

ASSESSMENT OF SOIL ERODIBILITY INDEX AT ENUGU STATE UNIVERSITY OF SCIENCE AND TECHNOLOGY, AGBANI CAMPUS

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Abstract

Soil erosion is one of the most pressing environmental challenges, contributing to land degradation, reduced agricultural productivity, and broader ecological imbalance. Understanding soil erodibility is central to predicting erosion risks and implementing sustainable soil conservation practices. Soil erodibility describes the intrinsic capacity of soil to resist detachment and transportation under erosive forces such as water and wind. It is primarily influenced by soil properties including texture, structure, organic matter content, and permeability. Soils with cohesive structures, such as clay-rich types, tend to have low erodibility, whereas silty and loose sandy soils are highly susceptible to erosion. This variability highlights the importance of evaluating the erodibility index of different soil types, as soils with higher indices are more prone to severe erosion under similar rainfall events compared to those with lower indices. Effective assessment of soil erodibility is therefore critical for guiding land use planning, agricultural management, and erosion control strategies. By integrating knowledge of soil characteristics and erosion dynamics, policymakers, researchers, and land managers can design targeted measures to mitigate soil loss, protect fertile land, and promote sustainable rural development. Ultimately, strengthening soil conservation practices through erodibility assessment not only safeguards agricultural productivity but also supports ecological stability and long-term societal well-being.

Keywords: *Soil erodibility, Soil erosion, Land degradation, Soil conservation, Sustainable development*

1.0 Introduction

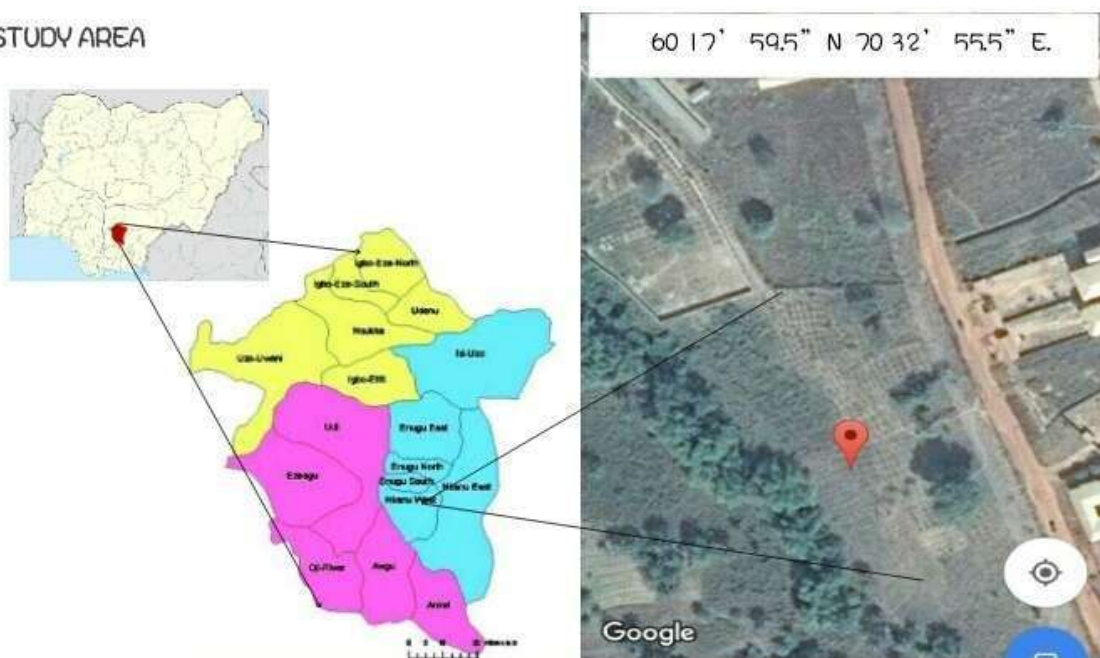
Understanding soil erodibility is crucial for soil conservation and land management, as it helps in predicting erosion risks and implementing effective preventive measures. Soil erosion is a major environmental problem worldwide is the process by which the top layer of soils are detached, transported and deposited to a new location due to natural forces like wind, water, or anthropogenic 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 $6^{\circ} 17' 59.5''\text{N}$ and longitude $7^{\circ} 32' 55.5''\text{E}$ in rainforest area of South East agricultural zone of Nigeria (Agroclimatic data 2007). The area cover about $100,000\text{m}^2$ 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 2000mm 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°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 from 11hrs 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.

STUDY AREA



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 Identificati on	1 st Depth (cm)	2 nd Depth(cm)	3 rd 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.

References

- Agroclimatic data (2007): Daily climatic data from National Root Crop Research Institute (N.R.C.R.I) umudike - Agro metrological dept.
- Anigbogu, T. U. (2023). Comparative analysis of soil erodibility indices across different land use types in Enugu State. *Nigerian Journal of Soil Science*, 33(1), 56-65. Enugu, Nigeria.
- Any, A. C. (2016). Comparative study of soil erosion in upland and lowland areas of Ebonyi State. *Soil and Tillage Research*, 157, 57-66. Abakaliki, Nigeria.
- Berneth, H.E (1926): soil conservation 2nd edition. McGraw-Hill, London. Pp105 – 128
- Bryan R.B. (2010). The Concept of Soil Erodibility and some problems of Assessment and Application. *Catena*. 16:393-412
- Chukwu, L. A. (2019). Determination of erodibility factors in erosion-prone areas of Enugu State. *International Journal of Environmental Studies*, 76(6), 984-993. Nsukka, Nigeria.
- De vente, j, poesen, j., (2005). Predicting soil erosion and sediment yield at the basic scale issues and semi – quantitative model earth science review 71, 95 – 125

