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Assessment of Soil Loss Change in Orlu and Environs Between 2012 and 2017

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ABSTRACT

Soil erosion generally is caused by several factors working simultaneously or individually to detach transports and deposit soil particles in different place other than where they were formed (Igwe, 2012). This study aimed to assess the soil loss change in oOrlu and environs between 2012 to 2017. The Multi-date landsat Etm+ of 2007, 2012 and 2017 and Aster DEm were downloaded through United State Geological Survey (USGS) web Site. the landsat imageries were used to assess the cover and management C factor through the maximum likehood image classification, the Runoff Erosivity R factor were derived from Rainfall data of January 2007 to December 2017. The soil erodibility K factor was extracted using georeferencing and digitizing of soil map. The aster Dem was used to generate the conservation support practices P factor and Slope Length and Steepness Factor, (LS) LS factor. The Revised Universal Soil Loss Equation (RUSLE) was employed to estimate annual soil loss between 2007, 2012 and 2017. The results of the study indicate that the amount of soil loss in the study area is high. Analysis of soil loss shows that Orlu LGA loss it soil annually at very high rate than Ideato North. While the soil loss in Ideato south decreased at rate of 150.2 annually from 2007 to 2012. But due to the high rate of Rainfall and topographic modification over the period of 2012 to 2017, the annual soil loss of all the LGA increased. Construction of concrete drains to accommodate run off during rainfall should be encouraged to avoid run off diversions therefore speeding up of gully formations.

Keywords: *Soil loss, RUSLE Model, Change, Erosivity*

1. Introduction

Soil erosion is recognized as one of the major causes of land degradation worldwide (Valentin et al., 2005; Chukwu, 2018) and a key impediment to environmental sustainability (Lal, 2001). It is a natural process of detachment, entrainment and transport of soil and materials through the action of erosive agents such as water, wind, gravity, and anthropogenic perturbations. At geological time-scales there is a balance between erosion and soil formation (Tricart and KiwietdeJonge, 1992), but at many locations worldwide, disequilibrium currently exists between these two processes. This disequilibrium is called accelerated soil erosion and is principally caused by anthropogenic land use changes like deforestation and agricultural practices (Ofomata, 1982). Soil loss is a grave concern and it is a world-wide problem. In general, Gully erosion is widely considered to be a serious threat to the long-term viability of agriculture in many parts of the world (El-Swaify et al., 1985). An important approach to gully erosion management involves mapping which is relatively new in Nigeria Igbokwe et al (2008). Through various space borne sensors currently orbiting the earth, satellite remote sensing can offer an important input to erosion assessments at various spatial scales. Gully erosion is the more visible form of soil erosion in Nigeria; mainly because of the remarkable impression they have on the landscape (Nwafor, 2006; Chukwu, 2018). The highest concentration of severe gully erosion in Nigeria is found in Eastern parts of Nigeria where gullies of over 120m in depth and 100m in width are common. Adinna (2001) asserts that considerable part of Akwa Ibom, Imo, Abia, Anambra and Enugu states are affected by gullies especially on the east facing scarp-land while sheet erosion with intermittent gullies are common in the Northern parts of Delta and Auchi in Edo state. Gully erosion has been observed to have adverse effects on the environment, in Orlu and environ studies by Ofomata (1975), Igbozurike (1990), who highlighted the dangers associated with heavy gully in the study area. In addition, the reduction in agricultural land in the study area with associated low productivity and increase in population has been documented by Ogbonna (2009). The aim of the study is to assess the soil loss change in orlu and environs between 2012 and 2017.

