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Effect of ESLRM Model Parameters on Soil Loss in Imo River Basin

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Abstract:
Soil loss in our environment is a very serious issue and has caused great damage to business activities. It poses serious hazard to properties. Many models and theories have investigated soil loss in various perspectives, while Empirical Soil Loss Regression Model (ESLRM) had approached it using empirical methods. This study focuses on the effect of those experimental parameters used or employed in (ESLRM). The parameters includes rainfall intensity I, Slope of the catchment S, Duration of the rainfall D, Soil density,ρ, size of catchment area A, Organic content, O and Clay content of the soil C. From the model equation, intensity, slope, duration, density and Area represent the erosive effect in soil loss operation with their power coefficient being positive, while organic content and clay content of the soil represent the erodibility component of soil loss operation with negative sign in their power coefficient. A total of thirty-two experiments were conducted, nine of which were used to develop the model while the remaining twenty-three were used for model verification. The model was used to predict soil loss and reusing the experimental parameter values measured. Thereafter calibration was carried out with the selected nine experiments while verification was based on the remaining twenty-two experiments. The individual parameters of the ESLRM were plotted on the graph against the measured and predicted soil loss values. The parameters, linear soil loss equations with coefficient of determination, r^2 of the graphs plotted were summarized in Tables 1 and 2 for calibration and for verification separately. For the calibration, the following: clay content, organic content, catchment area, duration and intensity were negative slope showing that their increase caused inverse relationship of soil loss. While density and slope showed positive slope meaning that as they increased; they are directly proportional to soil loss. However, during verification, apart from catchment area, intensity and duration were found to present negative trend showing that their increase caused reduction in soil loss this indicates that the soil is forming resistance due its organic content and clay particles which served as a binder material.

Key words*: ESLRM, Calibration, Catchment, Clay, Intensity, Measured, Organic, Predicted, Slope, Verification.*

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I. INTRODUCTION

Soil is a fundamental need to human life in many ways and its importance to human existence cannot be over emphasized. Without soil and water, food production will be difficult. That is to say that the contribution of soil to man is enormous. Therefore soil should be monitored and protected against vulnerability as a result of human and natural activities that tend to temper the topmost layers of the soil.

There exist popular erosion models and they are so ambiguous in their state. Full of indexes and factors, unlike ESLRM model which has it parameters in single elements form. The nature and form of those ambiguous erosion models made them difficult to know soil parameters and climate elements that contributes positively or negatively to the erosion process to common man practicing agriculture in the field. In line with our claim Mutchler and Hermsmerier (1995) did a very good work in soil loss prediction using rain simulator system which we adopt. Their study focus on soil properties, soil loss, TSS (total specific surface) and CEC (Cation Exchange Capacity). Then during their analysis they adopted instability index β which they used to determined aggregate instability and they used it to plot against TSS and CEC. Later present the measured soil loss value due to vertical rain drop and runoff leaving the well-known parameters unnoticed on their effect to soil loss and that left the study in the state of ambiguity. Nearing et al. (2004) did work on the monitory of soil loss or depletion over a top hill and agricultural area with water erosion prediction project WEPP model that estimate surface hydrologic parameter for prediction of soil erosion and not good at distinct slope and several hill slope watershed and is not applicable to area having permanent channels as gullies. In consolidating WEPP, Flanagaand Nearing (1995) which letter reviewed by Carlos et al. (2007) on precision Agricultural Landscape modeling system (PALMS) which monitor soil loss in agricultural area using conductivity, hydrometer reading and temperature in the model system, that sensory environment. The same system of sensor still go well with GWLF (Generalized watershed loading function) by Haith, D. A. and Shoemaker L. L. (2002) used leakage of infiltration on saturated and unsaturated zone process in annual soil loss prediction. Before Ferro and Porto (2000) used morphologic unit some slope and hydraulic dimensionless groups in soil loss prediction model called sediment delivery distributed model SEDD. The well-known manual soil loss model establish by Renard et al. (1997) first and second revised version by Foster et al. (2003) called universal soil loss equation USLE, RUSLE and RUSLE2 respectively have gone a long way in study of soil loss prediction and on an appreciable land slope not more than 13^0 degree with soil erodibility index K, length factor L, slope factor S, crop factor C, management factor/conservation practice grid P, and erosivity of rain R, for USLE while RUSLE consider LS as one element of slope length and steepness grid of slope less than 60^0 degree and RUSLE2 considered SCi as one element of slope steepness factor and cover management factor. Still in the state of index and factor making the model in state of ambiguity. These do not left the study of Osuagwu J. C. (2012) out, which is the mathematical model for sandbag checkdam which check and measured soil trap along a flowing path of drainage that considered the following in his model; dimensional coefficient, volume of sediment deposited, accumulation, initial and final concentration at a time, velocity and flow rate.

Taking a leverage from the problem, there is need to know the direct effects of each and every parameters in ELSRM models, has on soil loss. This study will go a long way to bring the process of erosion and how it will be controlled. And these knowledge will be made available to the common man that are into agriculture, civil engineering construction, estate and land management as while as to government in their policy making.According to Ibearugbulem *et al*. (2018), that has the modification of empirical soil loss regression model (ESLRM) for the prediction of the amount of soil loss from catchment area of a given slope, soil density, soil organic matter, clay content, rainfall intensity which produces runoff with duration as a tool to monitor soil loss in a catchment area. The result of the model will help in adopting measures that will aid in protecting the soil from wearing away. The ESLRM model is as shown in Equation 1.

The study ‘’Effect of individual experiment parameters (intensity, slope, duration, catchment area, organic and clay content) of the ESLRM model on soil loss’’ focused on checking the individual parameters in relation with soil loss amount and to know those that are erosive.

