Contemporary Journal of Social Science and Humanities | *ISSN 2766-757X*
Published by ACADEMIC INK REVIEW | *https://airjournal.org/cjssh*
12011 WestBrae Pkwy, Houston, TX 77031, United States
airjournals@gmail.com; enquiry@airjournal.org

Examination of The Management Strategies for Fluvial Erosion in South Eastern Nigeria

[1]Chukwu, Kevin Ejike (PhD) [2]Obuka, Esther Njideka (Ph.D)

[1&2] Department of geography and Meteorology
Faculty of Environmental Sciences, Enugu State University of Science and technology (ESUT) Enugu State

Publication Process	*Date*
Received	***July 29th, 2021***
Accepted	***August 17th, 2021***
Published	***August 31st, 2021***

ABSTRACT

Consequent to the problems caused by Fluvial (i.e. Erosion by running water), a number of management strategies has been put forward by scholars. These measures range from soil conservation strategies, mechanical/engineering methods, biological and agronomic method, mapping, land use practice, awareness campaign, legislation / policy and sustainability of land resources. Ofomata, (1985), observed that soil erosion is a grave environmental problem that can be effectively managed by addressing the vital components of the broad issue of environmental resources management in Nigeria. This study assesses the Examination of the Management Strategies for Fluvial Erosion in South Eastern Nigeria. The specific study guiding the study was to; to create and Implement the Geo database management system for monitoring of Gully erosion in the study area. The study finds out that 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.

Keywords: *Management Strategies; Fluvial Erosion; Ideato North*

1. Introduction

Conventional erosion control generally recommends the application of erosion control structures and cropping techniques that have shown an ability to retain water and slow down erosion in some other place and under some other circumstances, so it is hardly surprising that most projects involving erosion control have met with failure over the past 50 years (Hudson 1990). Consequent to the problems caused by soil erosion, a number of management strategies has been put forward by scholars. These measures range from soil conservation strategies, mechanical/engineering methods, biological and agronomic method, mapping, land use practice, awareness campaign, legislation / policy and sustainability of land resources. Ofomata, (1985), observed that soil erosion is a grave environmental problem that can be effectively managed by addressing the vital components of the broad issue of environmental resources management in Nigeria.

The US Department of Agriculture (USDA) has defined eight categories of land on the basis of the constraints to large-scale farming. Classes 1 and 2 are slightly sloping (from 0 to 2%) and are fairly well drained. Such land is suitable for almost all crops without any special intervention, apart from drainage. Classes 3 to 6 cover arable slopes: the limitations on cropping increase in accordance with how shallow the soil is, to what extent pebbles and stones prevent mechanization, and how steep the slope is. Classes 7 and 8 must be kept under permanent plant cover, protective forests or extensive grassland. Cropping is not permitted. However, land potential must be classified in each individual case on the basis of local climate, landforms and soil. For example, in the semi-arid Sudano-Sahelian conditions of the Mossi Plateau, distinctions are traditionally made between (i) the steeply sloping ironstone or gravel top of the top sequence, which is reserved for animal husbandry and extensive rangelands, (ii) the broad, gently sloping pediment, which consists, first, of a shallow sandy area, limited in use, and, secondly, a clay-loam area on the lower part of the slope, which is where cropping will be concentrated, and (iii) the soil at the bottom of the slope, which is always to some extent hydromorphic.

Once the map of soil potential has been drawn up, a map of present erosion risks and another of land use are needed. When these 1:10000 scale maps have been compared, a map of intervention and rural infrastructure for watershed management can be drawn up. Erosion control measures must be harmonized with the requirements needed for agricultural production, water management, transportation, industry and other branches of the national economy in order to attain a maximum economic effect in South East Nigeria.

2. Statement of the Research Problem

The problem of gully erosion in the study area has for some time now been addressed through different studies and approaches. The approaches include biological control measures, soil conservation approaches (Okafor and Fernandes, 1987); general awareness of causes and management (Ofomata, 1981, 1982, 1985 and 1991; Igbozuruike, 1977, 1990); engineering control strategies (Niger-Techno Ltd., 1979; Eze-Uzoamaka, 1982; Eze 2002). So far it would appear these efforts have not yielded effective results. Therefore, there is need for additional studies to update data on erosion trends in the study area using advance techniques.