2. Literature Review

Orlu and its environ consist of three Local council areas namely Orlu, Ideato South and Ideato North local Government areas all in the south Easthern Nigeria (Figure 1). It is located at Latitude 0060 59’ 30” to 0070 30’ 00” North and Longitude 0050 30’ 35” to 0060 10’ 00” East (Figure 3). The study area has boundaries with Anambra State to the North, Orsu local government area in the West, Onuimo and Okigwe local Government areas to the East and Njaba and Nkwerre Local Government Area to the South. Many networks of roads cut across the study area namely Owerri - Orlu - Ekwulobia road, Okigwe - Aro ndeizuogu - Nnewi road, Anara - Orlu -Ihiala road. The physiography of the study area is dominated by a segment of the NW-SE trending Awka-Orlu cuesta which rises to about 300m above mean sea level and to about 200m above the surrounding plains. Rainfall distribution in the study area is bimodal, with peaks in July and September and a two week break in August. The rainy season begins in March and last till October or early November. Economic trees like the Iroko, mahogany, obeche, gmelina, bamboo, rubber, cashew and oil palm trees are dominant in the study area. Due to high population density, most natural forest has been famed and degraded that the original vegetation has disappeared.

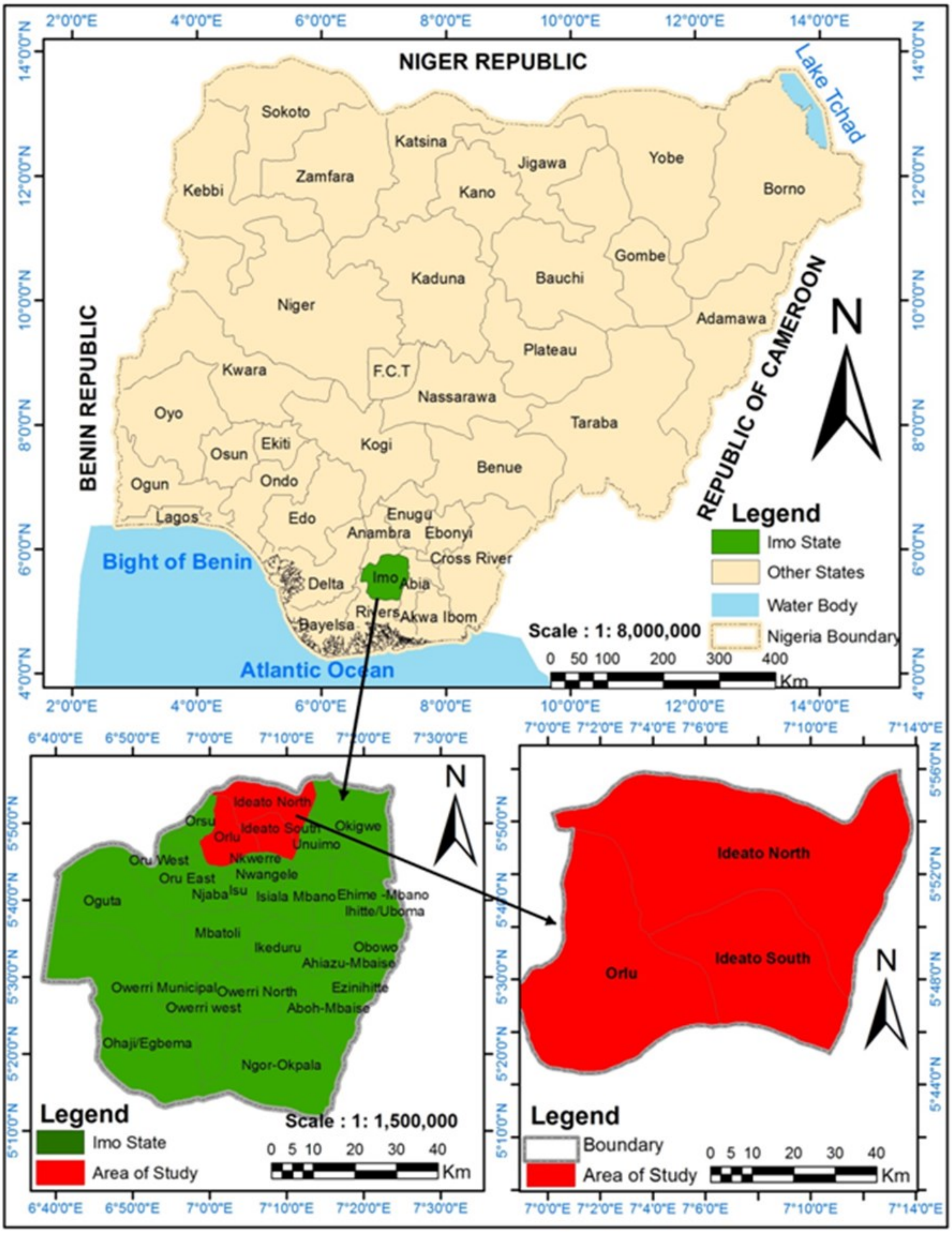
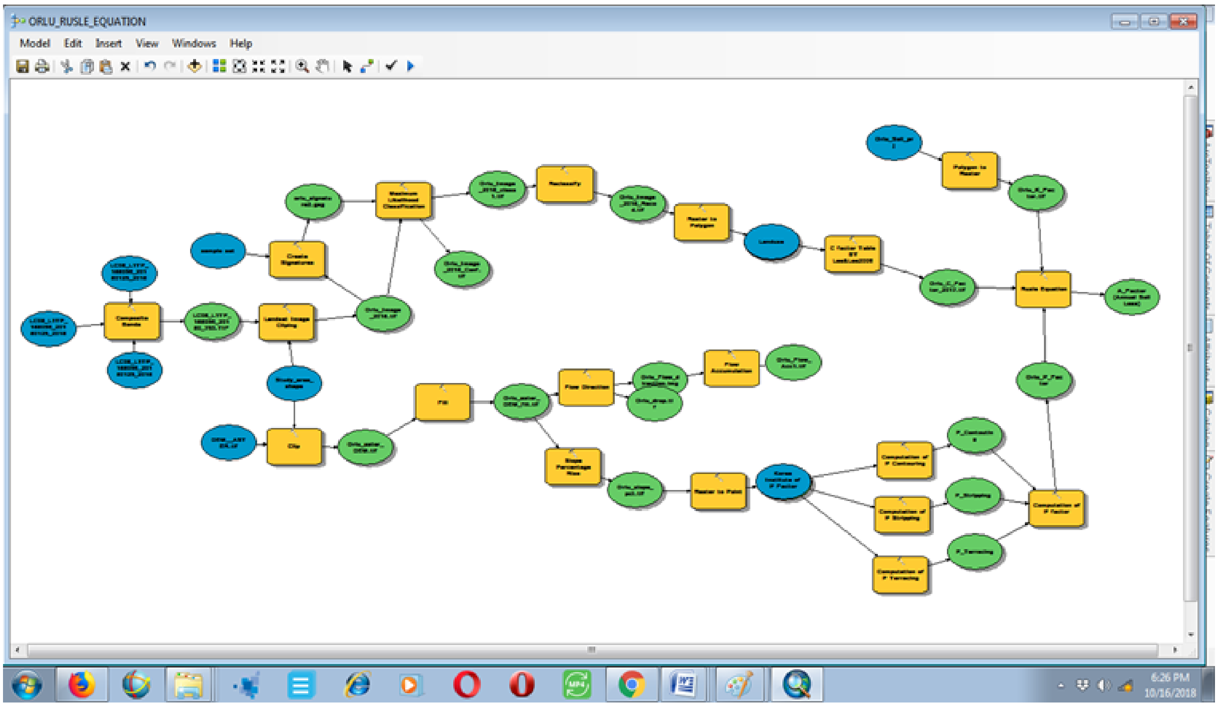


Fig 1: Map of Nigeria and Imo State Showing the Study Area Comprising the Three (3) Local Government Areas

