INDIGENOUS APPROACH TO SOIL EROSION CONTROL IN THE SOUTHWEST NIGERIA

Matthew IBITOYE and Suleiman ADEGBOYEGA, Nigeria

Key words: Soil erosion, Urban landscape, Non-biodegradable materials, Indigenous method

SUMMARY

Soil erosion has been identified as one of the problems of both rural and urban landscape in the world. The poor communities in the developing countries are however more vulnerable, especially with poor technology and financial constraints. In Nigeria, many lives and properties have been lost to perennial erosion problems in many communities. This is exacerbated by the increased rainfall and flood events and the increasing rate of unplanned urbanization. The study investigated the causes of erosion at community scale in the southwest Nigeria, where erosion problems have been found to be phenomenal. Attempts to control erosion in these communities are largely involved indigenous methods, and require a critical examination of their nature, success rates, limitations, and possible areas of improvement. The study showed that erosion type in these communities was mostly sheet erosion, 1^{st}, 2^{nd} and 3^{nd} order gullies, and that use of sandbags, stone bags, wooden pegs, trees, grass planting and non-biodegradable materials including, vehicle tyres, were the main control materials. The control measures put in place by relevant Government Authorities were however restricted to the main towns. It concluded that rural communities were vulnerable to the effects of erosion as the cities, and the indigenous approaches to control the menace were not effective because they were not technically grounded and poorly financed.

1. INTRODUCTION

Soil erosion is the single major process responsible for the loss of billion tonnes of soils worldwide. For example, Murck, et al. (1996) estimated global rate of soil loss through erosion at over 25 billion tonnes per year for both rural and urban environment. In another study carried out in a settled area of Australia, Hughes et al. (2001) observed that one kilometer of gully would produce 10,000 cubic metres of sediment per Km^2 of land. The scholars went further to say that if such happens for a gully aged 100 years; the mean annual rate of erosion would be 1.5 tonnes per hectare per year. Nigeria is not an exception as far as this problem is concerned. For instance, Enabor (1988) estimated that 30 million tonnes of soil were lost on annual basis from both rural and urban environments. Moreover, Jeje (2005) estimated that 531,417.6 and 329,436.5 tonnes of sediment were removed from gullies in Auchi and Ikpoba slope, Benin City respectively.

Apparently, soil erosion has been recognized not only within the rural but also in urban environment for years in Nigeria and in many other parts of the world as evident in the works of (Jeje, 1988, 2005; Ibitoye, 2006). The stakeholders' meeting held at Abuja in 2004 showed that all the states of the Federation were being confronted with one aspect of erosion or the other. For example, Jeje (2005) identified gully erosion in Auchi, Efon-Alaaye and Benin City and classified the gullies on the bases of their physiographic locations such as hillslope, road aligned and valleyside gullies. Also, he cited only a single example of valley floor gully located at Efon Alaaye. It has been reported in another study that gullies appear to be an urban phenomenon and has been occurring at unprecedented rates, creating numerous problems and resulting in heavy economic, human and social losses in many cities in south western Nigeria.

By location, South West Nigeria is in the tropics and so the factors responsible for the soil erosion tend to be difficult to determine. In literature, however factors such as land use, geology, the physical and chemical properties of soil, rainfall intensity, and terrain-based attributes such as slope gradient and slope alongside high population density and attendant pressure on the land in form of deforestation have been suspected (Hughes et al., 2001; Wall et al 2003). In a similar study, Ibitoye and Eludoyin (2010) identified the cause of soil erosion in some communities in Southwestern Nigeria as large volume of runoff generated by the typical high intensity tropical storms that flowed mainly on steep earth roads and unpaved drains. He noted that the continued keeping of unpaved building surroundings permanently bare and the grading of roads contributed immensely to the development of sheet and gully erosion in the rural communities.

Generally speaking, most developmental efforts at various tiers of governments in Nigeria are urban bias except in recent years that development strategy was overhauled to address specific issues in rural areas such as rural electrification, rural water supply, quality health delivery and rural road development. These laudable programmes were pursued with vigour but subsequently most of the facilities put in place were not maintained and sustained by the succeeding administrations.

