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EVALUATION OF GULLY EROSION SITES INSELECTED RAINFOREST AND DERIVED SAVANNAH ECOSYSTEM IN ABIA STATE, SOUTH EAST NIGERIA

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ABSTRACT

A study of gully erosion sites in selected Rainforest and derived savannah ecosystem was undertaking. Two single factor experiments in Randomized Complete Block Design (RCBD) with three replications were utilized separately to determine the dimensions of gullies in erosion sites. Result revealed that gully dimension in rainforest area of Abia State were highest in length in Ahiaeke Ntigbu at 1436.67m and lowest in Ossah Ibeku at 400m, width were highest in Amigbo Ubakala at 52m and lowest at 30m, depth were highest inAmigbo Ubakala at 31.67m and lowest in Ossah Ibeku at 16m. In derived savannah were seen highest in lentgh in Oruruala Amayi at 1450m and lowest in Amaekpu at 440m,width were highest in Oruruala Amayi at 92m and lowest in Akanu at 31.67m and depth were highest Oruruala Amayiin 33.33m and lowest in Akanu at 18.33m. Result of the study revealed gully erosion are more active in derived savannah area than the rainforest area of Abia State due to the type of soil in the region. Observation revealed that soil erosion in some communities was aggravated by human activities, such as deforestation and bush burning/removal of vegetation cover, mining activities, urban development and sand excavation. This problem is affecting the development because infrastructures such as houses, roads and many others are being destroyed yearly and this in turn constitutes an environmental menace. The services of competent professionals for design, construction and supervision of erosion control and soil conservation measures should be ensured and utilized.

Keywords: Soil degradation**,** Soil erosion, rainforest, derived savannah.

INTRODUCTION

Erosion is one of the surface processes that sculpture the earth's landscape and constitutes one of the global environmental problems. Soil erosion is perhaps the most serious mechanism of land degradation in the tropics (El-Swaify, *et al.*, 1982). However, gully is visually the most impressive of all types of erosion (El-Swaify, 1990). Gully erosion is a well-defined water worn channel (Monkhouse and Small, 1978). It is a recently extended drainage channel that transmits ephemeral flow, steep side, steeply sloping or vertical head scarf with a width greater than 0.3 m and a depth greater than 0.6 m (Brice, 1966).Soil erosion is a land degradation process that involves the gradual and systematic removal of soil particles, including nutrients from the land surface by various agents of denudation (Ofomata, 1987; McCauley *et al.* 2005). It usually occurs due to transport by wind, water or ice (as in the temperate regions), by down–slope creep of the soil (land slide) and other materials under the force of gravity in the case of bio-erosion (McCauley *et al*, 2005). Virtually all the states in Nigeria experience one form or the other of the soil erosion (Ofomata, 1987, 1997; Otegbeye *et al*., 2006). Soil erosion causes enormous social, cultural economic and environmental problems. Its implication extends beyond the removal of valuable topsoil and also includes loss of genetic diversity, damage to infrastructure, water pollution and watershed problems, loss of lives and relocation of settlements (Ofomata, 1987). Soil erosion in the south eastern part of Nigeria has been identified as the most threatened environmental hazard (Okorie, 1995; Lal, 2001). Abia State is one of the States in the sub-region noted for the ravaging of gully erosion (Abegunde

et al., 2006). Since its creation in 1991, Abia State has witnessed increased economic and infrastructural activities with obvious consequences on soil exposure and attendant soil degradation. Over 400 gully erosion sites were documented by Okoro *et al* (1995) and Irojiegbe (2002) in Abia state. Owunna (1977) reported that high pressure on the land together with geological peculiarities makes the Southeastern region the most erosion-prone zone in Nigeria with over 1,195 active gully erosion sites.