3. Methodology and Data Analyses

The Multi-date landsat Etm+ of 2007,2012 and 2017 and Aster DEm were downloaded through United State Geological Survey (USGS) web Site. The landsat data were subjected to pixel-based image classification and change detection using ArcGis 10.1 software. the cover and management C factor were then derived from Landuse lancover of 2017. The rainfall distribution from January 2007 to December 2017 collected from Nimet was analyses using the rainfall – runoff erosivity R factor formula. The analogue soil map collected from survey department was scanned, georeferenced and digitized. The soil erodibility K factor map was generated by converting soil map to raster format. The Aster Dem was used to process the terrain analysis using arc Hydro geoprocessing. the conservation support practices P factor was derived from slope while the Slope Length and Steepness LS factor was derived from, flow accumulation and slope. Having derived the various RUSLE factors, the average soil loss in tons per acre par year (A) in the study area for each of the study periods can be individually estimated through the multiplication of all the corresponding RUSLE factors. Having obtained the predicted soil loss for the time periods, the resulting data sets will be individually analyzed to determine effects of gully erosion in the area. This will help to adequately predict the likely effect of the problem within a time frame if not checked. The Revised Universal Soil Loss Equation (RUSLE) was employed to estimate soil erosion rates by water. RUSLE, the modification of the earlier erosion prediction model (USLE) developed by Wischmeier and Smith (1978), is a commonly applied model in erosion prediction studies. The equation provides an estimate of the Soil Loss Rate in Tonnes/hectare/year. This estimate can be used for soil conservation planning. The Revised Universal Soil Loss Equation is A = KR (LS) CP. In this study parameters were put into consideration including Soil erodibility factor (K), rainfall factor (R), lengh slope factor (LS), crop management factor (C) and support pratice factor (P). The RUSLE was carried out in ARCGIS 10.1 using RUSLE Modeler Created in arcGis 10.1. The coefficients of the module and their maps were achieved by using GIS tools and input data from the database. The Figure 2 showed the Diagram of GIS Modeler built for RUSLE computation.



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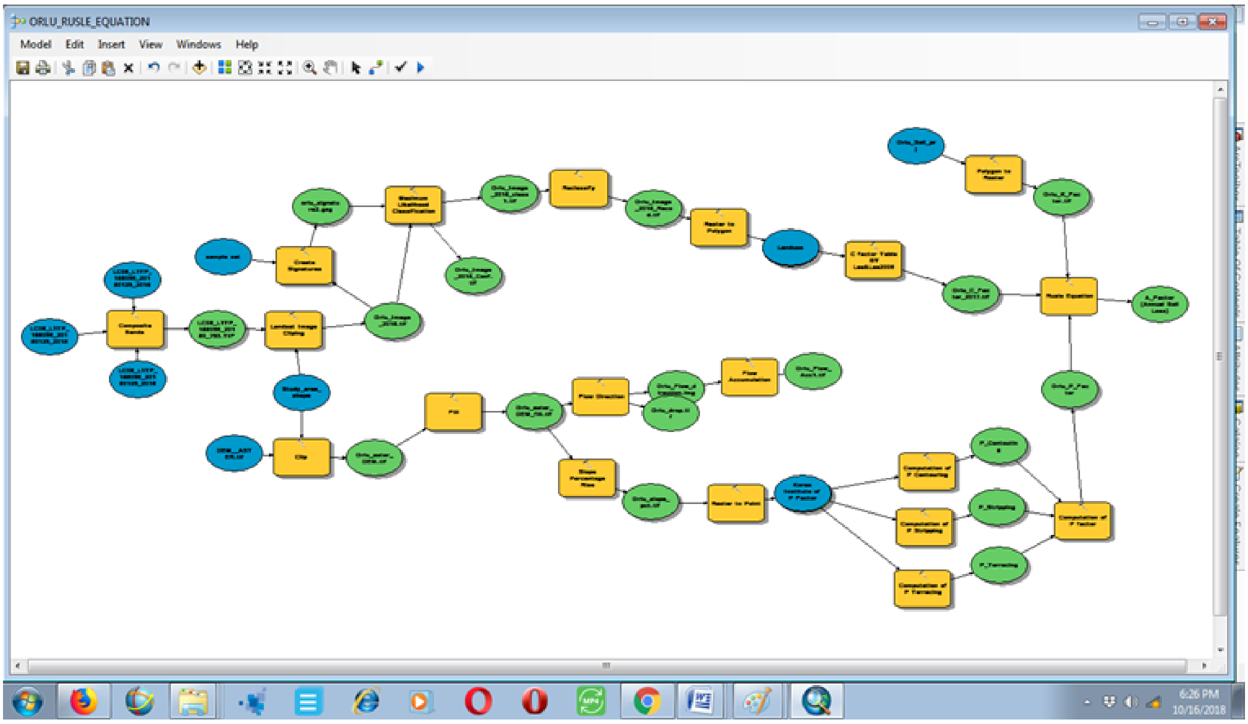