This study is a continuation of ESLRM model which is a study involving thirty-two experiments were nine experiments were used to develop and calibrate the model and the remaining twenty-two were used to verify and check the relationships of the parameters with the amount of soil loss.

Graphical statistical tool was employed in the calibration and verification of the individual parameters on the relation to soil loss amount. The graph was easy to interpret; That is, if the graph is negative, it means that the parameter increased the soil loss and decreased if the graph is positive. The linear trend equation with their coefficient of determination, r^2 was summarized in Table 1.The findings will be of immense help to famers and other land users to know how to properly manage their land(s) by knowing those physical factors that pose threats to land use.

The aim of this study is to know the effect of ESLRM model parameters which include; rainfall intensity, slope of the catchment area, duration of rain, density of soil, catchment Area, organic and clay contents,have on the amount of soil loss. The soil sample was obtained from Imo River Basin. However, the following specific objective was considered;Soil sample collection and soil characterization.Preparation of the collected soil sample for erosion experiments.Set-up the kamphustrainfall simulator machine was done.Prediction of the rainfall intensity and runoff and the erosion experiments was carried out.Prediction of soil loss with the ESLRM model with the soil characterized value and rainfall intensity was analyzed.Statistical Calibration and Validation of the measured and predicted soil loss values was carried out with individual parameters.

The scope of the study will be limited to the examination of the ESLRM model to know the direct effect of each parameter, plotting of the calibration and verification of graphs for each parameter against soil loss measured and predicted to determine positive and negative graphs based on the inclination of the scatter graph trend line. The equation with coefficient of determination, r^2 will be summarized in a table and the findings discussed.

II. MATERIALS AND METHODS

The study was based on soil loss in a laboratory using artificial raindrops simulator apparatus. The soil sampleswere collected from different sub basin/catchment of Imo river basin as location of the study area.

However, Laboratory Soil loss experiments was conducted using rainfall simulator on thirty-two soil samples. Soil loss was measured and the behavior of the soil during the experiments was studied. The parameters considered are rainfall intensity, slope of catchment, duration of experiment, bulk density of soil, catchment area, organic matter and clay content.

The following are the expected tools/apparatus needed for the study; GIS tools, Spade or auger, Khurpi, Core sampler, sampling bags, plastic tray and bucket, metal tray, tray angle setting, rainfall simulator, soil, meter for jet velocity. Etc.

2.1 LOCATION

The Latitude and Longitude focal point of the study location of Imo river basin was determined by use of GIS apparatus.

2.1.1 Sample collection from the location

The soil for the study was collected from the sub basin of the study location.Soil samples were collected from the three-two difference holes from each gully site named AgbagharaNsu, AcharaObowo, AforUkwu – AforNta Market, Agbaghara – Umuopara, EmekukuOwerri North, IhitteUbi/Oparanadim of Ahiazu L.GA, IbeaforUmunumu, Isiekenesi – Dikenafai, Owerri West, Umuopara – Nzerem, and UturuOkigwe for laboratory soil tests.

2.2 SOIL SAMPLE CLASSIFICATION

The collected soil sample was classified by running a soil classification test of organic and clay content as follows.

2.2.1 Organic Content Determination

This was done in accordance to ASTM 2974 method. The soil sample was oven dried at 100^0C then weighed before putting it in a porcelain dish. After which it was weighed together with porcelain dish and placed in a furnace and heat to a temperature of 440^0C for 2 hours. It was brought out of the furnace and allowed to cool to room temperature before weighing it together with the porcelain again. (Garg, 2013).

2.2.2 Clay Content Determination

The Soil Sample of about 150g wasdissolved in a beaker about (100ml) and stirred vigorously and allowed to settle for (24hrs) and the soil layered. (Venkatramaiah, 2012).

2.3 Simulation of Soil Loss

Preparation of the soil in the tray; the soil sample collected was prepared by filling and ramming it in the tray and after the ramming which the soil overlap the tray to an extent. Then the nature of the soil rammed was used in determination of the density of the soil before subjected it under simulator machine.

Soil loss experiments was conducted in the laboratory with the useofrain simulator, and on filed using artificial gully channel. In all a total of thirty-two experiments was carried out in three different patterns of soil loss tray catchment and gully channel. With different soil samples from different site and some soil samples was mixed with additive to form soil resistance to erosion. Soil loss was measured and the attitude of soils during the experiments was also studied. Samples of disturbed soil was used in the experiments.