Research has shown that gully processes had happened in the past even without human influence or interference. Thus, the phenomenon of gully erosion is either naturally-induced or artificially-induced, or both. Like in other parts of the world, gully erosion is one of the major environmental challenges facing Nigeria. The available literatures on the subject show that this menace is more predominant in the eastern half of the country compared to the western half. South-eastern part of Nigeria is more affected than its north-eastern counterpart. Soil erosion in the former has been identified as the most threatened environmental hazards in the country (Albert *et al.,*2006). Several millions of Naira have been spent on the control of gully erosion in the region without commensurate results (Igbozurike,1990; Abegunde *et al* 2006).

Gbadagesin (2006) reported that strategies to combat soil erosion in Nigeria have focused mainly on the construction of physical erosion control structure. These structures have tended to aggravate the soil erosion problems due to improper planning, faulty design and construction techniques that are used by the agencies mandated to implement erosion control. The need for a blend of bio-engineering methods with traditional technology for better result have been advocated (Igbozurike, 1993; Okorie, 1992; Ofomata, 2001). Odimegwu (1995) also noted that little attention has been paid to cultural and community perspectives and stated that environmental problems, such as soil erosion, require a multi-disciplinary approach for their solutions. The key to successful protection of the physical environment is first, to understand the causes of any problem.

The rainforest and the derived savannah ecosystems are the major ecosystems in Abia State. These agro-ecological zones are under immense pressure to meet the food and industrial needs of the expanding population. A large portion of the land mass of Nigeria (about 80%) is under severe sheet, rill, and gully erosion (Osui 1983; Ofomata 1991; NEST, 1991); Kalu, 2001). Soil erosion therefore, presents the nation with a physical land problem of enormous imporance to food security and economic development. Soil erosion menace has continued to increase in magnitude, intensity and spatial distribution in many States in Nigeria, especially in the south-east agro-ecological zone (Ivbijaro, 2006). The rate of soil loss and effectiveness of control methods have become a major concern. Akamigbo (1990), Okorie (1992) and Abegunde *et al* (2006) reported increases in the number of gully erosion sites in the zone. In Anambra State, Nigeria an increase from 530 in 1969 to 600 in 1990 and recently over 700 active gully sites were reported, while Okoro *et al.,* (1995. Disasters can be natural or man-made. Soil erosion is a common disaster that can be caused by nature because of the soil properties and also by man as a result of improper environmental management. Erosion is a serious threat to humans and infrastructures because of the devastation it can cause to homes, farmland, roads, water supply, communication, and migrations (Idah *et al.,* 2008). Soil erodibility is a function of complex interactions of a substantial number of the soil physical properties. Generally, soils that are high in silt, low in organic matter are the most erodible (Bhattacharyya *et al*., 2015). A soil type becomes less erodible with decrease in silt fraction, regardless of the corresponding increase is in the sand fraction. The efforts of the previous authors were mainly on control of existing gully sites, rather than preventive or prediction of erosion prone areas. Erosion begins when rain or irrigation water detaches soil particles and moved across it to other place (Trout and Neibling, 1993).

In Abia State, soil erosion is the most devastating common ecological feature that results in an annual soil loss of nearly 1 million metric tonne (Kio *et al.,* 1986; Okorie 1991). Taken on this scale, one only imagines the extent arable land that is being rendered unproductive. The results of this study will provide basis for articulating and promulgating integrated policies and methods capable of ensuring downward trend in the development of gully erosion and improved management of erosion prone areas in Abia state, Nigeria.

MATERIALS AND METHODS

Study area

The study was undertaken in the lowland rainforest and the derived savannah agro ecological zones of Abia State, which lies on coordinate of 5.43^0N and 7.52^0E latitude and longitude respectively. Two Local Government Areas (LGAs) were randomly selected from the high-erosion prone sites in the rainforest and two LGAs from the derived savannah ecosystems. The two LGAs in the rainforest zone are Umuahia South and Ikwuano LGAs; while Ohafia and Isuikwuato LGAs were randomly selected from the derived savannah zone.

