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Assessment of the Soil Erodibility Index of Enugu State University of Science and Technology, Agbani Campus

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Abstract
The havoc orchestrated by soil erosion and degradation in numerous locations of Eastern Nigeria are frightening and constitute a severe threat to life and economic operations of the region. This study investigated the soil erodibility index of Enugu State University of Science and Technology, Agbani Campus. Soil samples were randomly collected using soil augar at varying depths of 0-30cm, 31-60cm, 61-90cm from five different locations in the Enugu State University of Science and Technology (ESUT), Agbani and analyzed for structural class index, soil permeability class index, organic matter content, % silt + % very fine sand +% sand (100 % clay) from which soil erodibility indices were calculated and soil erosion loss ascertained. The result of the analysis revealed that location B (ESUT Access Bank/ICT area) had the highest K value of 0.07 with low mean clay content and location E (ESUT Engineering Complex axis) had the lowest K value of 0.03 with the high mean clay content. The average erodibility index was calculated to be 0.05 for ESUT, Agbani. The location B (ESUT Access Bank/ICT area) had the highest calculated erosion loss value of 165.14 tons/ ha/yr and it is therefore recommended that the soil depth which covered the first 60cm should be protected by the use of adequate conservation structure, drainage facilities.

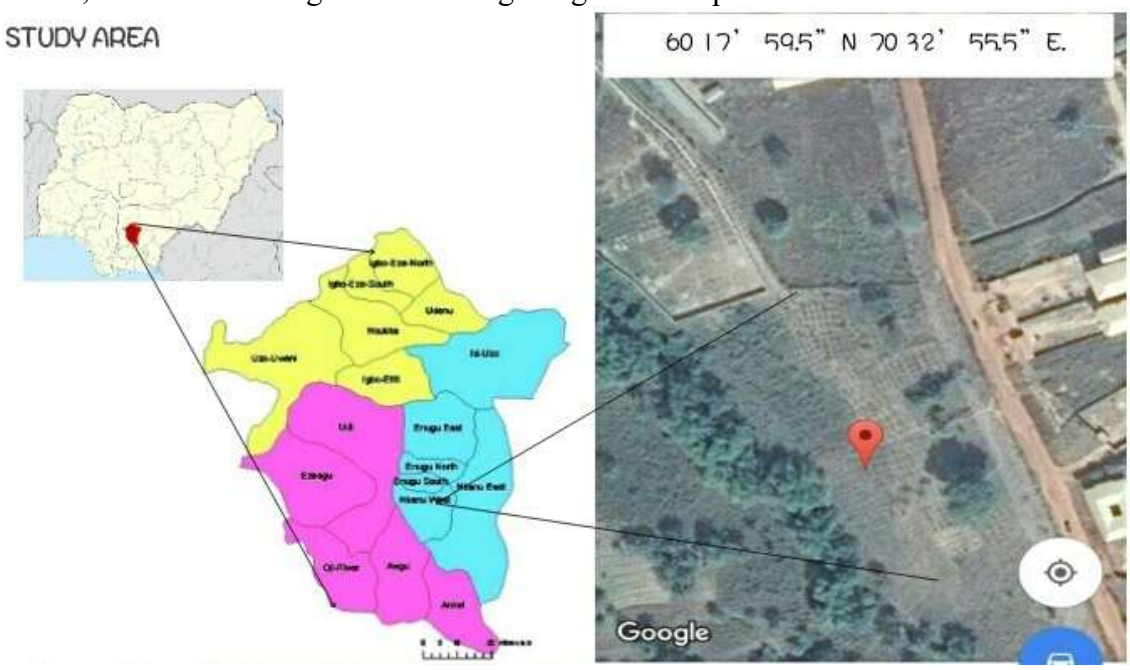
1.0 Introduction

Understanding soil erodibility is crucial for soil conservation and land management, as it helps in predicting erosion risks and implementing effective preventive measures. Soil erosion is a major environmental problem worldwide is the process by which the top layer of soils are detached, transported and deposited to a new location due to natural forces like wind, water, or anthropognic activities. Soil erosion can lead to land degradation, loss of fertile soil, and environmental problems like sedimentation in rivers and reduced agricultural productivity. It does not only cause severe land degradation and soil productivity loss, but, also threatens the stability and health of the society in general and sustainable development of rural areas in particular. Soil erodibility refers to the inherent ability of soil to resist erosion by water or wind. It is influenced by soil properties such as texture, structure, organic matter content, and permeability. Soil erodibility plays a key role in determining how susceptible a particular soil type is to detachment and transportation under erosive forces. While some soils, like clay or well-structured soils, exhibit low erodibility due to their cohesive nature, others, such as silty or loose sandy soils, are highly erodible and require additional protective measures. Soil with high erodibility index will suffer more erosion than a soil with low erodibility index both are exposed to the same rainfall event. Hence, this research work focuses on the determination of soil erodibility index of Enugu State University of Science and Technology, Agbani