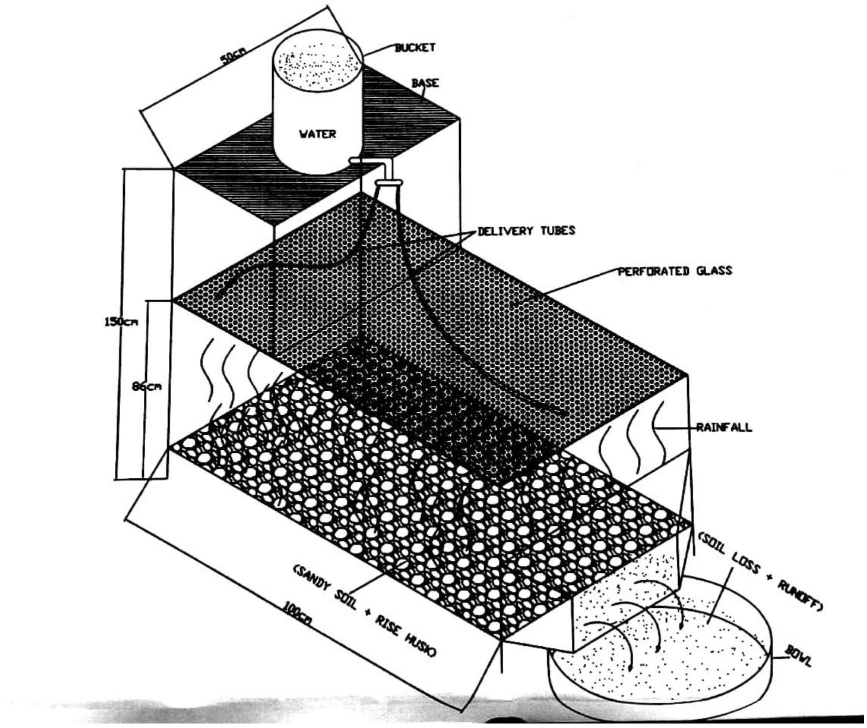

Figure 2: Diagram of a Rainfall Simulator

III. RESULTS AND DISCUSSION

The location site visited and their coordinate are as follows;Nsu $5^0$38'48''N $7^0$17'47''E, Obowo 5036'10''N 7019'21''E, AforUkwuIhitte 5047'34''N 7007'46''E, UmuoparaMbano $5^0$39'24''N $7^0$18'55''E, EmekukuOwerri North $5^0$28'05''N $7^0$06'21''E, OparanadimAhiazuMbaise $5^0$34'25''N $7^0$14'24''E, IbeaforUmunumo $5^0$39'15''N $7^0$16'23''E, Isiekenesi $5^0$47'33''N $7^0$07'41''E, Dikenafai $5^0$46'33''N $7^0$08'59''E, Owerri West $5^0$23'54''N $6^0$59'22''E, UmuoparaNzerem $5^0$40'50''N $7^0$19'13''E, and Uturu-Okigwe $5^0$49'51''N $7^0$25'19''E.

After the Rain Simulator experiment the values of all the parameters was used to do the Formulation of Empirical Soil Loss Regression Model as presented in Equation 1, thereafter statistical validation was done.

The Calibration and Verification of Soil losses predicted from ESLRM and Experimental Measured Soil Loss were plotted as presented on Figure1: and Figure2: respectively by Ibearugbulem *et al*. (2018).

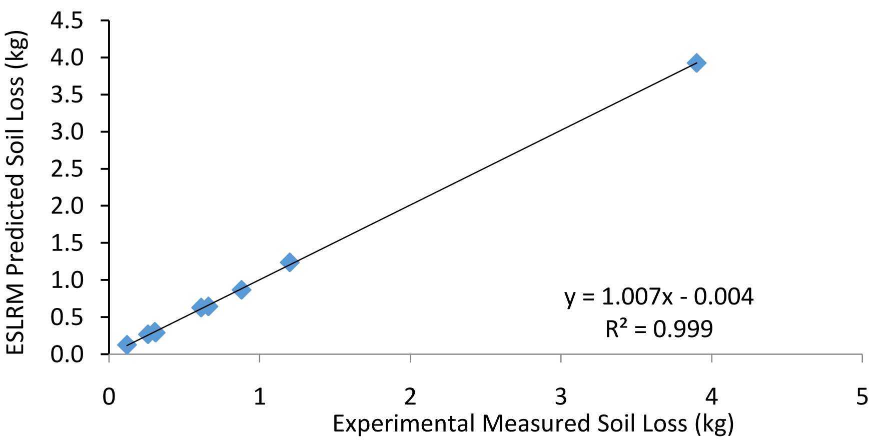

Figure. 1: Calibration of Measured and Predicted Soil Loss Using Empirical Model (ESLRM)

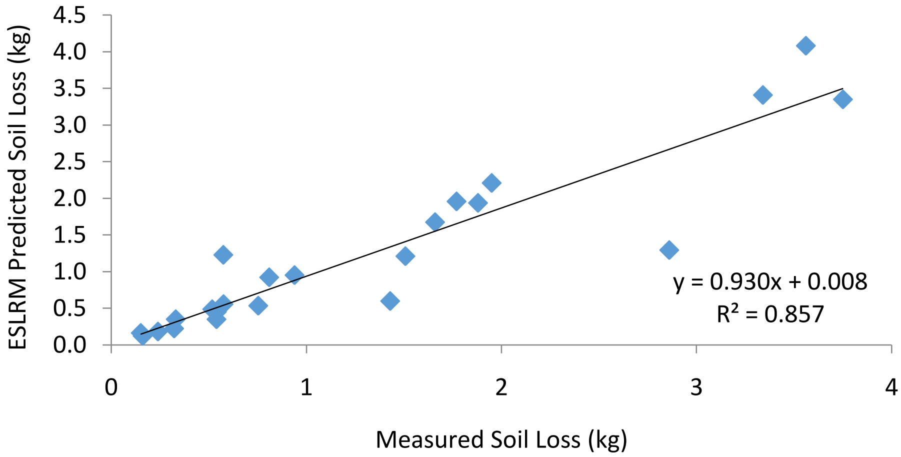

Figure. 2: Verification of Measured and Predicted Soil Loss Using Empirical Model for other 23 test

Figure1: shows that correlation of measured and predicted soil loss using ESLRM give a perfect relationship. The soil loss graphical linear equation was $Y = 1.007x - 0.004$ with coefficient determination $R^2\ as\ 0.999$ and the Figure gives a positive slope graph. This means that the model is feasible. Secondly, Figure 2: indicates that verification of measured and predicted soil loss using ESLRM for the entire experiment, give a perfect correlation. The soil loss graphical equation was $Y = 0.948x + 0.003$ with coefficient of determination$R^2\ as\ 0.897$.

3.1 Examined the ESLRM model

The examination is based on the rearrangement of the model, the terms that are on the numerator are those that their increase caused increase in soil loss yield; while those that are on the denominator are the ones that their increase leads to decrease in soil loss amount.

