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**Original Research Article**

# Determination of the Susceptibility of Soils to Erosion: A Case Study of Okigwe Zone of Imo State, Nigeria

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**ABSTRACT**

*The problem of susceptibility of soil to erosion is one of the most important factors affecting the Okigwe zone of Imo State, Nigeria. This problem is affecting the infrastructural development because houses, roads and many others are being destroyed yearly. The agricultural farmlands are also not spared. To tackle this problem there is need to evaluate some factors of soil that affects erosion. This study was carried out to determine the susceptibility of soils in Okigwe zone which comprises of Obowo, Ihitte-Uboma, Ehime-Mbano, Isiala-Mbano, Onuimo and Okigwe Local Government Areas using modified clay ratio (MCR). The MCR of the soil in Ehime-Mbano (sample C) was greater than that in Isiala-Mbano (sample D), Obowo (sample A), Okigwe (sample F), Ihitte-Uboma and (Sample B) and Onuimo (Sample E) which has the lowest MCR. The susceptibility of soils to erosion in terms of MCR followed this trend in Local Government Areas (LGAs) in Okigwe zone, Ehime-Mbano (87.95%) > Isiala-Mbano(29.32%) > Obowo(28.69%)> Onuimo (27.55%) > Okigwe (22.16%) > Ihitte-Uboma (14.42%). The result indicates that Erosion challenge in the Okigwe zone is more pronounced in the following order thus: Ehime-Mbano, Isiala-Mbano, Obowo, Onuimo , Okigwe. and Ihitte-Uboma LGAs respectively. However, soil erosion should be controlled by agronomic engineering and biological practices like soil mulching, use of manure and re-vegetation.*



## 1. INTRODUCTION

The importance of top soil in agricultural activity cannot not be over-emphasized, especially in Okigwe Zone of Imo State, Nigeria where agricultural production is crucial to development of the livelihoods of the

majority of the population. 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 loose 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.

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 (Jim Ritter, 2018). A soil with relatively low erodibillity factor may show signs of serious erosion, yet a 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). The factors include rainfall erosivity index (R), soil erodibility factor (K), slope length (LS), crop management factor (C) and conservation practice factor (P).

Erodibility varies with soil texture, aggregate, stability, shear strength, soil structure, infiltration capacity, soil depth, bulk density, soil organic matter and chemical constituents (Agassi and Bradford, 1999).

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 (Liu *et al.*, 2019). Most soils contain less than 15% organic content and many of the sands and sandy loams have less than 2%.

The problem of soil erosion especially Okigwe zone in Imo State, South-Eastern Nigeria is enormous. This problem is affecting the development because infrastructures such as houses, roads and many others as being destroyed yearly (Amangabara *et al.*, 2017). The inhabitants of Okigwe are engaged in farming, trading and civil service work which are their basic occupation. Excessive erosion is one of the most significant problems, the people of Okigwe zone face today (Izuogu et al., 2015). Therefore, this research is aimed at determining the susceptibility of soil to erosion in the six local government Areas of Okigwe zone of Imo State using modified clay ratio (MCR).

## 2. MATERIALS AND METHODS

### 2.1. Study Area

The study area include Obowo, Ihitte-Uboma, Ehime-Mbano, Isiala-Mbano, Onuimo and Okigwe local Government Areas, Imo State South-Eastern Nigeria. The area lies within latitudes 5º 33'N and 5º 8'N and longitudes 6º 58'E and 7º 035'E respectively. The study area is within the deforested evergreen rainforest commonly seen in South-Eastern Nigeria. The land is covered with vegetation except in areas where there are bare vegetation's due to excess cultivation. Oil palm is a major economic tree found in the area.

### 2.2. Materials

Soil samples were randomly collected from four communities/locations from the six (6) LGAs in Okigwe zone using a manual Auger and shovel to the depth of 0-20 cm from the earth's surface and was transferred into black polythene bag and taken to the laboratory for analysis. Other materials used include electronic weighing balance (Accuracy 0.001 g), nest of sieves and accessories like brush, scoop pan etc, mechanical sieve shaker, soil hydrometer (151H type), sedimentation cylinders (1000 ml capacity), time piece glass rod (stirrer), distilled water, wet sieving device, bowl, tap water etc., Electronic drying oven maintained at a temperature of between 100-105 ºC, manual drill Auger, Shovel, polythene bags, masking tape, and measuring tape.