2.0 Methodology

2.1 Study Area

The study area which Enugu State University of Science and Technology, Agbani lies on the latitude of 6^0 $17^0$59.5^{0}N and longitude 7^0 32^0 55.5^{0}E in rainforest area of South East agricultural zone of Nigeria (Agroclimatic data 2007). The area cover about 100,000m^2 and lies at about 37 kilometer 46min East of Agbani, in Enugu State. It has a humid tropical climate with marked wet season which is warm, oppressive and overcast, the dry season which is hot, muggy and cloudy. The rainy season starts from March to October and the dry season starts from November to February. The average annual rainfall for ESUT, Agbani ranges from 1500mm to 2000m within (10) years period (Agroclimatic data, 2007). The rainy seldom 1744mm has its peak occurring irregularly between July and September. Sometimes a little break is experienced in the month of August.. The average annual temperature of ESUT Agbani is 85^{0}F. The main average annual evaporation (pitche) from the ten years data is 301mm, and the main annual sunshine in hours is 3357hrs throughout the year and daylight varies from11hrs 45min to 13hrs 28min per day. While that of radiator is 3.9m, the geology of the study area is morphometric and pebble to the formation of sandstone texture.The agricultural land use is arable crop production, livestock farming and marketing of agricultural produce.



Map of Enugu State indicating the geographical location of the study area

2.2 Sample Collection and Laboratory Analysis

The soil samples were collected randomly from the designated study sites using soil auger at varying depths of 0-90 cm to determine the soil erodibility according to method proposed by Wischmeier and Smith (1963).

The soil samples were collected with ploy bags, air dried and sieved with 2.0mm mesh upon arrival at the laboratory for analysis.

Table 2.1: Samples collection depths and locations

Plot Identification	1st Depth (cm)	2nd Depth(cm)	3rd Depth (cm)	Sample Location
	0-30	31-60	61-90	
A	1	2	3	ESUT Engineering Lab Complex
B	4	5	6	ESUT Access Bank/ICT Complex
C	7	8	9	ESUT Football Field
D	10	11	12	ESUT Post Graduate School Complex
E	13	14	15	ESUT Engineering Complex

3.0 Results

3.1 Soil Structural Class Indices

The structural class indices of all the soil analyzed revealed that location B has the highest average structural class index of 4.0 whereas location E has the lowest average structural class index of 2.67. It was discovered that location A, C and D showed the same average structural class index of 3.33.

3.2 Permeability class indices (P)

The permeability class indices of all the soils analyzed disclosed that location E had the highest time range of (23-27 minutes) with the average of 25.33 minutes, while the least is location B which has the time range of (21-24 minutes) with an average of 23minutes. It was observed that location A,B,C, D & E had the average permeability class index of 3 at every location.

3.3 Organic Matter Content

It was observed that location C has the highest average organic matter content of 3.83% whereas location A revealed the least average organic matter content of 2.55%.

3.4 Percentage Silt + Percentage Very Fine Sand + Percentage Sand (100 % Clay)

The % silt + %very fine sand +% sand average revealed the highest for location B with the value of 86.54% and location D disclosed 82.56%, location A had 85.23% value and location C has 82.23 while location E with the lowest value of 75.89%.

3.5 Erodibility Indices for the Soil Simple

The erodibility indices result revealed that location A,C and D have the equal k value of 0.05 and location E has the lowest k value of 0.02 while location B indicated 0.07. The main average k value was therefore calculated to be 0.05 which is the erodibility index of ESUT Agbani soil.

3.6 Calculated soil losses at various location of ESUT Agbani.

The results disclosed corresponding values of soil loss with the erodibility indices for the locations understudied Location B has the highest average annual loss of 165.14 tons/ha/yr whereas location E has the lowest soil loss of 70.78ton/ha/yr. It was observed that location A,C and D have equal average annual loss of 117.96 tons/ha/yr . The main average annual soil was calculated to be 117.96 tons/ha/yr.