The empirical soil loss regression model (ESLRM) formulated in this work is presented herein as:

$$S_L = e^{(-12.2867)} * I^{(2.921707)} * S^{(2.057649)} * D^{(0.87341)} * \rho^{(0.074376)} * A^{(0.234785)} * O^{(-0.68998)} * C^{(-1.00134)} \quad (1)$$

Where, e is exponential, I is rainfall intensity, S is slope of the catchment, D is duration of the experiment, ρ is density of soil, A is catchment area, O is organic matter content in the soil, and C is clay content in the soil.

Re-write equation 1 or rearranged it in fraction form which yield;

$$S_L = e^{(-12.2867)} * \left(\frac{I^{(2.921707)} * S^{(2.057649)} * D^{(0.87341)} * \rho^{(0.074376)} * A^{(0.234785)}}{O^{(0.68998)} * C^{(1.00134)}} \right) \quad (2)$$

Rainfall intensity I is one of the experimental parameters in the ESLRM and was found to be on the numerator of Equation 2 and its exponential factor was 2.921707 that make it more significant enough to cause erosion at it slightly increase.

Catchment slope S, is also one of the parameters in the soil loss model which make part of those on the numerator of the equation with exponential factor 2.057649 which shows a great importance to soil loss etc. In summary from Equation (2) above; I, S, D, ρ and A are erosive element whereas O and C are non-erosive element.

3.2 MEASURED AND PREDICTED SOIL LOSS AGAINST EACH PARAMETERS

The soil loss measured and predicted were plot against each of the experimental parameters for calibration and verification.

3.2.1 Calibration of Experimental Parameters

Soil loss amount from the experimental process and the predicted was plotted with individual experimental parameter as presented on Figures 3 to 9.

The individual parameters of clay content were plotted against Soil loss for measured and predicted, as shown in Figure 3.

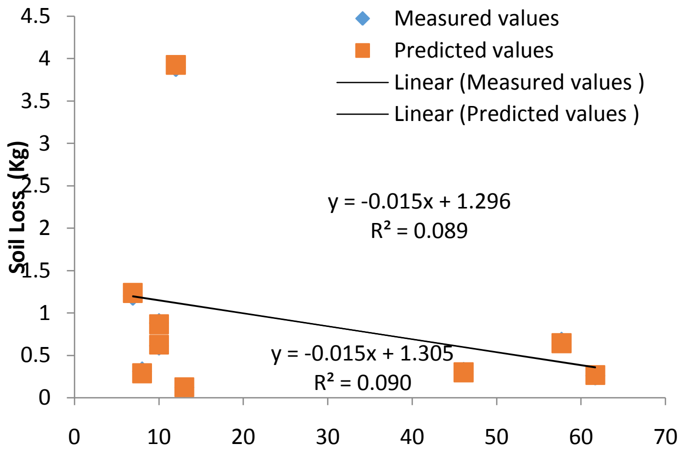

Figure 3: Calibration of Soil Loss and Clay Content (%)

Secondly, Organic content was plotted against Soil loss as shown in Figure 4.

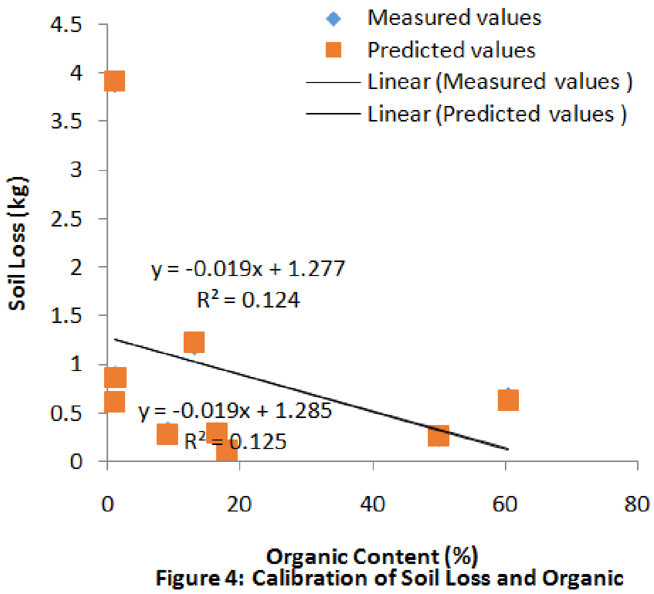

Figure 4: Calibration of Soil Loss and Organic Content (%)

On the other hand, Catchment area (A) was plotted against Soil loss as shown in Figure 5.

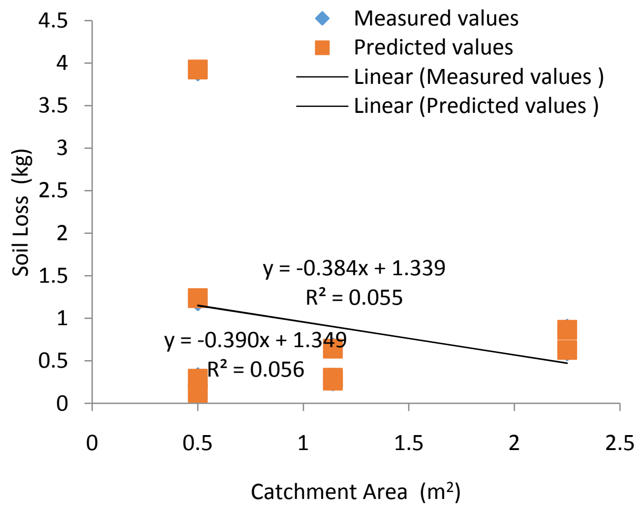

Figure 5: Calibration of Soil Loss and Catchment Area (m^2)

Soil loss was plotted against density as presented in Figure 6.