In the process of implementing the programmes, the rural villages were further exposed to direct impact of torrential downpour by removing some of the trees and vegetal cover that shelter rural landscape. The attitude of the villagers towards maintenance of bare open space in the rural communities to a large extent contributed to accelerated soil erosion. The condition of drainage constructed along roads under the rural road development programme was deteriorating. In fact some of the culverts have collapsed and the villagers have been made to suffer the impact of soil erosion which seems to be intractable.

The rural-urban drift of the young able men from these rural communities has not helped the matter because the aged left behind do not have capability and any other means of checking the erosion beside the traditional methods that tend to be ineffective as the volume of water constituting the runoff is increasing at alarming rate probably due to the current rainfall variability characterizing the global climate change. Attempts to control erosion in these communities are largely involved indigenous methods, and require a critical examination of their nature, success rates, limitations, and possible areas of improvement.

Obviously, information about gullies in few cities of the south western Nigeria has been documented but such gesture has not been extended to rural communities in the region. The study therefore considers it necessary to critically examine and document the nature, success rates, limitations and possible areas of improvement of the indigenous method often employed to mitigate the impact of soil erosion in the selected rural communities under investigation. The study also intends to explore the terrain characteristics of the rural communities by adopting Geographic Information System (GIS) to create the Digital Terrain Model as remarked by Nasir et al (2008) that such model enables the prediction of the threshold contributing area and/or other topographic effects and limits on initiation, distribution and location of erosion vulnerable areas in different conditions.

2. THE STUDY AREA

The study settlements namely Ode-Irele, Akotogbo, Ajagba and Lipanu are within latitudes 6^0 18' N and 6^0 43' N, and Longitudes 4^0 50' E and 5^0 10' E in Irele Local Government Area (LGA), Southwest Nigeria (Figure 1). These settlements fall within the tropical rainforest and the climate is characterized by two seasons namely rainy and dry season. The available 10-year meteorological data (1995-2005) for Ode-Irele show the annual rainfall to have varied from 1,900mm – 2,700 mm (Agro-climatological and Ecological Monitoring Unit, Akure). The rainfall is bimodally distributed with peak in June and September. The dry season occurs in November to March. The mean annual evaporation is 2.1 mm while mean temperature ranges from minimum 22.3^0c and maximum 31.4^0c. The onset and cessation of the raining season are usually marked by high intensity thunderstorms (Akinbote et al, 2008). The general elevation is about 45m above mean sea level with ground slopes imperceptibility in a North-South direction as evidenced by the flow direction of the drainage systems. As at the time of the study, the population of Irele LGA was 145,166 (Ibitoye, 2006) and 33% of the population reside in Ode Irele, 8% in Akotogbo, 7% in Ajagba and 3.4 % in Lipanu.

The development of these settlements occurred without any systematic planning; buildings sprang up without any recourse to physical planning particularly during the evolution of traditional urbanization, which took place in many of the Yoruba settlements in the late 18^{th} century' (Jeje, 1988). This development has given rise to haphazard arrangement of plots as evident in all the settlements. All the settlements were also poorly provided with drainage channels. Significant proportion of the overland flow therefore flows along the untarred and unpaved drains. In some areas, where concrete drains and culverts are constructed, runoff hardly flows through them. Drains in other areas are often blocked with debris and sands. The few unblocked drains and culverts could not accommodate the volume of surface runoff generated during heavy rainstorms. Improvised wooden bridges were constructed over some the gullies to link to link some of the streets and allow pedestrians to pass.

3 MATERIALS AND METHODS

In the study area, five settlements were randomly selected namely Ode-Irele, Lipanu, Ajagba, Atoranse and Akotogbo for this study. In all the settlements, erosional channels were identified and ten of the channels were randomly selected for the study. The catchment area of each gully was delineated based on slope gradient and gully pattern. Global Positioning System (GPS) was used to capture the coordinates of all the turning points until area enclosed by the gully catchment was covered. The areas of the catchments were divided into grids at interval of 50 metres from which spot heights were determined, using GPS. The data generated was used to produce Digital Elevation Model that described the terrain morphology of the catchment area under study, using GIS ILWIS Software 3.3 version (see Figure 2).