Field Experiment

A singly factor experiment in randomized complete block design (RCBD) was utilized to evaluate the dimensions of gully erosion sites in the four communities/locations within two LGAs in the study area.In each LGA. two communities were randomly selected. The randomly selected four gully erosion stricken communities in the rainforest ecosystem per LGA were as follows: Amigbo – Ubakala and Ossah-Ibeku in Umuahia South LGA and Ahiaeke-Ntigbu and Oloko in Ikwuano LGA. While derived savannah ecozone, the following four erosion stricken communities were also randomly selected, namely: Akanu and Amaekpu in Ohafia LGA and Amokwe Amiyi and Oruruala-Amiyi in Isuikwuao LGA. The length, width, and depth of the major gully erosion sites where measured using 30-meter steel chain/30-meter linen tapes, pegs and ropes and recoded in three replications. The data collected were statistically analyzed according to the procedures of Steel and Torrie (1980) and Alika (2006). The Fisher's Least Significant Differences (F-LSD) at $P \leq 0.05$ was used to determine differences between treatment means according to Steel and Torrie (1980) and Alika (2006).

RESULTS

Table 1 show that Amigbo - Ubakala in Umuahia South LGA. havesignificantly longer gully erosion sites (716.67m) than Ahiaeke - Ntigbu in Ikwuano LGA. (1436.67m) and Ossah-Ibeku (400.00m). The lengths of gully erosion sites in Amigbo-Ubakala (716.67m) and Oloko (606.67m) were statistically similar. However, Ahieke-Ntugbu and Ossah-Ibeku also had similar ($P<005$) length of gully erosion sites. The results of the lengths of gully erosion is widest at the sitewithin the Rainforest ecosystem in Abia State were significantly higher as Amigbo-Ubakala > Ahiaeke-Ntigbu =Ossah-Ibeku.Amigbo-Ubakala = Otoko.Oloko = Ahiaeke-Ntigbu.In terms of depth, the result shows that Amigbo-Ubakala also had significantly the widest gully erosion site (52.67m) among the study sites in the rainforest ecosystem in Abia State. No significant difference existed between the widths of gully erosion sites in Oloko, Ahieke-Ntigbu and Ossah-Ibeku. The overall result of the width of gully erosion sites are summarized statistically as follows: Amigbo-Ubakala > Oloko = Ahiaeke-Ntigbu - Ossah-Ibeku. Result also shows that Amigbo Ubakala had significantly the greater depth of gully erosion than Ossah Ibeku and Ahiaeke-Ntigbu. However no significant differences existed between the depth of gully of Amigbo Ubakala and Oloko. The depth of gully erosion in Oloko and Ahiaeke-Ntigbu both in Ikwuano LGA. and also Ossah-Ibeku are statistically similar.

Table 1: Gully Dimensions in the Rain Forest Ecosystem of Abia State

Location		Gully Dimension (M)		
Community	**LGA.**	**Length**	**Width**	**Depth**
Ahiaeke Ntigbu	Ikwuano	1436.67	33.33	19.67
Oloko	Ikwuano	606.67	40.00	23.67
Amigbo Ubakala	Umuahia South	716.67	52.00	31.67
Ossah Ibeku	Umuahia South	400.00	30.00	16.00
F-LSD(O.O5)		**177.89**	**12.03**	**9.44**

Table 2 shows that Oruruala Amiyi in Isuikwuato LGA had significantly the Highest length (1450.00m) of gully erosion in the study sites in the derived savannah ecosystem. The lengths of gully in Amaokwe Amiyi in Isuikwuato LGA. (600.00m), Akanu (516.67m) and Amaekpu (440.00m) both in Ohafia LGA were statistically similar. Also within the derived savannah ecosystem, Oruruala Amiyi had significantly the widest gully erosion sites. Amaekpu and Akanu as well as Amokwe Amiyi had statistically similar width of gully erosion sites. In terms of depth of gully erosion, Oruruala Amiyi had significantly the deepest gully erosion site within the derived savannah ecosystem in Abia State. The depths of gully erosion sites in Amaokwe Amiyi and Amaekpu were similar ($P<0.05$). However, Akanu had significantly the least depth of gully erosion site within the derived savannah ecosystem.