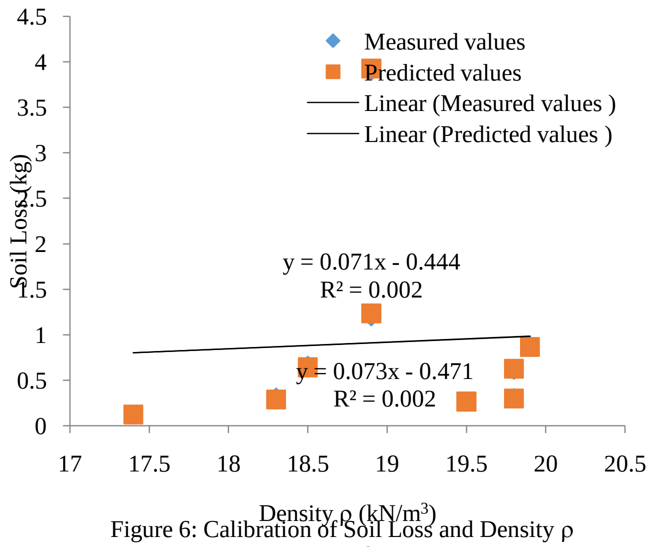

Figure 6: Calibration of Soil Loss and Density ρ (kN/m^3)

However, soil loss was plotted against duration of the runoff, as shown in Figure 7.

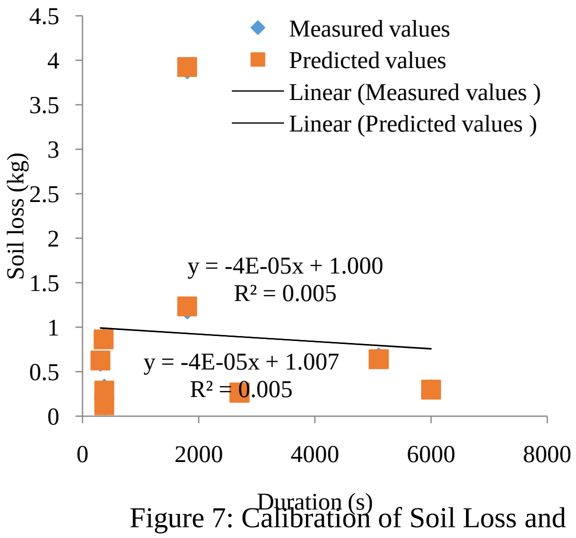

Figure 7: Calibration of Soil Loss and Duration (s)

Furthermore, soil loss value was plotted against slope in (%) of the catchment as shown Figure 8.

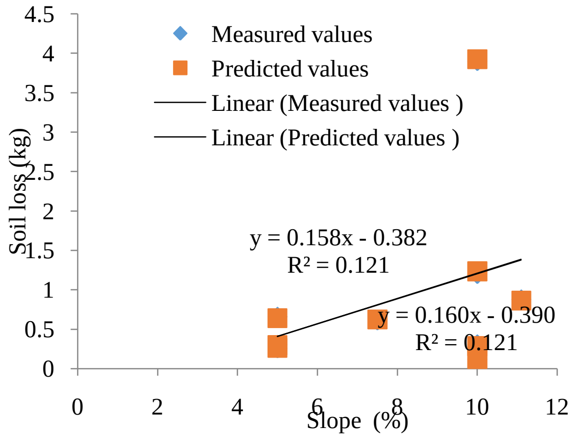

Figure 8: Calibration of Soil Loss and Slope (%)

Finally, Intensity of the simulated rain was plotted against Soil loss as shown in Figure 9.

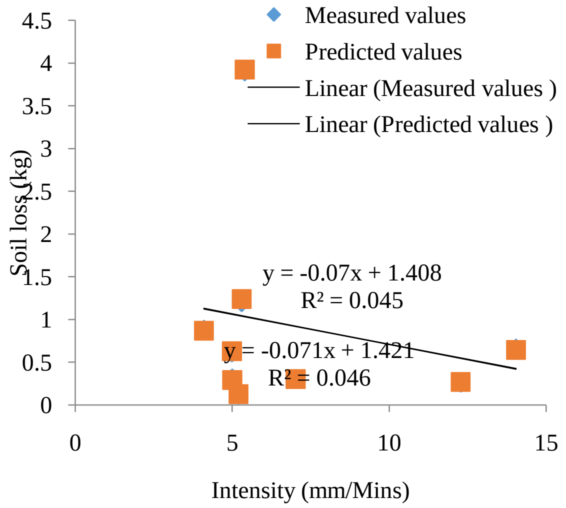

Figure 9: Calibration of Soil Loss and Intensity (mm/mins)

The results presented at Figures 3 to 9 of soil loss measured and predicted ones and effect of model variables for selected experiment used in model regression are summarized in Table 1. This shows that the Soil loss (measured), graphical equation and Empirical Soil loss Regression Model graphical linear equation with their successive coefficient of determination, R^2 values of soil loss and variable with percentage difference.

