

## A survey of erosion sites in Calabar Metropolis

A. U. Ogogo<sup>1</sup>, O. O.Egbai<sup>2</sup>, F.A.Aya<sup>1</sup> and O.E. Awala<sup>1</sup>

### ABSTRACT

Erosion is a common problem in Calabar metropolis. This has resulted in the loss of a large volume of soil, lives and destruction of property worth billions of naira. This study was undertaken to identify the erosion sites, determine the causes of the erosion and suggest solutions. Structured questionnaires and field measurements were used in the study. Stratified random sampling was used to administer the questionnaires. Four strata were established based on their topographic features and drainage pattern. Fifty questionnaires were administered in each stratum bringing the total number to 200. A 30m tape, 10m gunter's chain, ranging poles, twine and anchor (weight) were used to measure the length, breath and depths of each erosion site. A global positioning system was used to take the co-ordinates and height above sea level of each erosion site sampled. A total of 42 erosion sites were identified out of which 11 were randomly selected for measurement. The eastern and western parts of the town with steeper slopes had more erosion sites than the middle low land area. The relationship between slope angle and erosion intensity was highly significant ( $r = 0.90$ ). One hundred respondents (50%) agreed that lack of vegetation cover, poor drainage system, poor town planning, steep slopes and the sandy nature of the soil coupled with heavy rainfall (3,500mm per annum) were responsible for the erosion problem in Calabar metropolis. It was recommended that urban forestry projects should be embarked upon. There should also be provision of adequate drainage systems and development should conform to the approved plan of the town.

### INTRODUCTION

Over the years, the phenomena of soil erosion and land degradation have been recognized for their role in the modification of the earth's surface. According to Abanyam *et al.*, (2008) about 7.4 million acres of land in the Netherlands is devastated by erosion every year. This is in no way different from what happens in countries like Germany, Australia and the United States of America, where erosion has impacted negatively on soil entities.

In Africa, erosion devastation has continued to gain widespread recognition; for example, in sub Saharan Africa the largest single erosion site is in the Agulu Nanka area of Anambra, Nigeria, a site that has attracted tourists from all over the world because of its size (NEST, 1991). This is undoubtedly accompanied with severe hardship on the people of the area because it has continued to deprive them of land for their myriad purposes. The scenario might not be unconnected with the undulating topographic terrain of the area (Thomans, 1969, Faniran, 1979).

In Nigeria, states like Lagos, Gombe, Imo, Enugu, Abia are among the worst hit in terms of erosion menace (Agbi, 1995). In recent times, states in the southern region have joined the league of soil erosion prone areas because of the obvious deforestation scenarios. Soil erosion is largely viewed as a consequence of unguided human activity (Egbai, 2005, Glover, 2005, Aknsanni, 1992, NEST, 1991). Over 1,200 gully erosion complexes are found in Nigeria (Iloeje, 1992).

In order to measure short term gully erosion rates, field measurements would suffice (Moerson, 1991, Nyssen *et al.*, 2006).

Global positioning system (GPS) data, (WU and Cheng, 2005) and high altitude aerial photographs (Nachtergaele and Poesen, 1999) have been used for measurement. Long term gully erosion can be studied from written documents (Dotterweich *et al.*, 2003) but in the absence of documented evidence, oral history may be used (Nyssen *et al.*, 2006).

The primary aim of this study was to carryout survey of erosion hazards in Calabar Metropolis, establish the possible causes and suggest solutions.

### MATERIALS AND METHODS

#### Study Area

The study was conducted in Calabar Metropolis located at the extreme south eastern Nigeria with co-ordinates of 05° 45' and 05° 30' North and 08° 5' and 08° 20' East (Fig. 1). The area has an approximate land mass of 427.05km<sup>2</sup> (CR-SEED 2005-2007).

Calabar has an estimated population of 427,704 persons and a population density of 1,107 people per square kilometer and a mean annual rainfall of 350mm per annum (Balogun, 2003). The sharp increase in population is as a result of the enormous tourism potentials coupled with its urbanization policy. This is the main reason for immigrating population with resulting consequences on environmental components.

#### Method of data collection

A sample of the sites was obtained using stratified random sampling. This was achieved by subdividing the study area into four strata (zones) on the basis of topographic features and drainage patterns.

\*Corresponding author. Email: auogogo@yahoo.com

<sup>1</sup>Department of Forestry and wildlife Resources Management, University of Calabar, Calabar, Nigeria.

<sup>2</sup>Department of Geography and Regional Planning, University of Calabar, Calabar, Nigeria.