Figure 2.: Complete Diagram of RUSLE Model in ArcGis 10.1 modeler

Vector maps showing the extent of gully expansion in the different period were generated from the aid of the satellite imageries and the boundaries of eroded areas will be presented as polygon for each period. 2000, 2007 and 2017 using Arc editor tools in Arc GIS software.

The difference in the spatial extents of gully erosion expansion for the different years is compared with each other. The "EVENT" method by Aalto, et al (2008) which divides the difference in area of two consecutive gully polygons by the difference in time will be employed to determine the spatial dynamics of the gullies in relation to time.

1. Rate of change in length = $\sum \Delta a / \sum \Delta t$ = km/yr
2. Rate of change in length = $\sum \Delta a / \sum \Delta t$ = km^2/yr

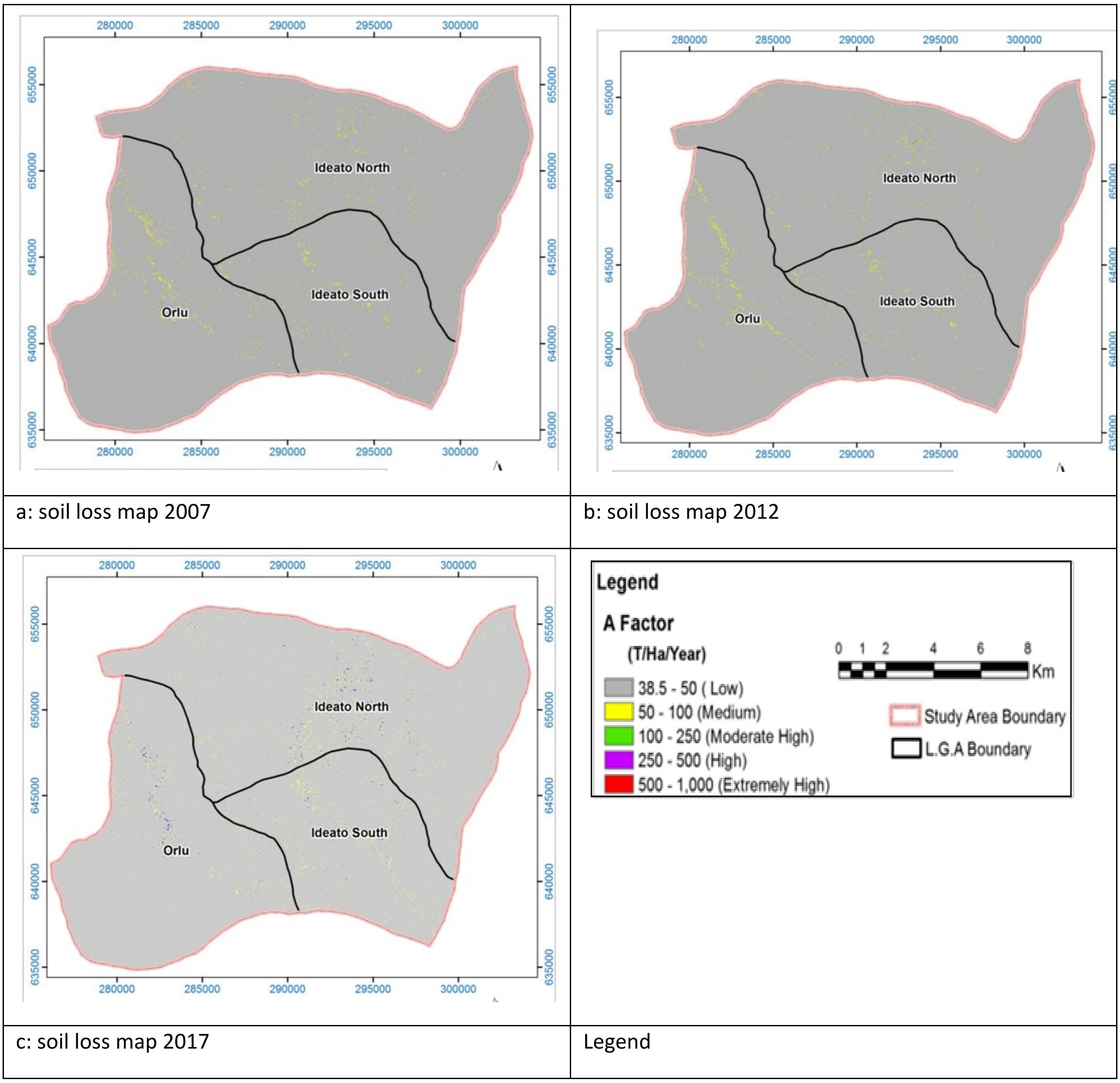
Were Δt = Difference in period, Yr= Year, Δa = Difference in total area.