Table 1: Effect/Calibration of Model Variables to Soil Loss Measured and ESLRM

Parameter	S.I Unit	Soil Loss Measured Equation	R^2	ESLRM Model	R^2	% Diff.
Clay Content	%	y = -0.015x + 1.296	0.089	y = -0.015x + 1.305	0.090	-1.124
Organic	%	y = -0.019x + 1.277	0.124	y = -0.019x + 1.285	0.125	-0.806
Catchment Area	(m^2)	y = -0.384x + 1.339	0.055	y = -0.390x + 1.349	0.056	-1.818
Density ρ	(kN/m^3)	y = 0.071x - 0.444	0.002	y = 0.073x - 0.471	0.002	0.0
Duration	(s)	y = -4E-05x + 1.000	0.005	y = -4E-05x + 1.007	0.005	0.0
Slope	(%)	y = 0.158x - 0.382	0.121	y = 0.160x - 0.390	0.121	0.0
Intensity	(mm/Mins)	y = -0.07x + 1.408	0.045	y = -0.071x + 1.421	0.046	-2.222
Soil Loss	(kg)	y = 1.007x - 0.004	0.999	y = 1.007x - 0.004	0.999	0.0

3.2.2 Effect of each Experimental parameter on Soil Loss Calibration

The result from Figure 3: above shows that soil loss decreased with an increase in clay soil possibly because of its binder effect. The graph gave a negative slope and produced same equation for the relationship in linear form: Y= -0.015x + 1.3 and $R^2$is 0.09 with insignificant %difference of -1.124.

Also, organic content has effect on soil loss as the increase in organic matter to the soil resulted to a decrease in soil loss in the catchment and the graphical relationship gave a linear equation as: Y= -0.019x +1.28 and R^2 is 0.125 as shown in Figure4: above with a very small and negligible %difference of -0.806.

However, in Figure 5, the more the catchment area, the more the soil loss for the resistant soil; but for the ordinary (normal) soil even at small catchment area; it yielded more soil loss which made the graph to trend in negative slope and changed the analogy of the more the catchment area, the more soil loss to the more the catchment area, the less soil loss and its graphic relation in linear form is: Y = -0.39x – 1.34 and $R^2$is 0.56 with a negative slope.

The plots of soil loss against density of soil have slight effect on soil loss as shown in Figure.6.
The graph is of positive slope which means that the more the soil density; the more the soil loss and the equation are as follows: Y = 0.073x – 0.47 and $R^2$is 0.002 with no %difference.

The soil loss decreased with an increase in rainfall/runoff duration as shown in Figure 7 above. That is to say that, the soil gained resistance as it gets saturated. And also, it indicate the much presence of soil erodibility i.e. Clay and Organic content are in the soil. The graphical equation of the soil loss gave: Y = -4E – 05x + 1 and $R^2$is 0.005

On the other hand, a plot of soil loss against earth gradient in Figure8 depicts/shows that soil loss increased with an increase in slope with a linear equation of: Y = 0.16x– 0.39 and $R^2$is 0.121

In Figure 9, the graph shows that the more the rainfall intensity, the lesser the soil loss which is not in real life situation but it obeys the principle of soil resistance. Because of the presence of soil loss erodibility (clay and organic content in soil). The linear equation is: Y = -0.07x + 1.41 and $R^2$is 0.046 while the insignificant %difference is -2.222.

3.3VERIFICATION OF EXPERIMENTAL PARAMETERS

Predicted and measured Soil loss amount from the entire experimental process was plotted with individual experimental parameters as presented in Figures 10 to 15.

Clay content was plotted against soil loss measured and predicted as shown in Figure 10.

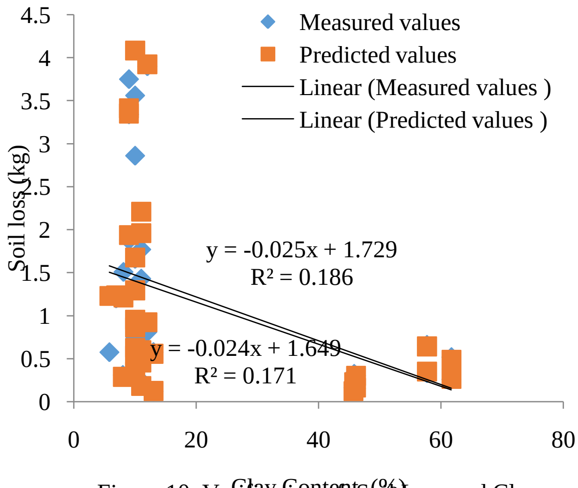

Figure 10: Verification of Soil Loss and Clay Content (%)

However, Organic content was plotted against Soil loss measured and predicted as shown in Figure 11.

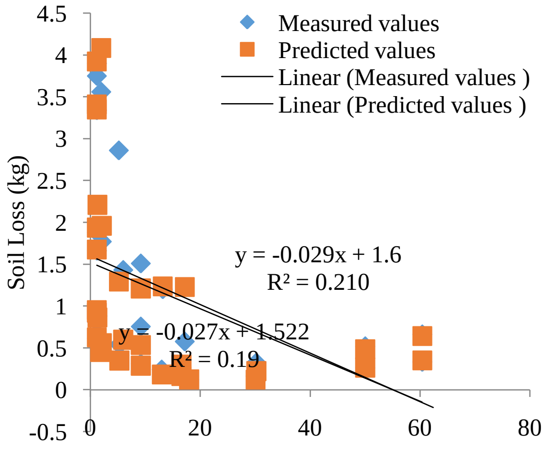

Figure 11: Verification of Soil Loss and Organic Content (%)

Thirdly, catchment area (A) was plot against soil loss measured and predicted as presented in Figure 12.