The study area has two major watersheds. One to the East and the other to the West, and they were referred to as watersheds A and B respectively. Watershed A had two zones, East and West, referred to as A<sub>1</sub> and A<sub>2</sub> while watershed B also had two zones B<sub>1</sub> and B<sub>2</sub>. Run-off A, flows into the Central low lands between A and B. Run-off B1 also flows into the Central lowland while the run off of B<sub>2</sub> flows Western into Calabar River. The run-off of A<sub>2</sub> and B<sub>1</sub> meet within the central lowland resulting in heavy flood which cuts across the city centre southward and south-eastward into big-qua river behind Cross River State University of technology (CRUTECH) Campus.

The four erosion zones (see fig:1) together constitute the entire population of the study (42 erosion sites), out of which 11 ranked as least to most hazardous were selected for the purpose of determining the degree of environmental hazard.

A 30m measuring tape, 10m Gunter's chain, ranging poles, twine (rope) and an anchor (a heavy metal) were used to measure the length, breath and depths (2 or 3 dimensional readings) of each erosion site. The anchor and rope were tied to a ranging pole and the anchor was carefully lowered into the bottom of the gully. The length of the rope was then measured in metres as an estimate of the depth of gullies that could not be reached. Ranging poles and Gunter's chains and survey pins were used in measuring the length and breadth of large erosion sites. Global positioning system (GPS) was used to measure slope gradient and for the determination of the geo-coordinates of each erosion site. A simple questionnaire comprising sections A and B was administered. Section A dwelt on personal data, while section B contained 16 questions reflecting the oral history, negative impact improved, government assistance and recommendations.

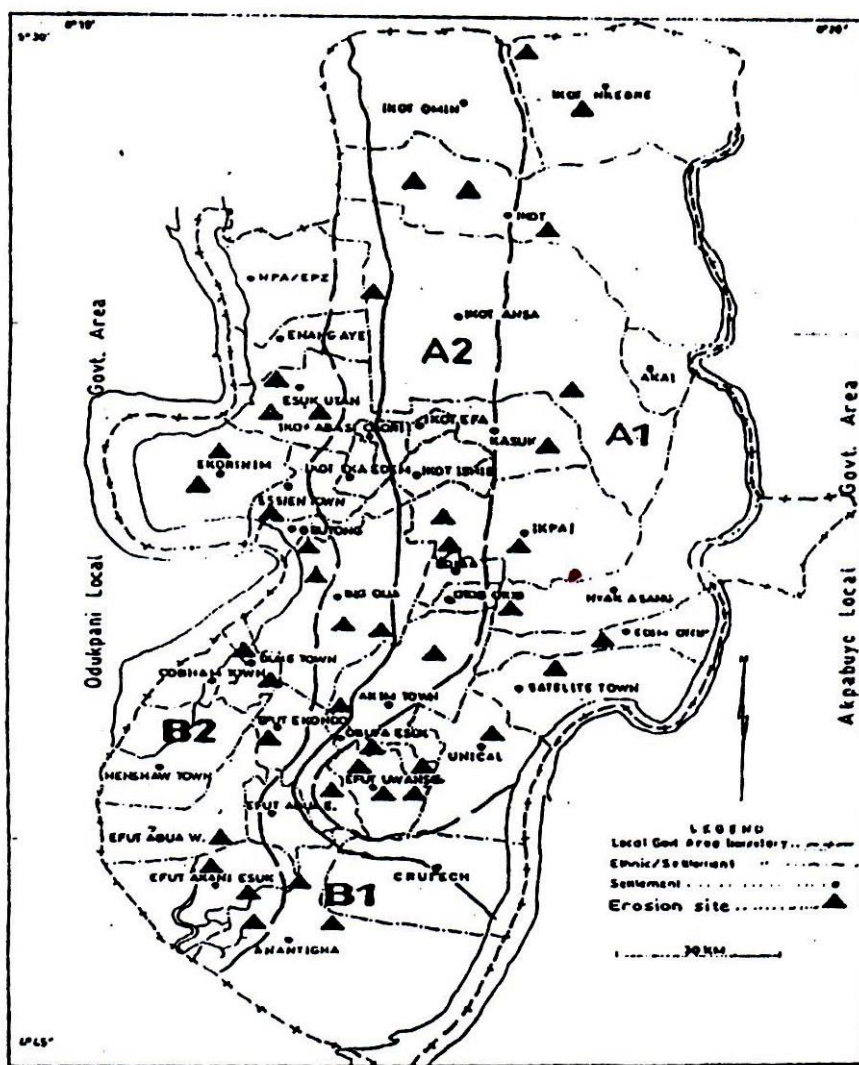


Fig. 1. Erosion sites in Calabar Metropolis.