4.0 Result and discussion

The table 1.0 shows that from 2007 to 2012 the soil loss in Ideato North has increased from 8223961t/h/yr to 8225486 t/h/yr and then 8341480 t/h/yr in 2017. Ideato North has been an erosion prone area due to the topographic structure of the area. meanwhile ideato south annual soil loss decreased from 3827658 t/h/yr to 3826907 t/h/yr and due to the abundance of rainfall in 2012 the soil loss in ideato south increased to 3886562 t/h/yr. Orlu LGA has increased throughout the period of study because of the venerability of it terrain which make it exposed to the Erosion. From 2007 to 2012 it increased from 5692441 t/h/yr to 5708512 t/h/yr and then 5726766 t/h/yr in 2017. The figure 1.3 below shows the soil loss change in the study area.

Table 1: Summary table of Annual soil loss change in the study area (from 2007, 2012 and 2017)

LGA	**Soil Loss (2007)**	**Soil Loss (2012)**	**Soil Loss (2017)**
Ideato North	8223961	8225486	8341480
Ideato South	3827658	3826907	3886562
Orlu	5692441	5708512	5726766
Total	**17744060**	**17760905**	**17954808**



a: soil loss map 2007

b: soil loss map 2012

c: soil loss map 2017

Legend

Figure 3: Map of the soil loss change in the study area

The table 2 below indicates that the sum of annual soil loss in Ideato North and Orlu LGA has increased from 2007 to 2012 at the rate of annual rate of 305 and 3214.2 respectively. The analyst shows that Orlu LGA losses its soil annually at very high rate than Ideato North. While the soil loss in ideato south decreased at rate of 150.2 annually from 2007 to 2012. But due to the high rate of Rainfall and topographic changing over the period of 2012 to 2017, the annual soil loss of all the LGA increased. Ideato North was highly increased at the very high rate of 23198.8, while Ideato south soil loss rate was 11931 Orlu soil loss rate was 3650.8. The figure 5.3.4 shows the zoom portion of the soil loss in the study area.