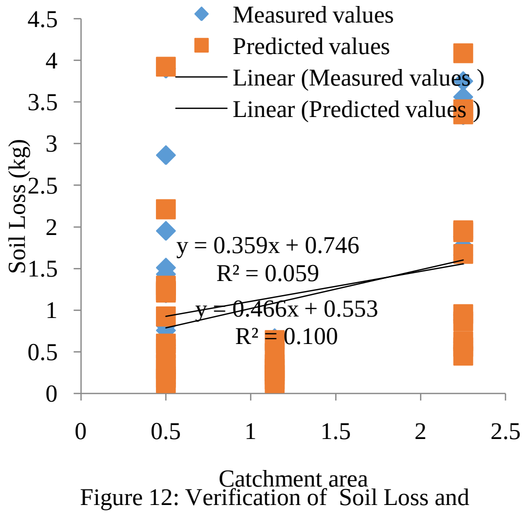

Figure 12: Verification of Soil Loss and Catchment Area (m2)

On the other hand, soil loss measured and predicted was plot against density as presented in Figure 13.

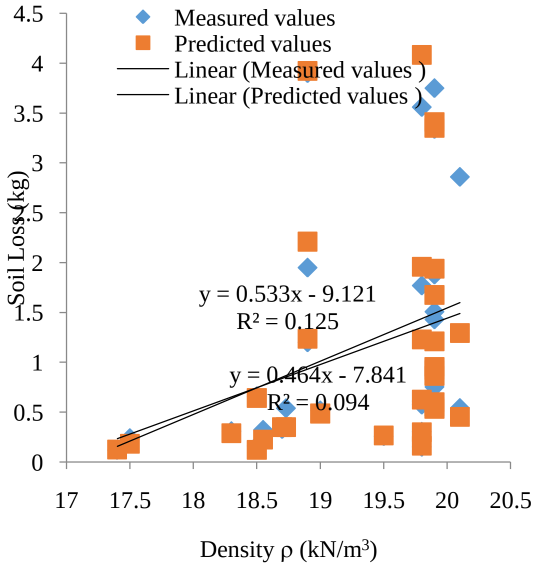

Figure 13: Verification of Soil Loss and Density ρ (kN/m^3)

In addition, Soil loss measured and predicted was plotted against duration of the as shown in Figure 14.

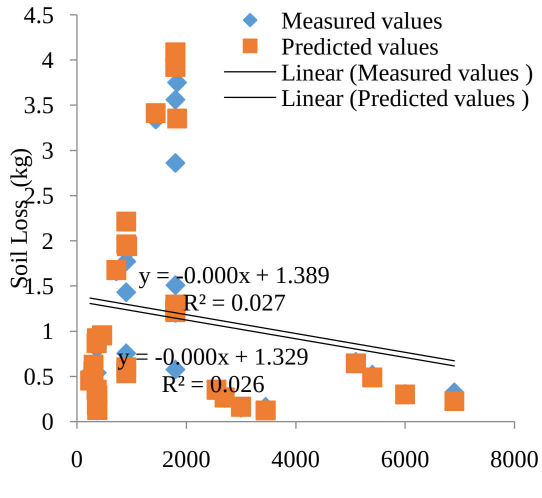

Figure 14: Verification of Soil Loss and Duration (s)

Furthermore, soil loss value was plotted against slope of the catchment as shown in Figure 15.

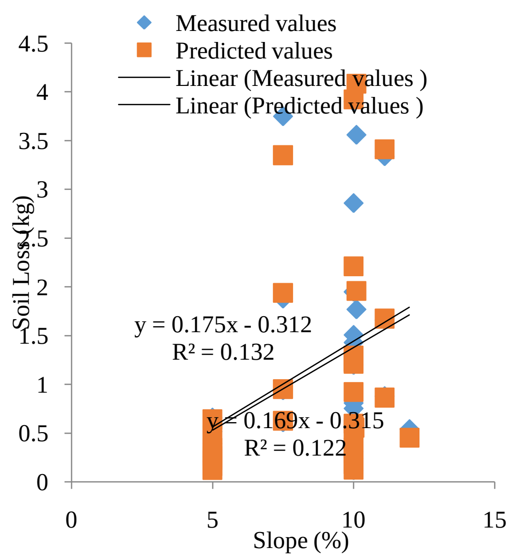

Figure 15: Verification of Soil Loss and Slope in percentage

The results presented in Figures 10 to 15, shows the soil loss measured and predicted soil loss and the effect of model variables for the entire experiment carried out. However, the soil loss measured graphical linear equation and Empirical soil loss regression model graphical linear equation with their successive coefficient of determination R^2 values and percentage difference and for the variables were shown in Table 2.

Table 2: Effect/Verification of Model Variables to Soil Loss Measured and ESLRM

Parameter	S.I Unit	Soil Loss Measured	R^2	ESLRM Model	R^2	% Diff.
Clay Content	%	y = -0.025x + 1.729	0.186	y = -0.024x + 1.649	0.171	8.064516
Organic	%	y = -0.029x + 1.6	0.210	y = -0.027x + 1.522	0.19	9.52381
Catchment Area	(m^2)	y = 0.359x + 0.746	0.059	y = 0.466x + 0.553	0.100	-69.492
Density ρ	(kN/m^3)	y = 0.533x - 9.121	0.125	y = 0.464x - 7.841	0.094	24.8
Duration	(s)	y = -0.000x + 1.389	0.027	y = -0.000x + 1.329	0.026	3.846
Slope	(%)	y = 0.175x - 0.312	0.132	y = 0.169x - 0.315	0.122	7.576
Intensity	(mm/Mins)	y = -0.136x + 2.049	0.112	y = -0.126x + 1.927	0.095	15.179
Soil Loss	(kg)	y = 0.948x + 0.003	0.897	y = 0.948x + 0.003	0.897	0.0

3.3.1 Verification of experimental parameters

Soil loss values for measured and predicted were plotted against the clay content in Figure 10. It shows that the soil loss decreased with an increase in clay content and the graph produced negative slopes. Thus:, Y = -0.025x + 1.729 (measured), $R^2$is 0.186 and Y = -0.024x + 1.649 (Predicted), $R^2$is 0.171.