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. Particularly for data-poor regions such as Nigeria, remote sensing data will assist in real time mapping of erosion over large areas, rather than using expensive and time-consuming surveying methods. There appears to be a scarcity of studies on the use of high-resolution imageries obtained from satellites.

3. Research Questions and Objectives

3.1 Research Questions

The study seeks to address the following research questions;

1. What are the management strategies for monitoring gully Erosion in the study area?

3.2 Aim and Objectives of the Study

The aim of the study is to assess the Examination of the Management Strategies of Soil Erosion or Fluvial Erosion) in South Eastern Nigeria. The objectives used in achieving the aim were;

1. To create and Implement the Geo database management system for monitoring of Gully erosion in the study area.

4. Literature Review

According to Mortlock et al., (1996), any erosion mapping methodology will result in a nice-looking map, but without validation of the results, it is unknown whether the obtained results are accurate. To assess the performance of methodologies for a specific region, spatial results therefore be compared with independent data such as derived from field measurements or surveys. Validation data may also be obtained through visual identification of erosion features from high-resolution (about 1m) airborne or space borne data. Besides aerial photographs, good options for this are currently offered by high resolution satellite like Quick Bird and IKONOS.

However, due to the time-consuming nature of obtaining ground truth data, and the lack of standard validation approaches particularly for larger regions, many erosion studies merely performed map construction without performing field validation of the outcomes. These include studies by (Fan et al., 2004; Sekhar and Rao, 2002; Reusing et al., 2000; Anys et al., 1994; Jurgens and Fander, 1993).

According to Ofomata, (1985) soil erosion studies in Nigeria started early 20th century with concentration in parts of the eastern and northern provinces of Nigeria, while (Ologe, 1972 and 1973) and (Sada and Amuta , 1979), concentrated their studies in the mid-western province of Nigeria, (Jeje, 1978) concentrated on the study of erosion in the western part of Nigeria.

5. Methodology of the Study

Vector maps showing the extent of gully expansion in the different period were generated with the aid of the satellite imageries. Boundaries of eroded areas were presented as polygon for the periods. 2000, 2007 and 2017 using Arc editor tools in ArcGIS software.

The difference in the spatial extents of gully erosion expansion for the different years will be 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 ……………… (6)
(2) Rate of change in length = $\sum\Delta a / \sum\Delta t$ = km^2/yr ……………… (7)

Were Δt = Difference in period, Yr= Year, Δa = Difference in total area.
Comparison of total soil loss using RUSLE and direct measurement of gully recession from satellite image will be made during the study.
Using GIS and simple linear regression analysis, future spread of the gully in 10 year time will be predicted.

The linear regression formula is given by

$$y = a + bx \ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

Slope (b) = $(N\sum XY - (\sum X)(\sum Y)) / (N\sum X2 - (\sum X)^2)$ ………… (9)
Intercept (a) = $(\sum Y - b(\sum X))/N$………………………………… (10)

Where;
x and y are the variables.
b=the slope of the regression line
a=the intercept point of the regression line and the y axis
N=Number of values or elements
X=Independent Observation
Y=Dependent Observation
$\sum XY$=Sum of the product of Independent and Dependent Observation first
$\sum X$=Sum of Independent Observation
$\sum Y$=Sum of Dependent Observation

$\sum X2$=Sum of squares of Independent Observation
Applying the above expressions to the gully prediction,
Were
X = is the difference in years
Y= is the difference in length of gully
x = is the number of years
y = is the predicted gully expansion

6. Analysis and Discussion of Results

6.1 Land covers Management Factor (C)

Soil erosion is a common cause of soil deterioration around the world and has been accelerated by improper land use practices over the last several decades (Stanley and Pierre, 2000). To understand the effects of land use on soil erosion, much effort has been devoted to understanding the relationship between land use and soil erosion at the slope, small watershed, basin, and regional scales (Smithson, 2000). The land cover and management factor (C) used by the Revised Universal Soil Loss Equation (RUSLE) reflects the effects of cropping and management practices on soil loss rates (Renard et al., 1997; Millward and Mersey, 1999; Navas, 2009).