Table 2: Gully Dimensions in the Derived Savannah Ecosystem of Abia State.

Location		Gully Dimension (M)		
Community	**LGA.**	**Length**	**Width**	**Depth**
Oruruala Amiyi	Isuikwuato	1450.00	92.00	33.33
Amaokwe Amiyi	Isuikwuato	600.60	33.33	25.67
Akanu	Ohafia	516.67	31.67	18.33
Amaekpu	Ohafia	440.00	38.33	25.33
F-LSD (0.05)		**281.96**	**40.14**	**6.97**

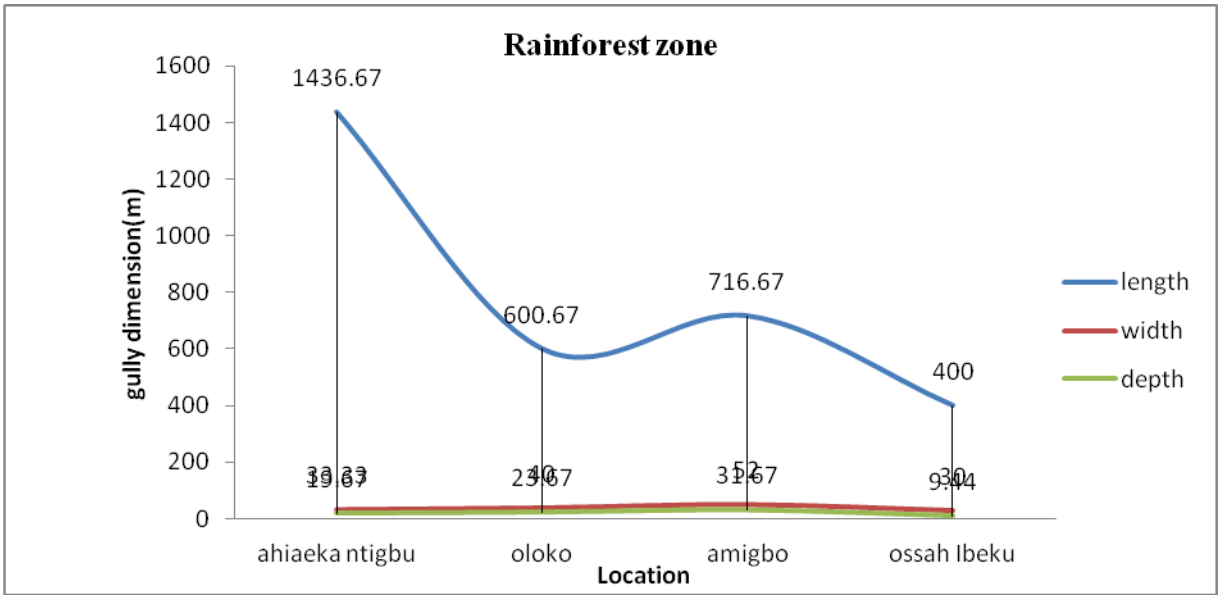

Fig.:1 Gully dimensions in four sample sites in the rain forest ecosystem of Abia State

