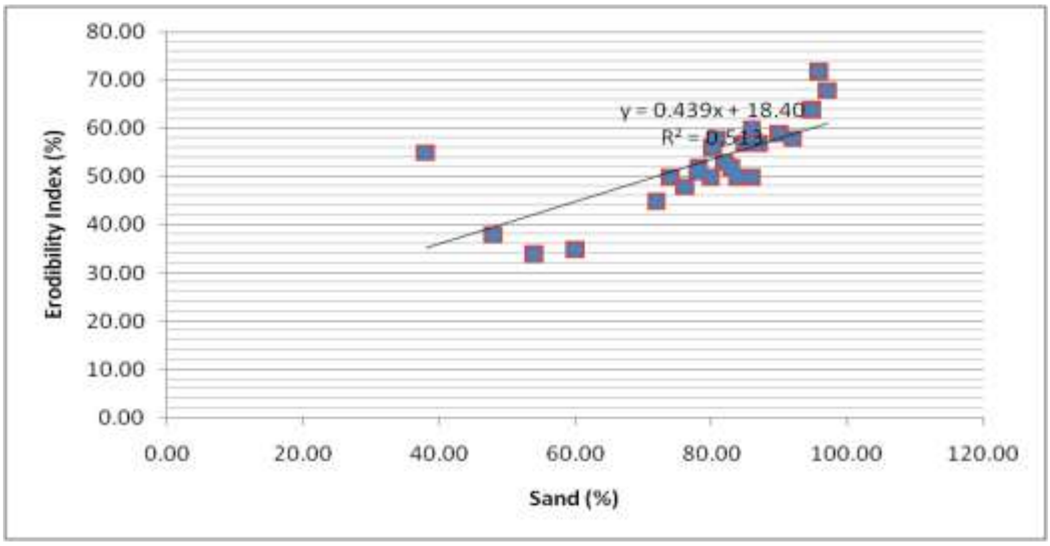


Figure 8: Relationship between Moisture Content of soils and erodibility index in farmlands in Imo and Abia States

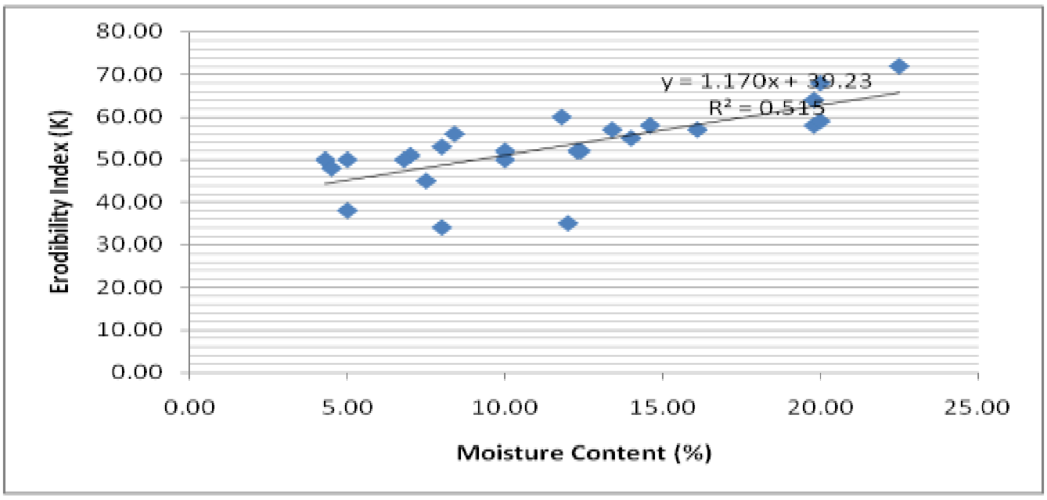
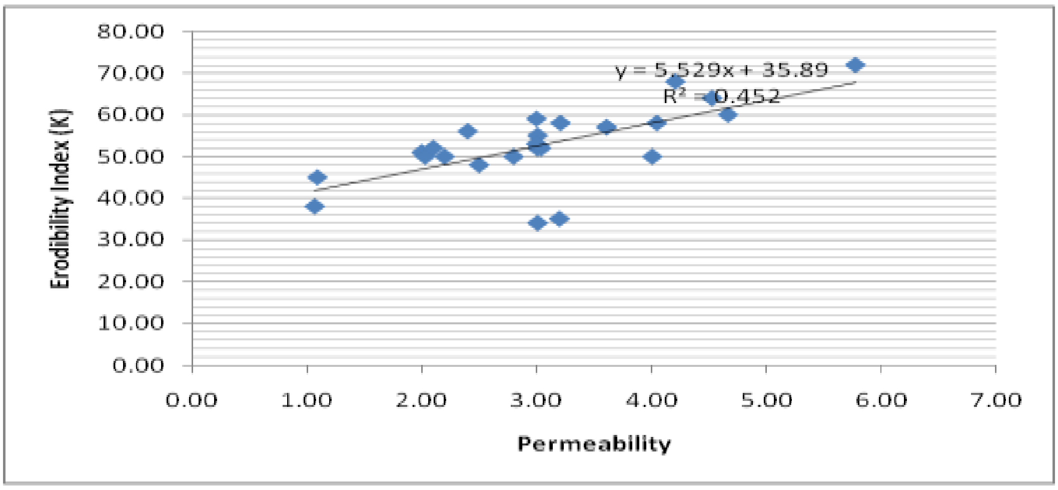


Figure 9: Relationship between Permeability of soils and erodibility index in farmlands in Imo and Abia States



CONCLUSION

The determination of erodibility status of soil in some communities in Imo and Abia states was conducted and from various results obtained, it showed that the soil in the communities are mainly sandy soils. The study revealed that the erodibility status of Isiukwuato have the highest erodibilty index of 72 and Arondizuogu has the least value of 34. Soil samples with higher percentage of sand has higher erodibilty status and those with high clay content having lower erodibility status and it can be concluded that particle size distribution is a major finger print on the erodibility indices of soil in the study area. However, the overall results of the research conducted in Abia and Imo States showed that erodibilty status is generally varied from 34 to 72. This implies that the extensive destruction of the physical character of the soil through erosion will limit the other uses of the land like urban and rural infrastructural developments. It is recommended that safe cultural practices like crop rotation, matching and adoption of organic farming techniques be incorporated into farming communities of Abia and Imo States in order to stem the advances of erosion in the study area. Vegetation is the key to the prevention of soil erosion. If all soils were perpetually covered with mature forests or grasses, accelerated erosion would not be a problem. So there is need to discourage deforestation and also in areas where the erodibility indices were high, there is need to plant crops like leguminous species in order to add nutrients to the soil as well as checking the soil erosion.

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