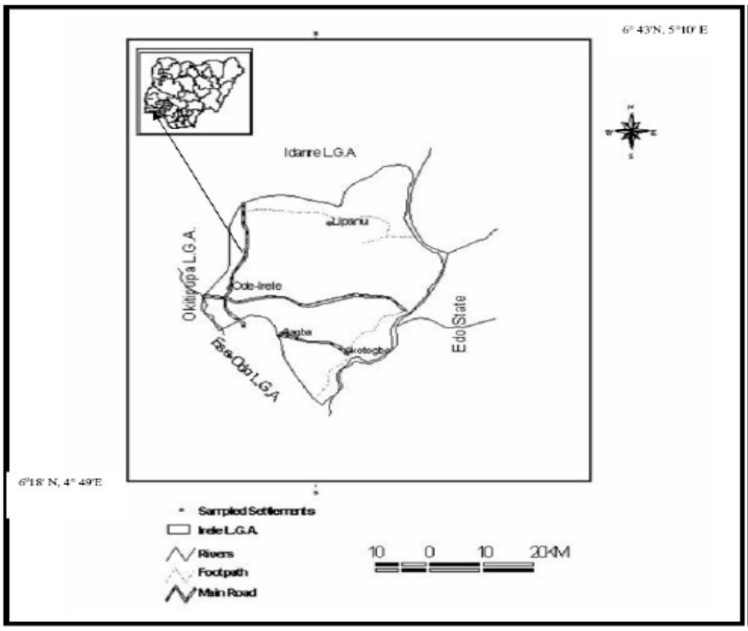

Figure 1: Map of the study area

Tape and leveling staff were used to capture the gully dimensions such as widths, lengths and depths. The gully widths and depths were determined at interval of 10 metres (except gully with less than 10 meters length) but the length was measured on continuous basis. From the measurements, slope gradient, gully profile, cross-sectional area and the volume of soil excavated were determined. The gully depths were measured from the gully shoulders. Soil samples were collected near gully shoulders and analyzed for bulk density, moisture content, and texture.

4 OBSERVATIONS

Human activities such as construction works such as haphazard erection of buildings on steep terrain, ineffective or uncompleted drainage project encouraged concentration of runoff and gave rise to gully erosion. The depths of erosion channels in the study area ranged between 1.0m and 5.85m, while width ranged between 2.37m and 5.58m. Also, the cross-sectional area ranged between 2.3m^2 and 35.66m^2 (see Table 1). The total volume of soil loss from the gullies was 47522.124m^3 (see Table 2). This value correlated positively with surface runoff with r = 0.55 which is an evidence that soil loss in these communities was influenced by volume of water generated within a catchment. As also evident in Table 2, the soil in the gully sites were characterized with high values of bulk density (1.45 – 1.89 g/cm^3). This implied a degraded soil due to urban activities which also reflect the degree of compatibility of the soil. The substrate contained a high proportion of sand about 59.0% (mean value) while the mean value of clay and silt were 34% and 7% respectively. As observed in the field, the top soil especially at the upper horizon is predominantly sandy clay and changes to sandy clay loam with depth. Ordinarily, with high proportion of sand at the upper layer, one would have expected these soils to be highly permeable and thus not susceptible to soil erosion. Because of compaction as a result of urban activities, the soil is relatively impermeable and therefore susceptible to sheetwash and gullying. These results confirmed that such soils would promote surface runoff. The area hence, experienced various degrees of sheet erosion, 1st, 2nd and 3rd order gullies which further strengthened by the high amount of rainfall intensity which often in excess of 75mm hr^{-1} (Jeje, 2005). The record on the effects of erosion in the study area showed that 24 houses which accommodated about 240 people were at risk at Idogun quarters, Ode-Irele and Ado quarters in Akotogbo. Also, most of the roads in the study area were severely eroded and rendered impassable to vehicular traffic. The inhabitants resulted to the use of indigenous ways of checking the erosional problem which include arrangement of sandbags, stone bags or wooden pegs across the erosional channels. Grass planting and non-biodegradable materials including, vehicle tyres, were often used as the main control materials (Plates e-i). These indigenous methods seemed to be ineffective as the erosion approaches disaster level particularly when the gully channel become wider and deeper in their width and depth respectively.