LGA	Rate of Change (2007-2012)	Rate of Change (2012-2017)	Change (2007-2012)	Change (2012-2017)
Ideato North	305	23198.8	Increased	Increased
Ideato South	-150.2	11931	Decreased	Increased
Orlu	3214.2	3650.8	Increased	Increased
Total	3369	38780.6	Increased	Increased

Table 2: Annual rate of Gully Change

Higher erosion rate on longer slopes may be due to increased runoff velocity on longer slope lengths (Kramer & Meyer, 1969), and therefore, due to increase in rill erosion (Foster et al, 1977). The C factors are related to the land-use and are the reduction factor to soil erosion vulnerability. It is an important factor in USLE, since they represent the conditions that can be easily changed to reduce erosion (Reshma P., Uday K. 2012). The support practice factor P represents the effects of those practices such as contouring, strip cropping, terracing, etc. that help prevent soil from eroding by reducing the rate of water runoff. Four class of soil was found and analyzed in the study area, this included: Clay, Clay loam, Sandy Loam and Silt Clay. Orlu and Ideato South LGA's are mainly covered by Silt clay and Sandy loam, While Ideato North is covered by clay, Silt and Sandy. Human activity, however, is the major factor that influences the erodibility of soil in the study area. The results of the study indicate that the amount of soil loss in the study area is high due to high rainfall, increased population and livestock growth leading to shortages of farm land for the sustenance of household livelihood, continuous plow of the same land without fallow, complete ruining of soil conservation structures and lack of perception to participate in soil conservation interventions for at least the last decades in the study areas in particular.

The erosivity factor R of Orlu and environs was derived from a large quantity of data on precipitation. The average annual value of factor R was calculated from long-term records of precipitation. Hence the rainfall erosivity factor R depends on the frequency of occurrence of rainfall, and on its kinetic energy, intensity and amount. The histogram (fig 1.4) shows that there has been abundant precipitation in the study area for 35 years. The lowest rainfall factor was 86.39 about 1642mm. and was recorded in 1998 while the highest rainfall factor was in 146.54 about 3704.2 mm and was recorded in 2012.

