AU J.T. 12(2): 130-133 (Oct. 2008)

# Determination of Erodibility Indices of Soils in Owerri West Local Government Area of Imo State, Nigeria

**Peter Aba Idah, H. I. Mustapha, J. J. Musa and J. Dike**

**Department of Agricultural Engineering, Federal University of Technology Minna, Niger State. Nigeria**
**Email: <pabaidah@yahoo.co.uk; jntmusa@yahoo.com>**

## *Abstract*

*The problem of soil erosion, especially in the south-eastern part of Nigeria, is enormous. This problem is affecting the development because infrastructures 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 soils that affect erosion. In this study, some indices of soil erosion in Owerri West Local Government Area were determined. This study involves taking measurements of some soil parameters such as permeability, soil texture, and classification index on the field as well as laboratory tests from which the erodibility indices were computed. The results showed that Ohi with index of 0.044 has the highest erodibility index while Ava with 0.030 has the least one. The practical implication of these findings is in the area of design of control structures that will be able to stand the test of time.*

***Keywords**: Erosion, infrastructures, permeability, soil texture, classification index.*

## Introduction

Soil is an essential input to agricultural production and in Nigeria where agricultural production is crucial to development the livelihoods of the majority of the population depend on this naturally abundant resource. Agriculture land use in Nigeria often results in the degredation of natural soil fertility and reduced productivity. Soil degradation under farming sometimes brings about soil erosion, sedimentation and leaching.

Soil erosion occurs when soil particles are carried off by water or wind and deposited somewhere else. Erosion begins when rain or irrigation water detaches soil particles. Relf (2001) stated that when there is too much water on the soil surface, it fills surface depressions and begins to flow. With enough speed, this surface runoff carries away the loosed soil.

According to Nyakatawa *et al*. (2001), soil erosion is a major environmental problem worldwide. Soil moved by erosion carries nutrients, pesticides and other harmful chemicals into rivers, streams and ground water resources. Food crops are the most affected by this development due to their shallow rooting systems. Destruction of farmlands and crops by soil erosion creates problems for the population as the farmers cannot find suitable lands on which to cultivate their crops. Extreme fragmentation of remaining farmland may follow, which may result in man overcropping the available land, hence, reducing output unless soils is being improved.

Eroded soils are deposited in water systems leading to pollution and siltation which cause drastic reduction of water volume and quantity, and eventual siltation and drying up of rivers, water reservoirs and dams. Hence, the aquatic life is eventually eliminated. There is drastic reduction in land productivity for agriculture. In case of gully erosion, the land may become submerged and not useful for any purpose. However, soil erosion being a complex interaction process of many factors, most basic of which are the edaphic (soil) and rainfall factors, need to be tackled effectively.

Other factors, namely landform, vegetation and cropping factors are amenable to changes.

Owerri West Local Government Area with its headquarters at Uumuguma is located between latitudes of $5^0$ 23' and $5^0$ 34W and between longitudes of $6^0$ 50' and $7^0$E, and has 15 autonomous communities namely Obinze, Avu, Nekede, Ihiagwa, Amakohia Ubi, Ndegwu, Okuku, Eziobodo, Oforola. Ohi, Umuguwaand Orogwe, Okolachi, Emeabiam and Irete.

The people practice shifting cultivation and crops grown on the area are maize, melon, yam, and cocoyam. The area also lies within the rainforest region of Nigeria, which has its peak rainfall within June, July, September and October and low rainfall in December, January and February.

With the soil map of Imo State, using the United States Department of Agriculture (Peech *et al*. 1947) and Food and Agricultural Organization of the United Nations (FAO 1976) classification systems, there are three classes of soil in Imo. Ferralitic soils from the coastal plain sand and the escapement are occupying an area of about 7,798 square kilometers, which is 61% of the total area of flat to undulating topography characterized by good grainage. Hydromorphic soils from plateau and Cross-River plain are occupying an area of about 31% of the total landmark and have developed along the escapement found in the Northeastern part of the State. Alluvial soils occupy about 8% of the total area of the state and are found along the low terrace of the Cross-River and Orashi River. They are poorly drained and are subject to permanent or periodic flooding.

The communities living in these areas hardly go through each year without adverse effect of soil erosion especially that due to water. Properties worth millions of Nigerian naira (₦, 1 USD = 118 ₦) are usually destroyed each year. Solutions to these problems require thorough knowledge of the edaphic factors of which erodibility index is one crucial factor.