Land use management influence the magnitude of soil loss. Among the different soil erosion risk factors, the cover-management factor (C-factor) is the one that policy makers and farmers can most readily influence in order to help reduce soil loss rates. The map (Figure 6.1) shows the management practices C- Factor of study area using land use land cover statistic above.

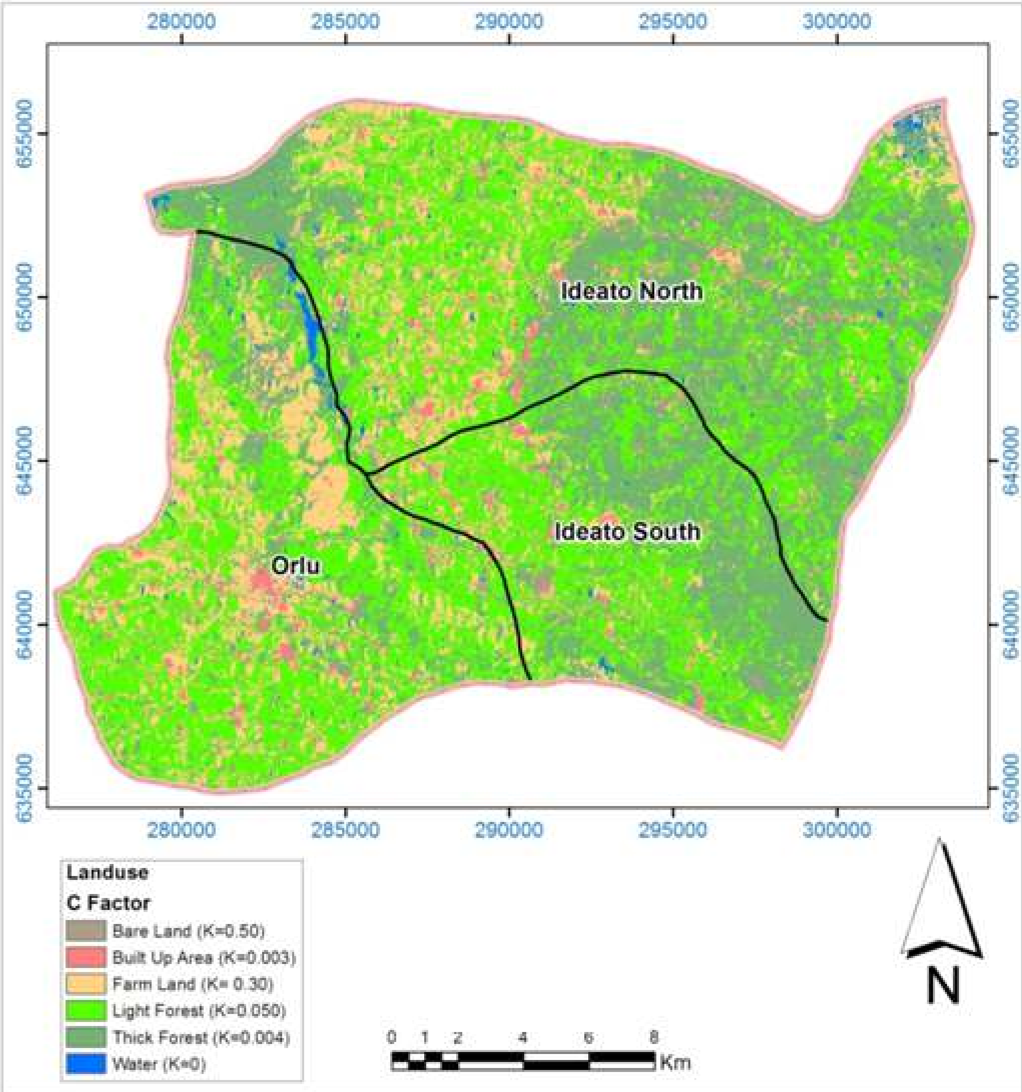

Figure 6.1 Map of land cover management factor.