- Ejas, N, Akhtar, n, Hashimi, Naum U.A, 2010. Environmental impacts of improper solid waste management in developing countries. A case study of Rawalpindi city. WIT transaction on ecology and the environment, The sustainable world, 142, 379 – 387
- Emeka – Chris, c.c. (2014), determination of erodibility index (K) of soil in Michael Okpara University of agriculture, umudike. International journal of engineering and science, 3, 12, 30 – 38
- Eze, C. C. (2020). Assessment of soil erodibility in different land use systems in Ebonyi State. Journal of Environmental Management, 265(5), 110548. Abakaliki, Nigeria.
- FAO and ITPs, (2015) status of the world's soil resources (SWSR)- main report food and agriculture organization of the United Nations and intergovernmental technical panel on soils, Rome, Italy.
- Isikwe M.O., Abutu C., and Onoja S.B. (2015). Erodibility of soils of the South West Benue State, Nigeria. The Pacific Journal of Science and Technology, Vol. 13 (2) 437-447.
- JING. K, Wang, W.Z, Zheng, F, I, (2005) soil erosion and environment in China science press, Beijing.
- Mbah, F. U. (2020). Predicting soil erosion risk in Ebonyi State. Environmental Modelling & Software, 124, 104606. Abakaliki, Nigeria.
- Morgan, R.P.C. (2001). A simple approach to soil loss prediction: a revised Morgan- Morgan-Finney model. Catena 44(4): 305-22.
- Nnaji, C. A., & Eze, S. C. (2021). Soil erodibility assessment and its implications for agricultural productivity in Enugu State. Agricultural Science Digest, 41(2), 89-98. Enugu, Nigeria.
- Nwankwo, J. I., & Okonkwo, A. C. (2020). Influence of soil properties on erodibility in southeastern Nigeria. African Journal of Agricultural Research, 15(7), 245-254. Awka, Nigeria.
- Nwosu, E. O. (2018). Effect of land management practices on soil erosion in Ebonyi State. Land Degradation & Development, 29(3), 637-647. Abakaliki, Nigeria.
- Nyakatawa, E.Z.; Reddy, K.C. and Lemunyon, J.L. (2001). Predicting soil erosion in conservation tillage cotton production systems using the revised universal soil loss equation (RUSLE). Soil and Tillage Res. 57(4): 213-24.
- Obinna, K. E. (2019). Soil erodibility assessment in Ebonyi State using rainfall simulation. Journal of Hydrology, 572, 746-754. Abakaliki, Nigeria.

- Ogban B.U. (2005). Soil Properties in Relation to Gully Erosion in Ogbadibo local Government Area of Benue State, Nigeria. Unpublished M.Eng. Thesis. Agriculture & Environmental Engineering Department. University of Agriculture, Makurdi, Nigeria.
- Ojo J.Š. (2015). Evaluating soil erosion risk in the basement complex terrain of Akure metropolis, Southwestern Nigeria. Vol. 7(1):56-64.
- Okerfor, O.O, Akinbile, C, O, Adeyemo, A 2018. Determination of Soil Erodibility factor (K) for selected sites in imoe State, Nigeria. Resources and Environment, 8, 1/ 6 -13.
- Okojie, E. I. (2018). Erodibility of agricultural soils in Ebonyi State, Nigeria. Journal of Agriculture and Rural Development, 25(2), 150-159. Abakaliki, Nigeria.
- Okoye, I. J. (2021). Impact of deforestation on soil erodibility in Ebonyi State. Forest Ecology and Management, 482, 118770. Abakaliki, Nigeria.
- Okpara, U. S. (2021). Influence of soil properties on erosion in Ebonyi State, Nigeria. Catena, 198, 104920. Abakaliki, Nigeria.
- Okwu, D. E., & Obi, R. N. (2022). Mapping soil erodibility indices in Enugu State: A GIS approach. Journal of Geographic Information System, 14(3), 337-348. Enugu, Nigeria.
- Olson, W.G. (1984). Standard erodibility indces Jowden and Culver inc.
- Robe, Ej. (1977). Doc Annese De Mesurde l. erosion j. arrest pourla conservation DE L’eauet Des soil cycle. Orston, Adicpodeme coast.
- Schwab, G.O, D.D Fragmeier, W.J. elliet and R.K. Frevert (1993). Soil and water corseroation Engineering 4th ed. John Wiley Sons Inc. Canada
- Song, Y.I., Liu, Yan. P., Coa, T., (2005), A review of soil erodibility in water and wind erosion research, journal of Geographical Science, 15, 2, 167-176.
- Tang, K.L. (2004). Soil and water conservation in China. Science press Beijing.
- Ugbaja, R. N. (2018). Assessment of soil erodibility indices in Enugu State, Nigeria. Journal of Soil Science and Environmental Management, 9(4), 123-132. Enugu, Nigeria.
- Wischmeier, W.H, Smith, D.D,(1963). A soil erodibility Monograph for land and construction site. Soil and water conservation, 26, 189-193.

Wischmeier, W.H, Smith, D.D,(1969). Predicting rainfall erosion losses from crop and land east of the Rocky Mountain. Agric Hardout, 477, 275-298 united state dept.

Zheng, K, Li, S, peng, W, Ya, B, (2004). Erodibility of Agricultural soil on the losses plated of China soil and Tillage research 76, 2, 157-165.