Table 1. Morphometry of the studied gullies based on gully location

Gully location	Gully order	Mean gull length (m)	Mean gully depth (m)	Mean gully width (m)	Mean cross sectional area (m^2)	Gully catchment area (Ha)	Catchment slope
Lipanu	1st	61	0.97	2.31	2.27	5.059	0^0 58’27’’
LA. Pry. Schl. Area (Ode Irele)	1st	750	3.07	5.14	21.95	86.895	1^0 06’06’’
Idogun Qtr (Ode Irele)	3rd	340	5.5	7.83	37.89	25.889	2^0 06’00’’
Ajagba	1st	214	1.54	3.32	5.57	11.887	4^0 51’31’’
Ado Qtr Akotogbo	2nd	130	2.66	4.79	12.48	13.269	3^0 02’41’’

Table 2. Soil properties and Sediment loss from the studied gullies

Gully location	Maen bulk density (g/cm^3)	Soil texture			Volume of soil loss (m^2)	Sediment loss (tonnes)
		% sand	% silt	% clay		
Lipanu	1.45	54	14	32	132.47	192.08
LA. Pry Schl area (Ode Irele)	1.61	63	07	30	16147.10	25,996.83
Idogun Qtr (Ode Irele)	1.88	59	04	37	16861.77	31,700.16
Ajagba	1.65	63	07	30	1167.54	1,926.44
Ado Qtr Akotogbo	1.89	56	03	41	13213.25	24,973.04