6.2 Conservation Supporting Practices Factor (P)

P factor is the support practice factor. (Figure 6.2) reflects the impact of support practices and the average annual erosion rate. It is the ratio of soil loss with contouring and/or strip cropping to that with straight row farming up-and-down slope. As the study of this research work to estimate soil erosion using RUSLE modeling was applied in the area of non-agriculture or on natural erosion, it was considered that there was no conservation practice (P) in non-agricultural areas. Therefore, as the conservation practice factor (P) value ranges from 0.00216 -1.0 and the highest value are assigned to areas with no conservation practice.

As with the other factors, the P-factor differentiates between cropland and rangeland or permanent pasture. Both options allow for terracing or contouring, but the cropland option contains a strip cropping routine whereas the rangeland/permanent-pasture option contains an "other mechanical disturbance" routine. For the purpose of this factor, the rangeland/permanent-pasture option is based on the support operation being performed infrequently, whereas in the cropland option the support operation is part of the annual management practice. P is the conservation practice factor. The RUSLE_P factor reflects the impact of support practices in the average annual erosion rate. It is the ratio of soil loss with contouring and/or strip cropping to that with straight row farming up-and-down slope. As with the other factors, the factor differentiates between cropland and rangeland or permanent pasture.

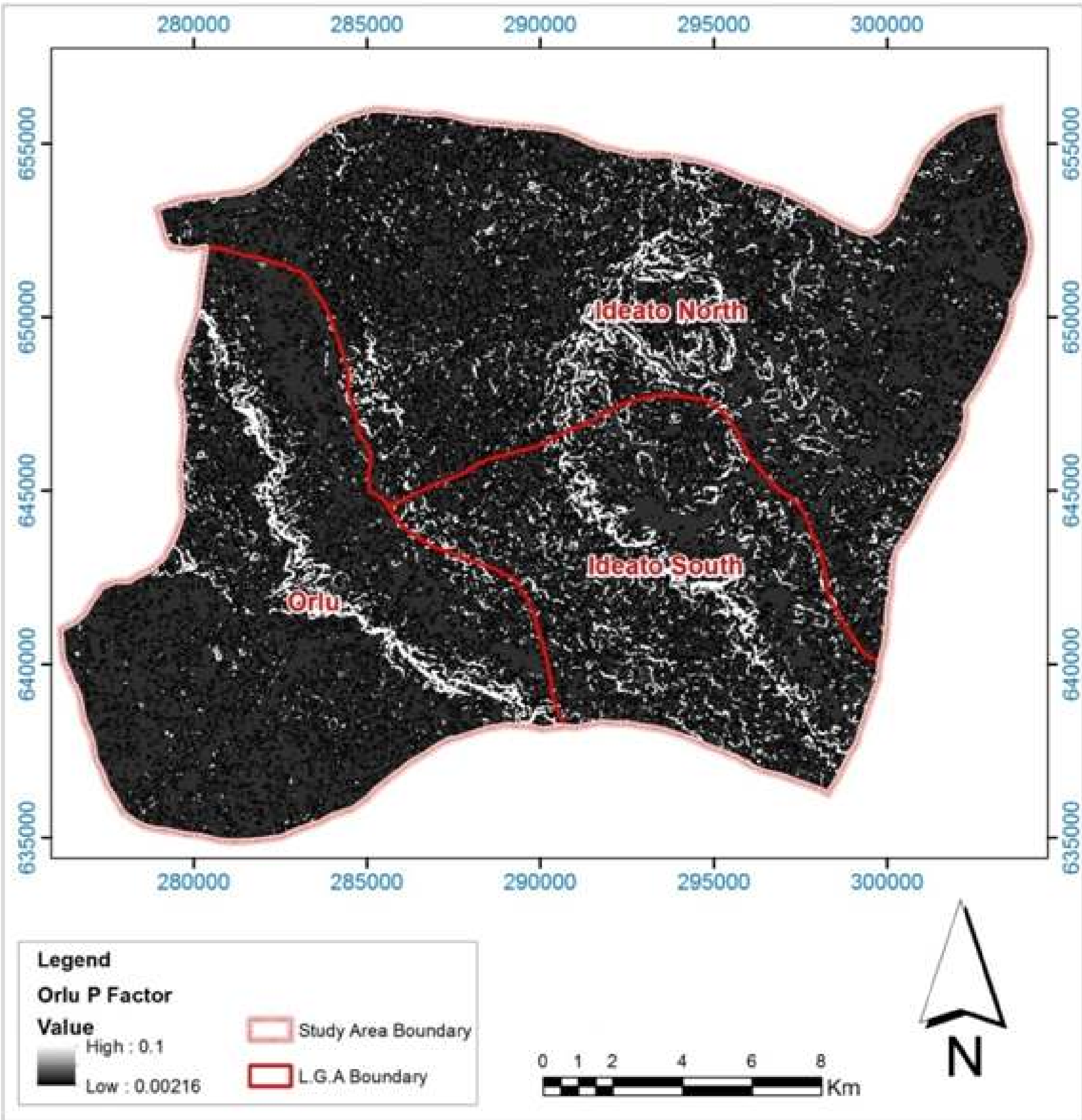

Figure 6.2: Map of land cover management factor of the study area.

6.3 Other Findings

For purpose of these objectives, the major findings of this study are;

(i) Table 5.3.4 indicates 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 5.3.4 below shows the zooming portion of soil loss change in the study area.

6.4 Management of Soil Erosion:

Consequent to the problems caused by soil erosion, a number of management strategies has been put forward by scholars. These measures range from soil conservation strategies, mechanical/engineering methods, biological and agronomic method, mapping, land use practice, awareness campaign, legislation / policy and sustainability of land resources.

Ofomata (1985), observed that soil erosion is a grave environmental problem that can be effectively managed by addressing the vital components of the broad issue of environmental resources management in Nigeria.

6.5. Soil Conservation:

Igwe, (2012), advocates for comprehensive soil conservation programme so as to check the catastrophic erosion hazard in the southeastern region of Nigeria. The soil conservation measures should be those farming practices which ensure sustainable soil productivity while maintaining balance between the ecosystem and regular anthropogenic influence. In combating localized erosion through various management and control strategies, Blackie, (1985) advocates effective community-based participation approach in the control of soil erosion and land management. In line with this, Ofomata (1988), opined that it is of primary importance to elicit the confidence of the local people, who as concerned as anybody else interested in the problem, and who should form part of any soil conservation movements in their various localities. According to him, effort should be continued to control the gullies on well-established order of priorities as well as checking sheet wash and those human activities which lead steadily to continuous soil deterioration.

Buttressing this is the submission of (Ajibade, 1997), that farmers should study and understand their own environments and then adopt appropriate management measures such as the traditional farming methods, which includes according to Jennings (1980) deep ploughing, crop rotation, liming, manuring, and the ploughing-in of grass crops and the avoidance of over-grazing in order to control soil erosion on their farmlands.

With the dwindling area of cultivable land resulting to growing rate of soil erosion in the southeastern Nigeria, Akamigbo (1988) suggests a more radical approach in soil conservation if the region will meet its self-sufficiency in food and timber production. Erosion is indispensible in the view of the expanding economy, population and the limitless use of natural resources.

According to (Goudie, 1990), erosion control measures must be harmonized with the requirements needed for agricultural production, water management, transportation, industry and other branches of the national economy in order to attain a maximum economic effect.

Lal (1990), noted that erosion mitigative measures are both preventive and control, according to (Lal, 1990), erosion preventive measures involve cultural practices that minimize raindrop impact, increase or enhance structural stability of the soil and improve the water intake rate or infiltrability, while the control measures involves management of surplus runoff water or overland flows for their safe disposal at low velocity. Degraded soil due to erosion and other environmental hazard should be subjected to soil conservation measures according to Akamigbo (2000).