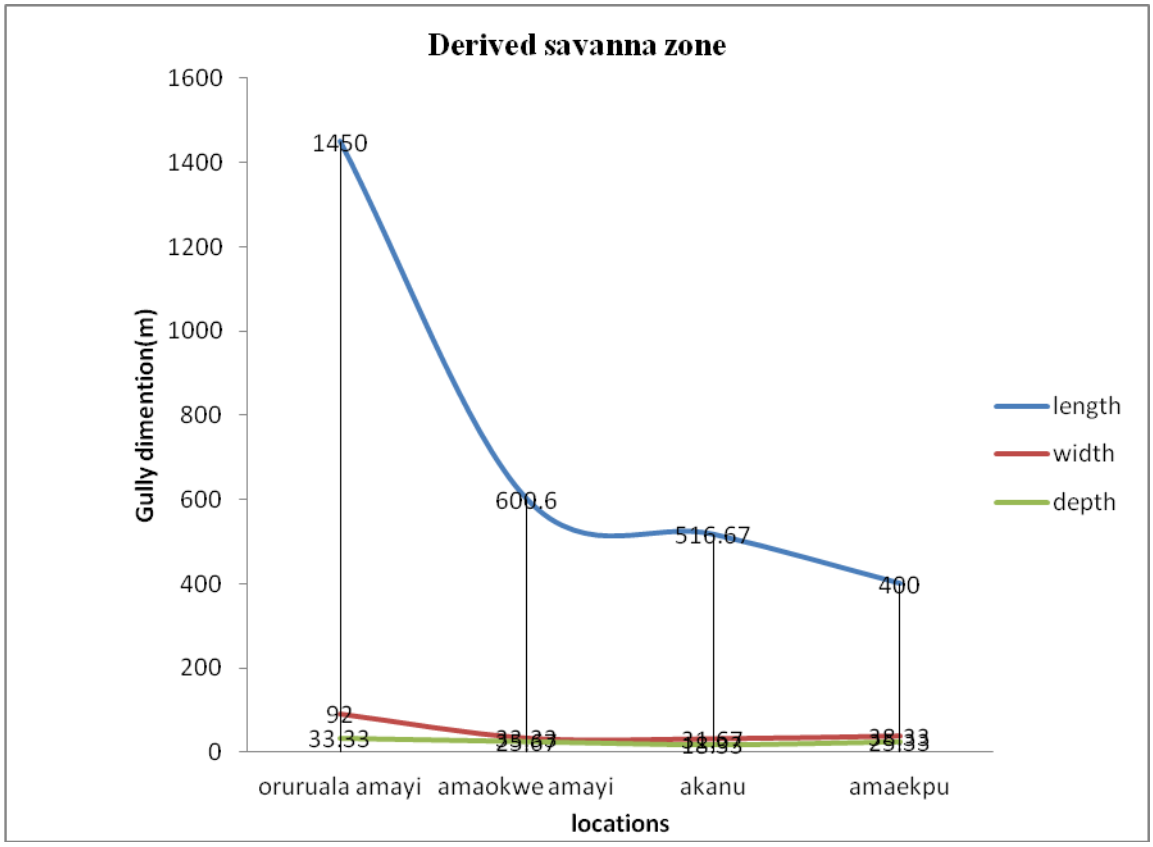

Fig.:2. Gully dimensions in four sample sites in the derived ecosystem of Abia State