A total of two hundred (200) copies of the questionnaire were administered as the team progressed from one erosion site to another, the residents included people from all walks of life, with differences, in gender, age, educational attainment, occupation and areas of origin. Copies of the questionnaires were collected back and analysed.

Data collected were posted into a spread sheet. The characteristics were then expressed as table and percentages for better understanding.

**RESULT**

**Size and rate of gully erosion**

The geo-spatial spread index of erosion sites shown in Table 1, while the ranking of erosion sites according to the index of hazard are shown in table 2. The ranking of 42 erosion sites was derived from the volume of eroded soil obtained by measuring the size of the gully. The degree of erosion was determined by the volume of eroded soil. This was different in all the sites and was believed to be as a result of certain factors such as relief, rainfall, drainage patterns, soil features, human activities etc. The relationship between slope and erosion intensity in the eleven erosion sites that were considered as least hazardous to most hazardous are listed in table 3.

**Table 1. Geo-spatial spread of erosion sites**

| Zone                    | A <sub>1</sub> | A <sub>2</sub> | B <sub>1</sub> | B <sub>2</sub> |
|-------------------------|----------------|----------------|----------------|----------------|
| Number of Erosion sites | 16             | 5              | 6              | 15             |
| Percentage %            | 38.09          | 11.09          | 14.30          | 35.71          |

**Table 2. Index of Hazard**

| Ranking      | 5     | 4    | 3    | 2    | 1     | 11  |
|--------------|-------|------|------|------|-------|-----|
| Frequency    | 5     | 1    | 2    | 3    | 31    | 42  |
| Percentage % | 11.90 | 2.28 | 4.76 | 7.14 | 73.80 | 100 |

**Table 3. Correlation of slope angle and erosion intensity at erosion site.**

| X         | Y     | X <sup>2</sup> | Y <sup>2</sup> | XY     |
|-----------|-------|----------------|----------------|--------|
| 4.6       | 6.30  | 21.16          | 39.69          | 28.98  |
| 4.3       | 0.00  | 18.49          | 4.84           | 9.46   |
| 3.9       | 0.60  | 15.21          | 0.36           | 2.34   |
| 4.4       | 4.32  | 19.36          | 18.66          | 19.01  |
| 4.3       | 2.42  | 18.49          | 5.76           | 10.32  |
| 4.4       | 3.75  | 19.36          | 14.06          | 16.50  |
| 4.3       | 2.40  | 18.49          | 5.76           | 10.32  |
| 4.5       | 6.00  | 20.25          | 36.00          | 27.00  |
| 4.2       | 1.44  | 7.64           | 2.07           | 6.05   |
| 3.9       | 0.09  | 15.21          | 2.92           | 3.74   |
| ∑ = 47.10 | 33.97 | 202.15         | 141.08         | 149.20 |

The East and West erosion zones (i.e. A<sub>1</sub> and B<sub>2</sub>) had more erosion sites than the inner low land zones (A<sub>2</sub> and B<sub>1</sub>) of the study area as shown in table 3 and figure 1. This was because the land relief at the extreme erosion zones had steeper slopes than the erosion zones as the central low land.

The result of the hypothetical test of eleven erosion sites sampled subjected to the Pearson Product Moment Correlation Coefficient R and t-test distribution proved that the calculated t-value (6.19) was higher than the table value which fell between 1 and 2. This implied that the value of the correlation coefficient was strongly significant (P < 0.05). One hundred respondents (50%) agreed that lack of vegetation cover, poor drainage system, poor town planning, steep slopes and the sandy nature of the soil coupled with heavy rainfall (3,500mm per annum) were responsible for the erosion problem in Calabar metropolis, and that virtually all the gullies in the area were initiated by anthropogenic activities. Eighty respondents (40%) also agreed that most of the erosion sites had existed for over five years and that the gullies were increasing each year.

**DISCUSSION**

Soil erosion can occur as a normal geological phenomenon which most times plays a predominant role in the formation of natural landscapes but the rates at which it occurs varies greatly depending on climate, terrain, soil structure and texture and the amount of vegetation cover (Evans, 1982). The high amount of rainfall in Calabar (3,500mm per annum, Balogun, 2003) coupled with the sandy nature of the soil is implicated in the high incident of erosion observed in the area.

In Cross River State, specifically in Calabar metropolis, in view of the high amount of rainfall that characterises the area and the poor



drainage systems in some parts of the metropolis, the menace of erosion has been a common place phenomenon. The poor attitude of some residents in waste disposal in which the dump rubbish into drainage channels thereby blocking them also helps to compound the problem. In recent times, hardly a year passes without an imprint of the catastrophic devastation of some environmental components ranging from the impairment of water quality, flooding, collapsed buildings, destruction of social amenities, reduction of soil nutrient and of course the death of humans. Aban (2001) remarked that the phenomenon of erosion is responsible for the drastic reduction in landscape and land space in a rural context.