6.6 Mechanical

Morgan, (1977), observed that mechanical field practices can be applied to control the movement of water and wind over the soil surface. A range of technologies available and the decision on which one is adoptable depends on the intended objective. (Ofomata, 1985), advocated curative and control measures for mitigation of soil erosion while (ASTFSEC, 1986), have advocated the application of engineering control measures for soil erosion management, the engineering method are largely preventive but costlier which are usually adopted when the erosion incidence is very active or has reached an advance stage. The curative engineering measures as put forward by (ASTFSEC, 1986) include, dams, dikes, walls, contour bunds, terraces, water ways, wave bedding. Recently big sand bags have been introduced to reduce the force of the water behind the dams as a stabilization structures (Adinna, 2001). Igbozuruike, (1993) also highlighted the use of sandbagging, as mechanical method of engineering control strategy. The success in the application of engineering measures such as wave bedding and beach terracing in the control of soil erosion in Anambra state has been documented by (ASTFSEC, 1986). In the view

6.7 Biological and Agronomic Measures

While Lal, (1982), pointed out that agricultural and forestry measures used for erosion control exist according to location and culture. Middleton (1990) is of the opinion that soil erosion can be controlled by agronomic measures, soil management measures or mechanical methods.

Hal, (1982) noted that the planting of culture (grass, cover crops, shrubs and trees) is conditioned by the location attributes, particularly climate and soil properties. Some of the preventive biological and agronomic measures as advocated by many authors are: Agric and forestry measures, use of vegetation, protective forest belts, shelter belts, and afforestation. The Udi forest reserve was created in 1922, followed by an Anti-Erosion plantation also at Udi in 1928 (Ofomata, 1988) all aimed at combating the nefarious effects of soil erosion.

Akamigbo, (1988) and Lal, (1990) recommended that the appropriate trees in the afforestation erosion control should be the fast-growing species with dense canopy, adaptive to local environmental conditions such as areas resistant to pest and diseases and able to regenerate soil by their leaf litters and encourage undergrowth to protect the top soil.

6.8 Mapping

Numerous studies on soil erosion have been undertaken by notable scholars (Ofomata, 1964, 1965, 1966, 1967, 1973, 1978, 1980, 1985, 1988 and 2001); Akamigbo (1988), Igbozuruike, (1980) and (1993), Agu, (1994, 1997), Okagbue and Uma, (1987), Ogbukagu, (1976), Egboka and Okpoko, (1984). Most of these studies have been focused on the eastern part of Nigeria. However, it was observed that none of these studies explored the application of mapping as a management strategy in combating erosion. Except for the research carried out by Nwilo et al., (2001) Igbokwe et al., (2008) and Okereke et al., (2012), ground survey method had always been the source of mapping erosion of affected area in the south east Nigeria.

Plate 3: Field work Carried out by researcher and his Field Officers at Orlu LGA.

7.0 Recommendations and conclusions

Considering the findings and observations made by this study, the following recommendations are therefore put forward;

(i) Due to increased population, pressure on available land spaces has increased. This calls for continuous mapping of land use and cover areas to enable adequate planning and distribution of resources.

(ii) Engineering design and construction of roads and adjoining drainages within the study area need to comply with comprehensive soil test to enable to prevent initiation and subsequent worsening of gully erosion.

Five levels of gully erosion damage ranging from extreme to low were identified based on the total amount of soil lost in each of the local government areas comprising the study area. Most of the gully erosion sites are located in Ideato north with 30 active sites, Ideato south with 27 active sites and Orlu local government area with 9 active sites.

It was observed that in many parts of the study area, the soils have become thin indicating serious signs of soil loss due to erosion process. There are remarkably increase rate of gully erosion in the three local government areas. The rate of soil loss due to gully erosion was projected between 2022 and 2032. In 2022 soil loss was projected at 18.32 square kilometers, in 2027 soil loss was projected at 18.84 square kilometers while in the year 2032, soil loss was projected at 19.54 square kilometers of area to be affected. The implication of this, devastation of agricultural lands will affect food security within the study area by the year 2032.