Soil loss decreased appreciably in Figure 11 with an increase in organic matter in soil and the graphical linear relationship gave: Y = -0.029x + 1.6 (measured), $R^2$is 0.210 and Y = -0.027x + 1.522 (predicted), $R^2$is 0.19 respectively.

However, in Figure.12, the more the catchment Area, the more the soil loss and the linear equation is: Y = 0.359x + 0.746 (measured), $R^2$is 0.059 and Y = 0.466x + 0.533 (predicted), $R^2$is 0.10. The slope is positive unlike the calibration graph that suggested otherwise possibly due to few numbers of data and that has justified our observation/claim.

A graph of soil loss against density was plotted in Figure.13 and the result show that soil loss increased with increase in density. The graph yielded a positive slope and the graphical relation is: Y = 0.533x – 9.121 (measured), $R^2$is 0.125 and Y = 0.464x – 7.841 (predicted), $R^2$is 0.094.

In Figure 12, the soil loss decreased with an increase in runoff/rainfall. It means that the soil gained resistance as it gets saturated. The graphical equations are: Y = -0.000x + 1.389 (measured), $R^2$is 0.027 and Y = 0.000x + 1.329 (predicted), $R^2$is 0.026.

The graph plotted in Figure14 shows that the more the slope of the catchment; the more the soil loss. The linear graphical relation is: Y = 0.175x – 0.312 (measured), $R^2$is 0.132 and Y = 0.169x – 0.315 (predicted), $R^2$is 0.122

Lastly, in Figure 15, the graph shows that the soil loss reduced with an increase in rainfall intensity which is not true in real life situation but it obeys the principle of soil resistance. The graph yielded

Y = -0.136x + 2.049 (measured), $R^2$is 0.112 and Y = -0.126x + 1.927 (predicted), $R^2$is 0.095 respectively.

3.4 DISCUSSION

Contributing Effect of ESLRM Parameter are discussed herein as follows;

Intensity/Geological Slope: Soil loss occurs when there is a strong storm of high intensity that produces runoff. An increase in rainfall intensity gives the highest quantities of soil loss or eroded sediments as against other patterns of rains, (Mohamed 2015).

Results have shown that erosion from surface of soil per unit rainfall and runoff increased as the ground or topography slope of the catchment increased. Their relationship with respect to soil loss was positive, linear and significant enough under different conditions of slope (El-Hassanin and Gaber 1993).

Rainfall Duration and Pattern: Rainfall pattern has a lot to do with the soil loss, while rain pattern is a function of rainfall intensity and duration of rainfall, their increase produced runoff which is the basic principle that causes soil loss and such has effect on soil erosion. Results have shown that when rainfall intensity which is a function of rainfall depth and duration, is small or lowered, it has a linear function fits and the graph of soil loss with rainfall intensity slightly increased trend positive graph; whereas at higher rainfall intensity, the graph showed a non-linear positive graph, Mohamed (2015).

Density: Soil loss can be said to have occurred when there is a movement or removal of topsoil which is a function of many activities on the soil surface to the subsoil by tillage, water shear stress or wind etc. During the harvest of farm produce, there is a tendency for the soil loss to be high due to excavation, shape and size of the crop. That is agronomic factor as density of the soil and soil particle been loosed as these activities have taken place, has effect on the soil erosion, Pius and Olusegun (2016).

Organic Content: Organic matter was found to contain a lot of nutrient value, which is supplied to plants by means of decomposition process through soil microbes. The organic matter is being replenished through the atmosphere interactions, of plant and animal on soil surface. Therefore, the loss of organic matter and its nutrient by erosion has a great effect on the soil nutrient value and its productivity in terms of food supply. This leads to the use of artificial means of reclaiming the soil nutrient by composition and organic fertilizer from animal waste or manure or commercial fertilizer (Mahdi, 2019).

Clay Content: Increase in clay and decrease of organic matter leads to decrease in amount of available soil moisture for plant, this result from erosion which in turns lowers the soil productivity, leads to scarcity of food. Water holding capacity (WHC) is higher in the soil when the amount of organic matter is on the increase. In other words, the application of organic matter enhances the value of WHC and as well affects the bulk density of soil which helps in soil porosity (Shreeja, 2019). Thus the ESLRM model is in order by incorporating the following parameters: soil bulk density, organic matter, and clay content as its parameters (Ibearugbulem, *et al.* 2018).

Catchment Area/trey area: the area / basin where overland flow occur due to excess precipitation which initiate the process of soil erosion starts from sheet /interrill erosion to rill erosion gradually developed gully erosion in the direction of the outlet of all rainfall drops in the basin. (Foster *et al.* 2003)

IV. CONCLUSION

This study has exposed how catchment area, density, slope, clay content, organic matter, rainfall duration and Intensity are related to amount of soil loss. In any catchment, if the soil characteristics are known, the Empirical Soil Loss Regression Model (ESLRM) can be confidently adopted in calculationof the amount of soil loss without running into difficulties and waste of time in field measurements.

Based on ESLRM model, the higher the values of the following parameters: clay content, organic matter, rainfall duration and rainfall intensity; the lower the values of soil losses. On the other hand increase in values of parameters like; Catchment Area, Density and Slope resulted in higher estimates of soil loss.

4.1 RECOMMENDATION

1. We recommend that farmers and land users adopt appropriate measures in making sure that their land's topography are properly designed to ensure that the topmost soil is not washed away due to steep slope.
2. Farmers should also incorporate organic matter composite into their farmlands to improve soil nutrient and also discourage soil loss due to its binding effect on the soil.
3. Farmers who plant certain crops like paddy rice, yam etc. are encouraged to use clay-organic matter composite due to their water holding capacity and resistance to soil loss.

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