### 2.3. Test for Organic Matter

Organic carbon of the soil was determined using the wet oxidation method (Nelson and Sommers, 1996) as shown in Equation (1) and organic matter was determined by multiplying the value of organic carbon with 1.724 (Van Bemmelin factor) as shown in Equation (2).

$$\%Organic\ carbon = \frac{(Mek_2Cr_2O_7 - MefeSO_4)\times 0.003 \times 100 \times F}{\text{Mass of soil}} \quad (1)$$

where F is correction factor (1.33) and Me= Normality of solution x ml of solution used

$$\%\ organic\ matter\ =\ \%\ organic\ carbon\ \times\ 1.724 \quad (2)$$

### 2.4. Modified Clay Ratio

Modified clay ratio can be used to estimate soil erodibility based on soil characteristics. In general, grass land and forest soil have lower values of modified clay ratio. According to the criterion of Abdulkadir, (2018), soil having modified clay ratio > 1.00 and erosion ratio > 0.10 are erodible in nature. Kukal *et al.* (1993), observed that the soils that have forest land use were more stable compared to the soils with higher organic carbon contents resulting in more stability of soil aggregates.

$$Modified\ clay\ ratio\ = \frac{(\%\ Sand\ +\ \%\ Silt)}{(\%\ Clay\ +\%\ Organic\ \ Matter)} \quad (3)$$

### 2.5. Particle Size Distribution

The soil samples were spread on different flat dry tray pans and were labeled A, B, C, D and F representing Obowo, Ihitte-Uboma, Ehime-Mbano, Isiala-Mbano, Onuimo and Okigwe Local Government Areas (LGAs) respectively for easy identification and were kept under the sun for about 48 h with steady checking and turning to prevent any loss of the soil and to enable every part of the sample to dry properly. The dried sample were placed on the sieving machine with different sieve sizes as indicated as follows: boulder (> 200 mm), cobble (60-200 mm), gravel (2.0 – 60 mm), sand (0.06-2.0 mm), silt – (0.002 -0.06 mm), clay (0.002 mm and below). After the sieving, the pans were removed and their contents were measured and their percentages were obtained according to BS 1377: (1990).

## 3. RESULTS AND DISCUSSION

The values of organic matter and organic carbon are summarized in Table 1. Organic matter reduces erodibility because it reduces the susceptibility of the soil to detachment and it increases infiltration, which reduces runoff and thus erosion. Onuimo (sample E) had the highest percentage of organic matter followed by Ihitte-Uboma (sample B) with the second highest percentage in organic matter followed by Okigwe (sample F), followed by Obowo (sample A), followed by Isiala-Mbano (sample D) and finally Ehime-Mbano (sample C) with the lowest organic matter. The higher the value of organic matter, the lower the susceptibility to erosion, therefore the soil at Onuimo is less susceptible to erosion while that of Ehime-Mbano is highly susceptible to erosion, according to the results obtained.

The results of the determined particle size distribution in percentage (clay, silt, and sand), organic (carbon), organic matter and modified clay ratio, respectively are shown in Table 2. Modified clay ratio is one of the methods to determine soil erodibility, and the higher the percentage of MCR the higher the susceptibility of any soil to erosion. The MCR of the soil in Ehime-Mbano (sample C) was greater than that of Isiala-Mbano (sample D), Obowo (sample A), Onuimo (Sample E), Okigwe (sample F), and Ihitte-Uboma (Sample B) which had the lowest MCR. The susceptibility of soils to erosion in Okigwe zone followed this trend; Ehime-Mbano>Isiala-Mbano>Obowo>Onuimo>Okigwe>Ihitte-Uboma LGAs. Since the higher the percentage (%) of sand particle size in soil, the higher the erodibility, the percentage (%) of sand in the Six (6) LGAs is higher than the percentage (%) of the various other soil constituents (silt and clay) therefore, the soils in Okigwe zone are prone to erosion.

Table 1: Organic matter and organic carbon composite for the soil samples

| Soil sample | % Organic carbon | % Organic matter |
|---|---|---|
| A | 0.1197 | 0.2064 |
| B | 0.1796 | 0.3095 |
| C | 0.0399 | 0.0688 |
| D | 0.0599 | 0.1032 |
| E | 0.2594 | 0.4471 |
| F | 0.1397 | 0.2408 |

Table 2: Modified clay ratio results obtained from the soil samples

| Location | % Clay | % Silt | % Sand | Modified clay ratio |
|---|---|---|---|---|
| Sample A | 3 | 2 | 90 | 28.6929 |
| Sample B | 6 | 4 | 87 | 14.4226 |
| Sample C | 1 | 4 | 90 | 87.9501 |
| Sample D | 3 | 3 | 88 | 29.3247 |
| Sample E | 3 | 1 | 94 | 27.5591 |
| Sample F | 4 | 2 | 92 | 22.1659 |

## 4. CONCLUSION

After carrying-out the experiments on the soil samples from the six Local Government Areas of Okigwe zone of Imo State, Nigeria to determine their susceptibility to erosion, it was found that the soils in Ehime-Mbano L.G.A were more prone to erosion menace while Onuimo L.G.A was least affected.

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## 6. CONFLICT OF INTEREST

There is no conflict of interest associated with this work.

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