References

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

Ajibade, L. T. (1997). Erosion, Deforestation and Industrial Pollution in Kwara State, Workshop Organized by Kwara State Environmental Protection Agency, Ilorin Nigeria. 6 – 8th June.

Egboka, B. C. E., and Okpoko, E. I. (1984). Gully erosion in Agulu-Nanka region of Anambra State, Nigeria. Challenges in African Hydrology and water Resources (Proceedings of the Harare Symposium, July 144.

Favis-Mortlock D T, Quinton JN, and Dickinson WT. (1996): The GCTE validation of soil erosion models for global change studies. *Journal of Soil and Water Conservation* 51(5): 397-403.

Goudie, A.S. (1990). Geomophological Techniques. London Routledge, P. 226

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. (1977). Erosion in the Agulu-Nanka region of Nigeria: A suggestion on control measures; paper presented at the conference of the soil society of Nigeria university of Nigeria Nsukka 29th August – 2nd September.

Lal, R. (1977). Anlysis of factors affecting rainfall Erosivity and Soil Erodibility in Soil Conservation and Management in the Humide Tropics. In D. J. Green and Lal R. (Eds.) New York: John Wiley.

Morgan R P C. (1974): Estimating regional variations in soil Erosion Hazard in Peninsular Malaysia, *Malayan Nature Journal,* (28) 94-106.

Millward, A. A. and Mersey, J. E. (1999). Adapting the RUSLE to Model Soil Erosion Potential in a Mountainous Tropical Watershed (Online). Available: SUT Library via http://www. Sciencedirect.com. (Accessed November 24 2016).

Ofomata, G. E. K. (1966). Quelques observations sur l’ eboulement d’ Awgu, Nigeria Oriental, *Bulletin De l’ IFAN*. Series A, (28) 433-443.

Ofomata G.E. K (1981). The management of soil erosion problems in Nigeria. Paper presented at the 24th annual conference of Nigerian geographers’ Association. Kano, April 6th-10th.

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.

Ofomata G.E.K (1985): Soil erosion in Nigeria: The views of a geomorphologist. Inaugural Lecture Series. No 7 University of Nigeria Nsukka: 43.

Ofomata G.E.K (1991): Soil erosion: An Impediment to Better Life for Nigerians. Fellowship Lecture, 34th Annual Conference of the Nigerian Geo. Assoc., Alvan Ikoku College of Edu., Owerri, April 7 – 11.

Okafor J.C and Fernandes E.C.M. 1987: Compound farms of Southeastern Nigeria: A predominant Agro forestry Home Garden systems with crops and small livestock: *Agro forestry System,* 5: 153-168.

Okereke, C. N., Onu, N. N., Akaolisa, C. Z., Ikoro, D. O., Ibeneme, S. I., Ubechu, B., Chinemelu, E., S. and Amadikwa, L. O. (2012). Mapping Gully Erosion Using Remote Sensing Technique: A case study of Okigwe Area, Southeastern Nigeria. *International Journal of Engineering Research and Applications* (3) 1955-1967.

Ologe, K. O. (1972). Gullies in the Zaria Area. A Preliminary Study of Head scarp Recession. *Journal of the Environment and Social Sciences,* A.B.U. Zaria (1) 55-60

Renard, K. G., Foster, G. R., Weesies, G. A., Mc Cool, D. K., and Yoder, D. C. (1997). Predicting Soil Erosion by Water: A guide to Conservation Planning with the Revised Universal Soil Loss Equation. U.S. Department of Agriculture, *Agriculture Handbook*, 703, 384-385.

Smithson, P. (2000): Soil erosion at multiple scales. *Principles and methods for assessing causes and impacts, Agr.Syst.,* 64, 131–136, 2000.

Stanley, S. W. and Pierre, C. (2000): U.S. soil erosion rates – myth and reality, Science, 289, 248–250, 2000.