Location	R= 0.05H	K	Erodibility loss
A: ESUT Engineering Lab	1053.21	0.05	117.96
B: ESUT Access Bank/Ict	1053.21	0.07	165.14
C: ESUTFootball Field	1053.21	0.05	117.96

D: ESUT Post Graduate School	1053.21	0.05	117.96
E: ESUT Engineering Complex	1053.21	0.03	70.78
Main Value	1053.21	0.05	117.96

From the result, it was observed that location B which is ESUT Access Bank/ICT Complex had the highest average K value of 0.07 with the lowest main clay content while location E which is ESUT Engineering Complex with lowest average K value of 0.03 and highest main clay content. This result is in line with that of (Emeka, 2014). Soils with higher K value should have lower clay content and are more prone to erosion. Low clay % content result in lower binding force and poor cohesion. Therefore, the interlocking forces between the grain will be reduced to the detachment by any force what so ever. But, soils with the lower K value are less erodible. These value of low K index ensure a high cohesion and good interlocking force which could resist the force due to detachment and transportation by water. The K-value obtained from this study are slightly lower when compared to that of Okefor et.al; 2018 and Peter et al, (2008). The erosion loss value in this study is relatively close to that of Okafor et al, (2008), with an exception ESUT Access Bank/ICT Complex (165.14tons/yr) which is far higher.

4.0 Conclusion

The study successfully determined the soil erodibility of ESUT soil, providing valuable insights into the potential risks of soil erosion in the area. By evaluating the erodibility index across different soils within ESUT, it was observed that certain areas are more prone to erosion due to their physical and chemical properties. Predictive analysis of soil losses highlighted areas at significant risk, underscoring the urgent need for sustainable soil management practices. Additionally, the investigation identified primary causes of erosion, including poor land use practices, deforestation, and inadequate drainage systems, offering a basis for targeted interventions to mitigate erosion.

The calculated average annual erosion losses was highest for location B with the value of 165.14 tons/ha/yr. It was observed that location E has the lowest soil loss of 70.78 tons/ha/yr. Location A, C and D had equal average soil loss of 117.96 tons/ha/yr and the main average annual soil loss therefore 117.96 tons/ha /yr.

It is therefore recommended that the soil depth which covered the first 60cm should be protected by the use of adequate conservation structure, drainage facilities such as culvert and bridges as well as wind breakers or shelter belts which will help prevent water and wind erosion thereby reducing occurrences of erosion hazards.

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Soil structural class index (SSI)

Location A: ESUT Engineering Lab

Depth(cm)	Structure	Class Index
0-30	Massive	4
31-60	Coarse granular	3
61-90	Coarse granular	3
Average		3.33

Location B: ESUT Football Field

Depth(cm)	Structure	Class index
0-15	Massive	4
31-60	Massive	4
61-90	Massive	4
Average	---------	4

Location C: ESUT Access bank/ICT Complex

Depth(cm)	Structure	Class index
0-30	Massive	4
31-60	Fine granular	2
61-90	Massive	4
Average	------	3.33

Location D: ESUT Post Graduate School

Depth(cm)	Structure	Class index
0-30	Massive	4
31-60	Fine granular	2
61-90	Massive	4
Average	-------	3.33

Location E: ESUT Engineering Complex

Depth(cm)	Structure	Class index
0-30	Massive	4
31-60	Fine granular	2
60-90	Fine Granular	2
Average	-------	2.67

Permeability class index

Location A: ESUT Engineering Lab

Depth(cm)	Structure	Class index
0-30	22	3
31-60	24	3

60-90	24	3
Average	23.33	3

Location B: ESUT Football Field

Depth(cm)	Structure	Class index
0-30	21	3
31-60	24	3
60-90	24	3
Average	23	3

Location C: ESUT Access Bank/ICT Complex

Depth(cm)	Structure	Class index
0-30	22	3
31-60	25	3
60-90	25	3
Average	24	3

Location D: ESUT Post Graduate school complex

Depth(cm)	Structure	Class index
0-30	22	3
31-60	25	3
61-90	24	3
Average	23.67	3

Location E: ESUT Engineering Complex

Depth(cm)	Structure	Class index
0-30	23	3
31-60	26	3
61-90	27	3
Average	25.33	3

Organic Matter Content

Location A: ESUT Engineering Lab

Depth(cm)	Structure	Class index
0-30	1.90	3.28
31-60	1.62	2.79
61-90	0.91	1.57
Average	1.48	2.55