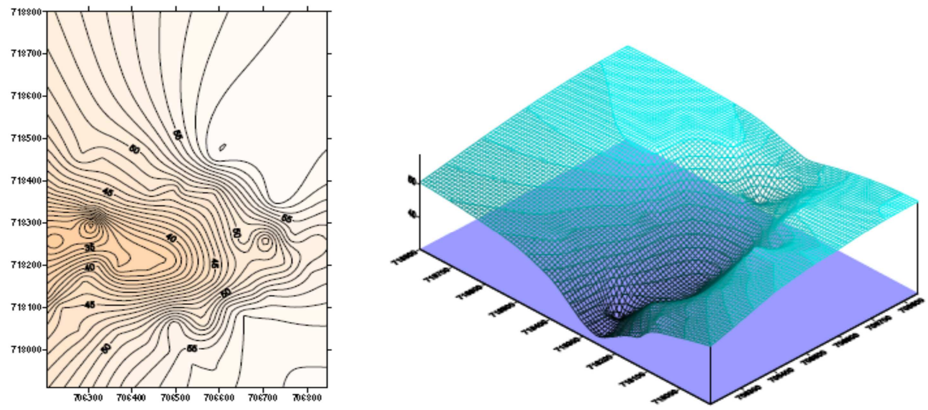

Figure 2a. Contour and DEM of gully catchment at Idogun Quarter, Ode Irele

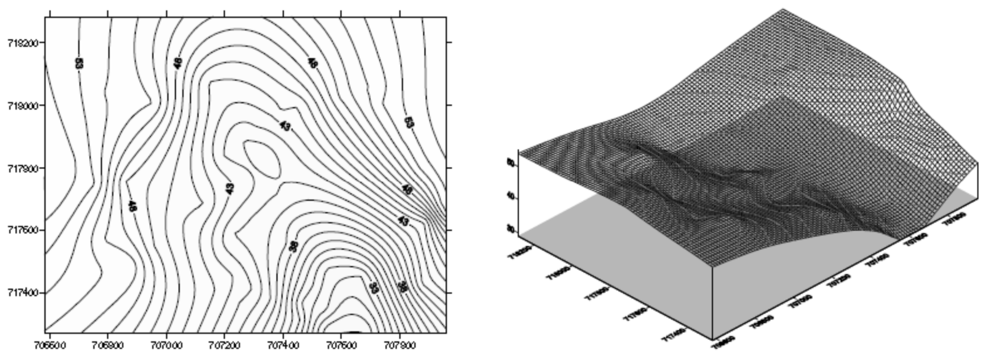

Figure 2b. Contour and DEM of gully catchment at LA Primary School, Ode Irele

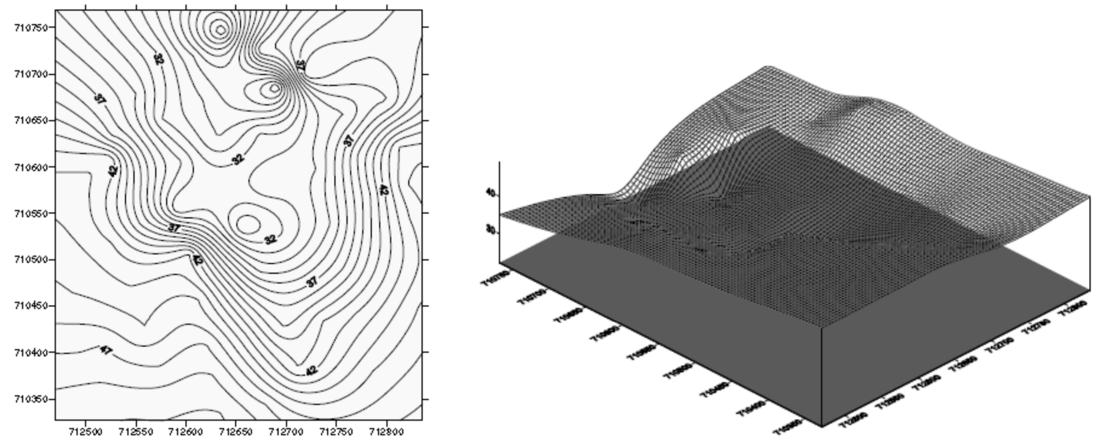

Figure 2c. Contour and DEM of gully catchment at Ajagba, Ode Irele

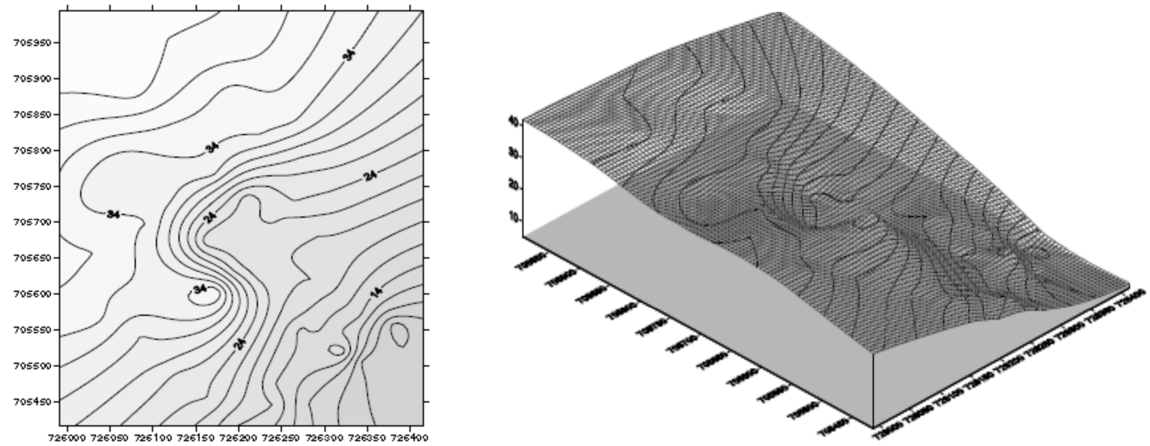

Figure 2d. Contour and DEM of gully catchment at Ado quarter Akotogbo

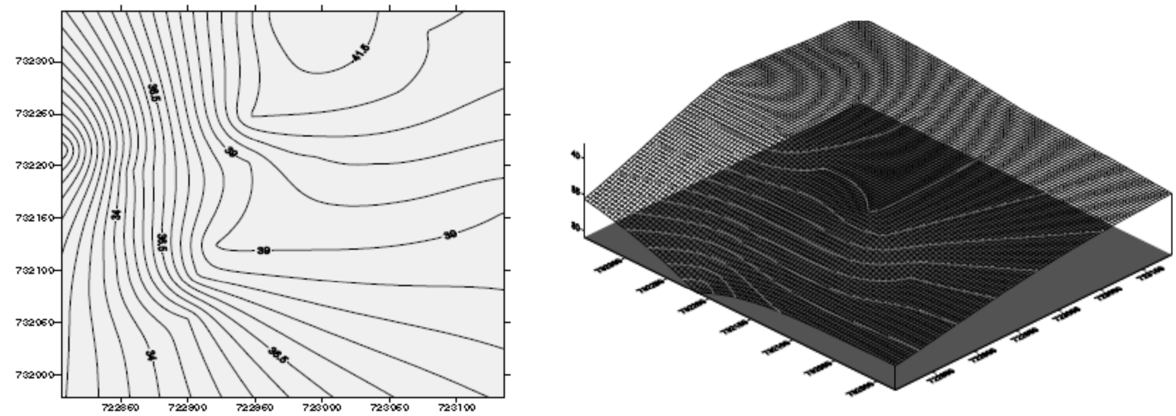

Figure 2e. Contour and DEM of gully catchment at Lipanu

a

b

Plates a-b: Effects of gully erosion on the housing properties

c

d

Plates c-d: Effects of sheet erosion on housing properties

e

f

g

h

i

Plates e-i : Examples of indigenous methods of erosion controls

5 CONCLUSIONS

Sheet erosion and gullies have been promoted by both man-induced and natural forces in the study area. Though the study found that the erosion problem had not reached a disaster level when compared with gullies in Agullu-Nanka in Enugu, Nigeria but the government intervention was not forthcoming. The governments (State and local) ought to have taken proactive measures to arrest the situation but the use of fire brigade approach to problem solving has become the order of the day. However, the data generated from this study can be developed into a GIS database which can be updated and retrieved at will. The study of this kind should be broadened to include more settlements in the future research and rainfall parameters such as rainfall amount, intensity and duration on daily basis should be considered for a well improved result.