Soil erodibility is an estimate of the ability of soil to resist erosion based on the physical characteristics of each soil. Generally, soils with faster infiltration rates, higher levels of organic matter and improved structure have a greater resistance to erosion (Wall *et al*. 1987).

A soil with relatively low erodibility factor may show signs of serious erosion, yet a soil could be highly erodible and surfer 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 control practice factor (*P*). This is represented in the universal soil loss equation as (Renard *et al*. 1997)

$$A = R\,K\,LS\,C\,P.$$

Erodibility is the resistance of the soil to both detachment and transport. The soil erodibility factor *K* is a quantitative expression of the inherent susceptibility of a particular soil to erode at different rates when the other factors that affect erosion are standardized. Erodibility varies with soil textures, aggregates, stability, shear strength, soil structures, infiltration capacity, soil depth, buck density, soil organic matter and chemical constituents (Agassi and Bradford 1999).

The depth of erosion is very often determined by the soil depth. Soils below the plough layers are often compact and less erodible. Rills will develop in areas where resistance bedrock is close to the surface if the parent material is unconsolidated such as sands and gravel (Morgan 2001).

The organic and chemical constituents of the soil are important because of their influence on stability of aggregates. Soils with less than 2% organic matter can be considered erodible (Evans 1980). Most soils contain less than 15% organic content and many of the sands and sandy loams have less than 2%. Morgan (2001) suggested that soil erodibility decreases linearly with increasing organic content over the range of 0 to 10%.

The objective of this study is to determine the soil erodibility indices of some towns in Owerri west Local Government area in order to ascertain areas prone to severe erosion and to predict soil losses by erosion under the same environmental condition. The data obtained can also form data bank for the design of conservation structures.

## Research Methodology

**Soil Erodibility Determination**

The method of field test developed by Wischmeier *et al*. (1958) was used to determine soil erodibility. Samples were collected from depths ranging from 0-20, 20-40 and 40-60 centimeters for soil structural classification. The in situ permeability test was also used along with the field test of dropping clods from known height.

**Laboratory Test**:

The hydrometer test was carried out to determine the percentage of sand, silt and clay in the samples of soils taken from these communities. From this, erodibility index (*K*) was determined using Bouyoucos (1935) equation.

The percentage of sand, silt and clay were determined as follows:

$$\%\,\text{sand} = \frac{\text{sample weight} - 40\,\text{seconds reading}}{\text{sample weight}},$$

$$\%\,\text{clay} = \frac{8\,\text{hours reading}}{\text{sample weight}} \text{x}\,100,$$

$$\%\,\text{silt} = 100\% - (100\% + \%\,\text{clay}).$$

**Erosion Prediction**

Using the relationship given by Roose (1977), the rainfall factor (*R*) was determined:

$$R = 0.5\,H,$$

where *H* is the mean annual rainfall.

Prediction of the amount of soil loss in each of these communities was carried out putting this in the revised USLE equation:

$$A = 2.24\,R\,K,$$

where *A* is the soil loss converted to tons/ha/yr by multiplying by 2.24 , *R* is the rainfall factor and *K* is the erodibility factor (Hudson 1995).

## Results

The results of the determined erodibility indices in the various communities are as shown in Table 1. From the erodibility indices of the soils in the various communities, it can be observed that the soils in Ohi are more erodible with a value of (0.044). The least indices were found in soils at Obinze (0.029) and Ihiagwe (0.029).

The results of the predicted soil losses in the various communities under study are also shown in Table 1. Ohi being the most erodible has the highest predicted soil losses of 9.462tons/ha/yr. This is followed by Amakohia-Ubi (8.602tons/hs/yr) and Orogue (89.6 tons/ha/yr). Obinze and Ihiagwa have the least predicted soil losses of 6.236 tons/ha/yr each.