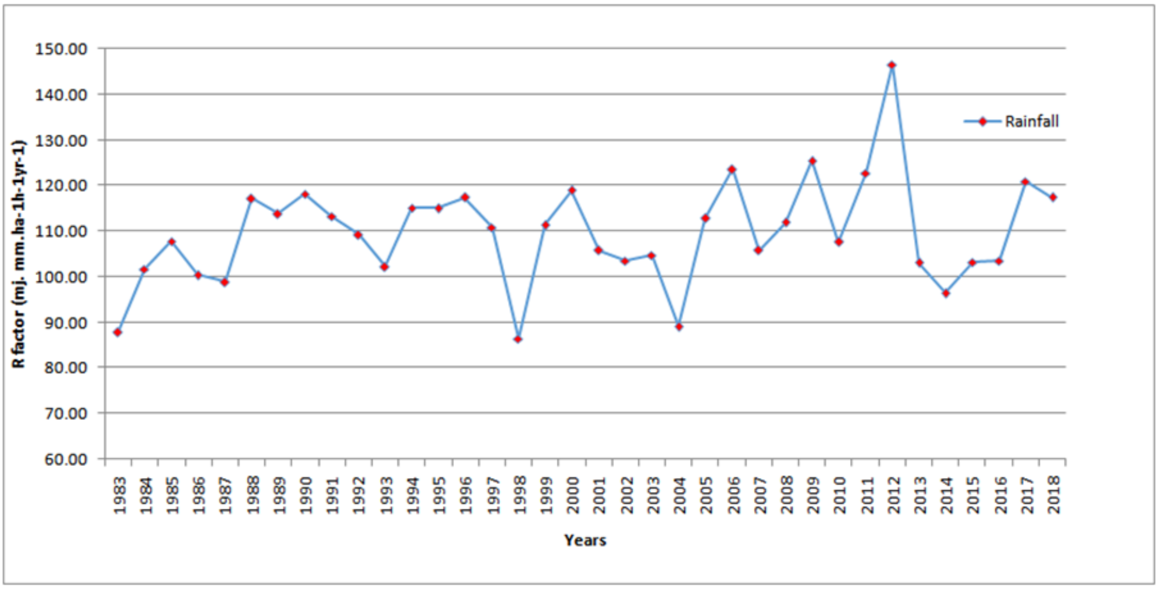


Figure 4: Graph of Rainfall Erosivity Factor (R) of the Study Area

5.0 Conclusion and Recommendations.

Soil erosion is a worldwide phenomenon which ravages large areas of land particularly in high rainfall or windy locations (Poesen et al. 1996). The application of GIS in gully erosion study cannot be over emphasized (Nwilo et al. 2011). The results of the study indicate that the amount of soil loss in the study area is high. This is due to high rainfall, increased population and livestock growth leading to shortages of farm land for the sustenance of household livelihood, continuous plow of the same land without fallow, complete ruining of soil conservation structures and lack of perception to participate in soil conservation interventions for at least the last decades in the study areas in particular. Analysis of soil loss shows that Orlu LGA losses its soil annually at very high rate than Ideato North. While the soil loss in Ideato south decreased at rate of 150.2 annually from 2007 to 2012. But due to the high rate of Rainfall and topographic modification over the period of 2012 to 2017, the annual soil loss of all the LGA increased. Ideato North was highly increased at the very high rate of 23198.8, while Ideato south soil loss rate was 11931 Orlu soil loss rate was 3650.8. Massive soil conservation practice needs to be applied to mitigate the effect of gully erosion in the study area. Construction of concrete drains to accommodate run off during rainfall should be encouraged to avoid run off diversions therefore speeding up of gully formations.

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References

Adinna, E.N. (2001): Environmental Hazard and Management, Enugu: Snaap Press Limited.

Chukwu, k.E. (2018). "Evaluation of Physiographic Features that lead to soil erosion problems in Nekede, Imo State". International Journal of Engineering and Scientific Research 4(3): 61-72

El-Swaify et al. (1985). Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. Quoted in Eaton, D. (1996). The Economics of Soil Erosion: A Model of farm Decision-making. Environmental Economics Programme Discussion Paper, DP 96 – 01, The Hague, The Netherlands, P. 52.

Igbokwe, J. I., Akinyede, J. O., Dang, B. Alagac, T., Onoh, M. N., Nnodu, V. C. Anike, L. O. (2008). Mapping and monitoring of the impact of gully erosion In Southeastern Nigeria with Satellite remote sensing and Geographic Information System. The international Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences 2 (37) Beijing.

Igbozuruike, U. M, 1990: "Socio-Economic Impact of Soil Erosion". Paper presented at the National Seminar on Erosion Ravages in Southeastern Nigeria: Quest for Solution, Owerri.

Lal R. (2001). Soil degradation by erosion. Land Degradation & Development 12(6): 19-39.

Nwafor, J.C. (2006): Environmental Impact Assessment for Sustainable Development, the Nigerian Paspective. Enugu: El demak Publication.

Nwilo, P. C., Olayinka, D. N., Uwadiegwu, I., Adzandeh, A. E., (2011). An Assessment and mapping of Gully Erosion Hazards in Abia State: A GIS Approach: Journal of Sustainable Development (5).

Ofomata G.E.K (1975). Soil erosion Nigeria in maps, Eastern States. The Ethiope Publishing House, Benin City Nigeria

Ofomata, G. E. K. (1982): Use and misuse of Nigeria's Agricultural Land Resources. In F.O.C Ezedinma et al., (eds). Agric and Land Resources, Kaduna 10–38.

Ogbonna, J. U. (2009). Macro-analytic study of the impact of gully erosion in Old Imo State of Nigeria. An Unpublished Ph. D Thesis of the Department of Geography and Planning of Abia State University, Uturu. Nigeria.

Reshma P., Uday K. (2012), Integrated Approach of Universal Soil Loss Equation (USLE) and Geographical Information System (GIS) for Soil Loss Risk Assessment in Upper South Koel Basin, Jharkhand, Journal of Geographic Information System Vol. 4 No. 6 (2012), Article ID: 26324, 9 pages DOI:10.4236/jgis.2012.46061

Tricart J, and Kiewietdeionge C. (1992). Ecogeography and Rural Management - a Contribution to the International Geosphere-Biosphere Programme Harlow, Longman Group: 267