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BIOGRAPHICAL NOTES

Matthew O. Ibitoye is Fellow of the Nigerian Institution of Surveyors, a Registered Surveyor and the Managing Director of Geomatt Associates and Environmental Services, Akure, Nigeria. He holds B. Sc. and M.Sc. degrees in Geography and Environmental Control and Management, respectively from the University of Calabar and Obafemi Awolowo University, Ile Ife, Nigeria. He is an alumnus of the Federal School of Surveying, Oyo where he obtained postgraduate qualifications in Surveying and Geographical information Systems (GIS). He is Ph.D student in the Department of Geography, Obafemi Awolowo University, Ile Ife, Nigeria where he is researching in urban geomorphology.

Suleiman Adegboyega is a Lecturer at Federal University of Technology, Akure. He holds B.Sc., PGD (Mgt), M.Sc. (Remote Sensing and GIS) and currently a Ph.D student at Department of Geography, OAU, Ile-Ife, Nigeria. He specializes in applications of Remote sensing and GIS to Land Use studies and Environmental Management.

CONTACTS

Matthew IBITOYE

Geomatt Associates and Environmental Services

Oyemekun Commercial Complex,

Box 3432, Akure Ondo State

+ 234803730290

geomattim@yahoo.com

NIGERIA

Suleiman ADEGBOYEGA

Department of Remote Sensing and GIS,

Federal University of Technology,

Akure, Ondo State

+2348035012873

adegboyega_s@yahoo.com

NIGERIA