Table 1. Average erodibility index (*K*) of project locations and predicted soil losses for the various communities using Hudson (1995) equation.

| Location | Average *K*-index | Soil loss (tons/ha/yr) |
|---|---|---|
| Ndegwu | 0.035 | 7.526 |
| Orogwe | 0.040 | 8.602 |
| Amakohia Ubi | 0.40 | 8.602 |
| Obinze | 0.029 | 6.236 |
| Oforola | 0.032 | 6.881 |
| Avu | 0.03 | 6.451 |
| Umuguma | 0.036 | 7.741 |
| Okolochi | 0.036 | 7.741 |
| Emeabia | 0.033 | 7.096 |
| Eziobodo | 0.032 | 6.881 |
| Ihiagwa | 0.029 | 6.236 |
| Nekede | 0.034 | 7.311 |
| Irete | 0.036 | 7.741 |
| Ohi | 0.044 | 9.462 |
| Okuku | 0.037 | 7.956 |

From the particle size analysis sandy soils were found to be the most common. Erodibility factors of Ohi, Orogwe and Amakohia-Ubi communities were found to be high which is due to the presence of high quantity of sandy soils in these areas. Sandy soils are known to have low cohesive force and therefore are more prone to detachment and transportation by water and wind. Furthermore, high sandy soil content encourages high rate of permeability of water into the soil, which induces landslide and erosion. The communities with high clay content have low erodibility factor because of the higher binding and interbinding forces that help in resisting detachability of soil by wind and water.

The erodibility indices for the samples of soils from the fifteen communities when

compared with standard erodibility indices which showed that the erodibility indices of the communities in Owerri West Local Government Area fall into group I (Table 2), indicating that the soils are permeable, well drained with stony substrata.

Table 2. Standard erodibility indices.

| Group | *K*-Factor | Nature of Soil |
|---|---|---|
| I | 0.0 – 0.1 | Permeable gracia outwash well drain soils having stony substrata |
| II | 0.11– 0.17 | Well drain soils in sandy graded free material |
| III | 0.18– 0.28 | Graded loams and silt, loam |
| IV | 0.29– 0.48 | Poorly graded moderately fine and textured soil |
| V | 0.49– 0.64 | Poorly graded silt or very fine sandy soil, well and moderately drain soils |

## Conclusion

The determination of the erodibility indices of soils in Owerri West Local Government Area of Imo State has been carried out and from the various results obtained it showed that the soils in Owerri West local government area are mainly sandy soils. The hydrometer test used in the computation of the erodibility indices revealed that Ohi has the highest erodibility indices of 0.044 followed by Orogwe and Amakohia-Ubi with 0.040. The least erodibility indices were obtained in Obinze and Ihiagwe towns, both with erodibility indices of 0.029. The data obtained from this study will be useful in the design and construction of conservative structures that can adequately check the menace of erosion in these communities in Imo State.

## References

Agassi, M.; and Bradford, J.M. 1999. Methodologies for interrill soil erosion studies. Soil and Tillage Res. 49(4): 277-87.

Bouyoucos, G.J. 1935. The clay ratio as a criterion of susceptibility of soils to erosion. J. Amer. Soc. Agron. 27(9): 738–41.

FAO. 1976. A framework for land evaluation. FAO Soil Bulletin No. 32. FAO, Rome, Italy.

Hudson, N.W. 1995. Soil conservation. 3rd Ed. Iowa State University Press, Ames, IA, USA.

Morgan, R.P.C. 2001. A simple approach to soil loss prediction: a revised Morgan-Morgan-Finney model. Catena 44(4): 305-22.

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.

Peech, M.; Alexander, L.T.; Dean, L.A.; and Reed, J.F. 1947. Methods of soil analysis for soil-fertility investigations. Circ. 757, USDA, Washington, DC, USA.

Relf, D. 2001. Reducing erosion and runoff. Virginia Cooperative Extension, Publication No. 426-722, Virginia Polytechnic Institute and State University, Blacksburg, VA, USA.

Renard, K.G.; Foster, G.R., Weesies, G.A.; McCool, D.K.; and Yoder, D.C. 1997. Predicting soil erosion by water: A guide to conservation planning with the revised universal soil loss equation (RUSLE), USDA Agriculture, Handbook 703, US Government Printing Office, Washington, DC, USA.

Roose, E.J. 1977. Application of the universal soil loss equation of Wischmeier and Smith in West Africa, pp. 177-87. *In:* Soil conservation and management in the humid tropics. Greenland, D.J.; and Lal, R. (Eds.). John Wiley & Sons, Chichester, West Sussex, UK.

Wall, G.; Baldwin, C.S.; and Shelton, I.J. 1987. Soil erosion - causes and effects. Ontario Ministry of Agriculture and Food Factsheet Agdex# 572, Canada.

Wischmeier, W.H.; Smith, D.D.; and Uhland, R.E. 1958. Evaluation of factors in the soil loss equation. Agric. Eng. 39: 458-62.