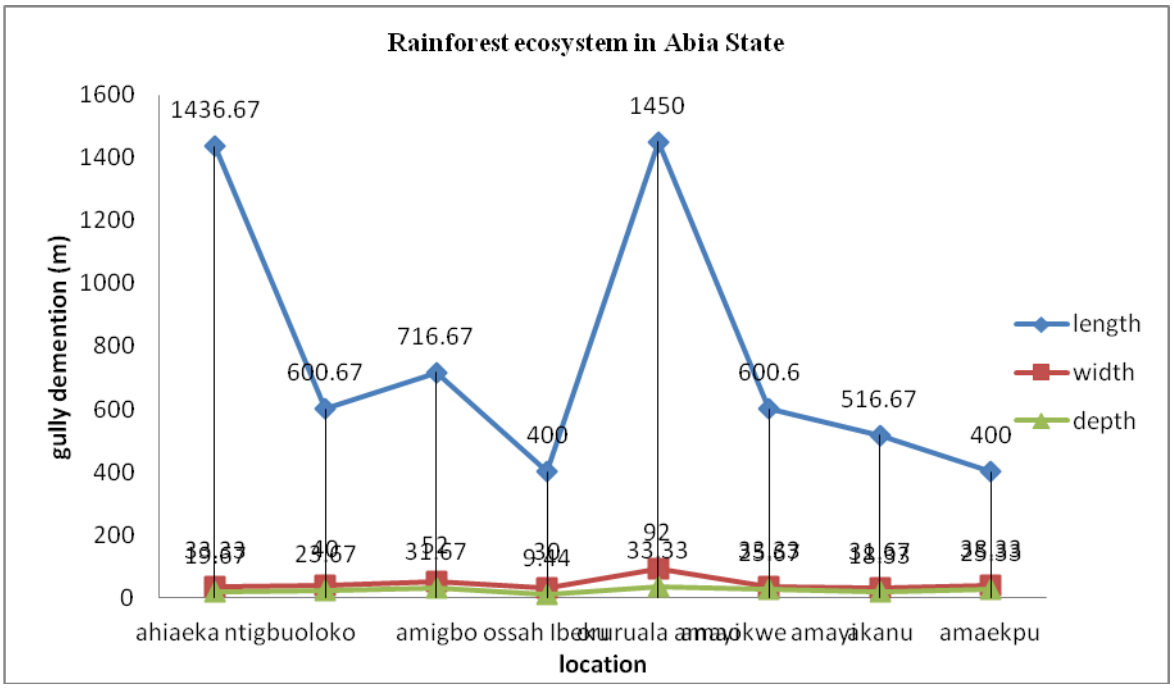

Fig.: 3 Gully Dimensions in four LGA sample sites in the rainforest ecosystem of Abia State.

DISCUSSION

Results of the scope of gully erosion in the study sites show that Oruruala-Amiyi in Isuikwuato LGA was the most extensive. Evidence of landslide and falling trees suggest that gully erosion is still very active in Oruruala-Amiyi and also indicates greater risk of destruction of buildings (including schools, churches and residential) and other infrastructures therein. The gully erosion sites in the derived savannah ecosystem were longer, wider and deeper than those sampled in the rain forest ecosystem this agrees with the devastating experiences carried out by Nwilo *et al* (2011) who used GIS as an

approach to assess and map gully erosion hazards in Abia State. This feature may be due to the transformation of the rainforest vegetation to derived savannah due to unsustainable land use practices which include sand excavation, farming on slopes and soil type. Ofomata (1984) and Abegunde *et al., (*2001) reported that gullies advance due to human activities which increase runoff. The presence of trees and their roots coupled with higher clay content which are capable of reducing the erodibility of soils in the rainforest ecosystem could be responsible for narrower dimension of gully erosion sites in the rainforest zone (Lal, 2001).

CONCLUSION

Soil erosion in its varied forms is rife and so are its socio-economic consequences in Abia State, Nigeria. The effects cut across various life supports system such as the natural resource base (land, water, biodiversity, air, climate, etc), physical infrastructures.

Human activities through various land use practices have continued to increase the scope and intensity of soil erosion thereby rendering more areas prone to soil erosion. This is exacerbated by the weak soil formation in the area coupled with vulnerable landscape and high rainfall regime.

The persistence of soil erosion in its various ramifications will continue to jeopardize development efforts at improving standard of living and will endangered our environment. Traditional known–how based on sound understanding of the environment should form part the extension and environmental education which are strongly advocated for a sustained approach towards combating environmental problems such as soil erosion. Every effort should be made to use ecological adapted vegetation (for erosion control) that will survive in a particular area with minimum maintenance. Erosion control plan should be designed or developed before embarking on soil erosion to reduce the incidents of abandonment or collapse of erosion control structures.

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