According to CR-SEED, 2005-2007, there are 65 erosion sites in Calabar metropolis and they keep increasing in number, length, depth and width each year. However, only 42 erosion sites were identified in this study. This could be due to the fact that 23 (35%) of the erosion sites have been controlled. While this is commendable considering the high cost of the exercise, it still falls short of expectation as new sites emerge every year. To keep the erosion menace in check, conscious effort needs to be made. This means mobilizing enough funds, personnel, equipment and materials to combat the problem.

**CONCLUSIONS AND RECOMMENDATIONS**

The result of this work showed that erosion is not only a universal problem but a local one too as stated by Evan (1982). The issue of erosion perturbation in Calabar metropolis is sufficient enough to attract concern. The environment is fragile because of heavy rainfall, steep terrain and the sandy nature of the soil coupled with increased human activities. This indeed is the main reason for the increasing erosion problem. The original soil quality status is unduly compromised. There is need to forestall imminent environmental disaster by restoring the erosion sites with land filling and tree planting.

**REFERENCES**

Abam, O. T. (2001). The Socio-Economic Implications of Environmental Degradation in Nigeria. A paper presented at the Training Workshop on Environmental Reporting for Correspondents of the news Agency of Nigeria, University of Calabar.

Abanyam, P. A., Alasha, P. U., Jala-Igwe, C. N., Ohwojeheri, A. and Onwudiwe, T. H. (2008). Impacts of soil erosion on the Socio-economic status of Calabar Municipal L.G.A., C.R.S. A proceeding of Association of Nigerian Geographers, (ANG) 50<sup>th</sup> Annual Conference; held in University of Calabar, Calabar.

Agbi, A. (2003). *Environmental Resources and Degradation* Hill-Alex Publishers. : 74-77.

Akinsanmi, f. a. (1992). *Our Forest Environment and Heritage: Challenges for our people*. Proceedings of the 22<sup>nd</sup> Annual Conference of the Forestry Association of Nigeria. Held in Kano, Kano State.

Balogun, O. Y. (2003). *Senior Secondary School Atlas (Second Edition)*. Pp. 5, 18 and 19.

C. R. – SEED, (2005-2007). *Cross River State Economic Empowerment and Development Strategy*. State Planning Commission Journal Publishers and Press pp. 74.

Dotterweich, M., Schmeh, A., Schmidtchen, G. and Bork, H. R. (2003). Quantifying historical gully erosion in Northern Bavaria. *Catena* 50 : 135 – 150.

Egbai, O. O. (2005). *Loss of forest watershed and the consequences on stream health in Betem, Nigeria*. Unpublished M. Sc. Thesis Department of Geography and Regional planning, University of Calabar, Calabar.

Evans, J. (1982). *Plantation forest in the tropics*. Carendon Press Oxford New York Toronto.

Faniran, A. (1986). *Plantation Forest in the tropics*. Carendon Press Oxford New York Toronto.

Glover, E. K. (2005). *Tropical dry land rehabilitation. Case study on participatory forest management in Gedaraj, Sudan*. Ph. D Dissertation. Faculty of Agriculture and Forestry of the University of Helsinki, Helsinki, Finland.

Iloje (1992). *A new geography of West Africa*. Honk Kong, Sheck Wah Tong Press.

Moeyersons, J. V. (1991). Ravine formation on step slopes. Forward versus regressive erosion. Some case studies from Rwanda. *Catena* 18: 309-324.

Nachtegaele, J. and Poesen, J. (1999). Assessment of soil losses by ephemeral gully erosion using high altitude (stereo) aerial photographs. *Earth surface processes and landforms* 24:693-706.

NEST (1991). Nigeria threatened Environment. Produced by Nigeria Environmental Study Team Ibadan Pp. 48-57.

Nyssen, J., Posen, J., Veyret-Picot, M., Moeyersons, J., Hail, M., Decker's, J., Dewit, J., Naudts, H., Teka K. and Govers, G. (2006). Assessment of gully erosion rates through interviews and measurements: A case study from northern Ethiopia. *Earth surface processes and landforms* 31: 167-185.

The United Nations General Assembly (1995). International Decade of Natural Disaster Reduction (IDNDR) Conference, Agenda 21. Rio de Janeiro.

Thomans, M. F. (1979). *Tropical Geomorphology: A study of wealthy and landform development in warm climates*. The Macmillan Press Ltd. London and Basingstoke.

Wu, Y. and Cheng, H. (2005). Monitoring of gully erosion on the Loess Plateau of China using a global positioning system. *Catena* 63:154-166