Location B: ESUT Football field

Depth(cm)	Structure	Class index
0-30	2.38	4.10
31-60	1.38	2.38
61-90	1.81	3.12

Average	1.36	3.20

Location C: ESUTAccess Bank/ICT Complex

Depth(cm)	Structure	Class index
0-30	2.52	4.34
31-60	2.19	3.78
61-90	1.95	3.36
Average	2.22	3.83

Location D: ESUT Post Graduate School complex

Depth(cm)	Structure	Class index
0-30	2.14	3.69
31-60	2.29	3.95
61-90	2.14	3.69
Average	2.19	3.78

Location E: ESUT Engineering complex

Depth(cm)	Structure	Class index
0-30	2.10	3.62
31-60	1.71	2.95
61-90	1.81	3.12
Average	1.87	3.23

Percentage silt + Percentage very fine sand + Percentage sand (100-%clay)
Location A: ESUT Engineering Lab

Depth cm	% Very fine sand (0.02-0.1mm)	% Sand (0.1-2.0mm)	% Silt	% Clay	% Silt + Very fine sand + % silt (100-%clay) (M)
0-30	3.79	80.03	7.74	81.44	91.56
31-60	3.61	76.25	4.70	15.44	84.56
61-90	3.43	72.43	3.70	20.44	79.56
Average	3.61	76.24	5.38	14.77	85.23

Location B: ESUT Football (Field)

Depth cm	% Very fine sand (0.02-0.1mm)	% Sand (0.1-2.0mm)	% Silt	% Clay	% Silt + Very fine sand (100-%clay) (M)
0-30	4.29	90.57	0.64	4.50	95.50
31-60	3.70	98.16	1.74	16.44	83.86
61-90	3.43	72.43	4.70	19.44	80.56
Average	3.81	80.39	2.35	13.46	86.54

Location C: ESUT Access Bank/ICT Complex

Depth cm	% Very fine sand (0.02-0.1mm)	% sand (0.1-2.0mm)	% silt	% clay	% silt + very fine sand (100-%clay) (m)
0-30	3.39	71.47	14.70	10.44	89.56
31-60	3.40	71.86	3.30	21.44	78.56
61-90	3.39	71.47	3,70	21.44	78.56
Average	3.39	71.60	7.23	17.77	82.23

Location D: ESUT Post Graduate School Complex

Depth cm	% VERY FINE SAND (0.02-0.1mm)	% SAND (0.1-2.0mm)	% SILT	% clay	% SILT + Very fine sand (100-%clay) (M)
0-30	3.84	81.02	6.70	8.44	91.56
31-60	3.34	70.52	3.70	23.44	76.56
61-90	3.38	73.38	2.70	20.44	79.56
AVERAGE	3.55	74.97	4.03	17.44.	82.56

Location E: ESUT Engineering Complex

Depth cm	% VERY FINE SAND (0.02-0.1mm)	% SAND (0.1-2.0mm)	% SILT	% clay	% SILT + Very fine sand (100-%clay) (M)
0-30	3.61	76.25	7.70	12.44	87.56
31-60	3.11	65.75	2.70	28.44	71.56
61-90	2.89	60.97	4.70	31.44	68.56
AVERAGE	3.20	67.66	5.03	24.44	75.89

Erodibility indices for the soil samples

Location A: ESUT Engineering Lab

depth (cm)	Erodibility index (k)
0-30	0.09
31-60	0.04
61-90	0.04
Average	0.05

Location B: ESUT Access Bank/ICT Complex

Depth (cm)	Erodibility index (k)
0-30	0.07
31-60	0.07
61-90	0.07
Average	0.07

Location C: ESUT Football Field

Depth (cm)	Erodibility index (k)

0-30	0.07
31-60	0.02
61-90	0.07
Average	0.05

Location D: ESUT Post Graduate School Complex

Depth (cm)	Erodibility index (k)
0-30	0.07
31-60	0.002
61-90	0.04
Average	0.05

Location E: ESUT Engineering Complex

Depth (cm)	Erodibility index (k)
0-30	0.07
31-60	0.002
61-90	0.002
Average	0.03
Main Erodibility index	0.05

Standard Erodibility Indices

Group	k-factor	Nature of soil
I	0-0.1	Permeable glacia outwash drains soil. Slowing permeable substrates
II	0.11-0.17	Well drained soil in sandy grad free mat.
III	0.18-0.28	Graded loams and silt loams.
IV	0.29-048	Poorly granded moderately fine and fine texture soil.
V	0.49-0.64	Poorly graded air or very fine sand soil, well and moderately grained soils.

Source: standard erodibility indices by Olson W. Gerald (1984). Dowden and Culver Inc.