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PEOPLE'S PERCEPTION OF SOIL EROSION AND ITS IMPACT IN IMO STATE, NIGERIA

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ABSTRACT

This study constitutes a critical measure of comprehension among the local residents of various communities on how they view the causes and impacts of soil erosion; this is in view to designing a sustainable control measure against erosion. On the basis of gully erosion density determined from satellite imagery, thirty communities were selected from the twenty-seven Local Government Area of Imo State where One thousand, five hundred (1,500) semi structured (closed ended) questionnaire made up of fourteen (14) questions addressing the issue of soil erosion, its impact and remedial measures were randomly administered (50 copies in each Community). The observations were ranked and simple percentage/descriptive statistical tools were deployed to analyze the data so generated. The findings show that the majority (79.9%) of respondents have lived in the area for more than 30 years. Traders and farmers constitute the highest respondents. Respondents perceived loss of land, loss of vegetation, water pollution, stream sedimentation, declining soil quality and landslides as major environmental impacts. While erosion control levy, loss of land for farming, undermining of transport routes/bridges were considered as socio-economic impacts. They attribute soil erosion (gully) to civil works (road construction) and soil quality and slope as major factors of erosion The result further showed that the mean (4.0) for environmental impacts across the study area is greater than the criteria mean (3.5) which makes it very significant. It was also observed that communities in the northern part of the State consider soil erosion as environmental challenge while communities from the Southern and Central part of the State consider it as socio-economic.

KEYWORDS: Soil, Erosion, Environmental Impacts, Communities, Farming

INTRODUCTION

Soil erosion is the detachment / removal and transportation of soil particles, including plant nutrients from the land surface by various agents of denudation, it is widespread in Nigeria, the degree and severity of occurrence, the types/forms and factors of erosion are varied under different geologic, climatic and soil conditions in different part of the country, the consequences are usually several and frequently hazardous. However, soil erosion is more active and widespread geomorphic process in the South eastern part of Nigeria (comprising of Anambra, Imo, Abia, Enugu, Ebonyi and Akwa Ibom States)(Nwachukwu and Iwuagwu, 1991; Ibitoye *et al.,* 2008). The area is associated with phases of high intensity rainfall which combines with non-cohesive soil structure to make erosion one of the most serious environmental hazards in the area.

It has been estimated that available arable lands in the States of the southeastern Nigeria have been reduced by 50% as a result of erosion. In the Agulu-Nanka area alone, over 1100km^2 of gully affected land is unsuitable for

agricultural production (Onwueme and Asiabaka, 1992). Apart from reducing the total cultivatable land area, erosion also impoverishes the remaining available land due to the washing away of the fertile soil. Grant (1975) estimated that bare soil could lose up to 450 tons of material per hectare per year due to the action of erosion. In a study by Asiabaka and Boers (1988), a group of farmers in southeastern Nigeria perceived declining soil fertility as the most serious impact of gully erosion, followed by declining yield of crops and destruction of farmland, in that order. Loss of soil has both on-site effects, such as loss of soil fertility, rooting depths for crops and lowered water holding capacity, depletion of the soil's filter and buffer capacity and off-site effects, such as potential accumulation of pollutants by elevated concentrations of fertilizers and pesticides in local deposition areas, siltation of reservoirs and lakes (Braide 1982)

Communication between villages are sometimes disrupted as a result of roads or bridges being washed away by gully erosion. Rural water supply from streams is also constantly being polluted by heavy sediment load, thereby adding a health hazard to the problem of damage to infrastructure (EU, 2004). The economic cost of erosion is very difficult to quantify, but is definitely very large.

Soil erosion issues have been discussed since the early 1920s (Sykes, 1940). Previous studies on soil erosion have concentrated on issues relating to concepts and damages by erosion (Barker*atal.*, 2005) and socio-economic impact of erosion on farmers (Abergunde, 2006). While cognitive studies have considered farmers' perception and response to erosion (Yusuf and Ray 2011), farmers' response and adoption of investment measures (Onu, 2013) and erosion problems on food production (Pimentel and Burgess, 2013). However, there is paucity of information on the perception of soil erosion and its impacts by a broad spectrum of the society in erosion ravaged communities.

This study constitutes a critical measure of comprehension among the local residents of the various communities on how they view the causes and impacts of soil erosion, this is in view to designing a sustainable control measure against erosion. This raises the following questions. How do people view erosion? What are the socio-economic characteristics of residents in these communities? What are the major socio-economic and environmental impacts occasioned by soil erosion? The overall purpose of this study was to investigate community's perception of soil erosion and their impacts. Specifically, the objectives were to: describe socio-economic characteristics of the people in these communities, ascertain local inhabitants' knowledge on the causes and control of erosion as well as the impacts and highlight implications for sustainable development of the area.

METHOD AND MATERIALS

Study Area

The study area (Imo State) is located in the South eastern region of Nigeria and is one of the 36 States of the Federation, with Owerri as its capital and largest city. It lies between latitude $4^0 45^{'}$N and $5^0 50^{'}$N, longitude $6^0 35^{'}$E and $7^0 30^{'}$E. The State is located between the lower River Niger and the upper and middle Imo River in the South eastern part of the country. The State experiences heavy rainfall, with an average annual rainfall of 2000-2400 mm and an average number of 152 rain days particularly during the rainy seasons (April–October). However, variations occur in rainfall amount from year to year. Rainfall distribution is bimodal, with peaks in July and September and a two weeks break in August. The rainy season begins in March and lasts till October or early November. Rainfall is often at its maximum at night and during the early morning hours. The higher annual rainfall depths and rainfall days encourage the production of large volumes of runoff that move over the land surface and cause degradation. The bimodal pattern of rainfall distribution

in southeastern Nigeria helps to increase the presence of erosion, the superficial soils consisting mainly of silty clay, becomes saturated reducing infiltration to the barest minimum and encouraging run-off (Amangabara, 2014). Average annual relative humidity is 75 per cent and rises to about 90 per cent in the raining season. Temperatures are similar all over the State. The hottest months are January to March, with the mean annual temperature above 20°C. The influence of the harmattan lasts for about nine weeks (i.e. from late December to late February).

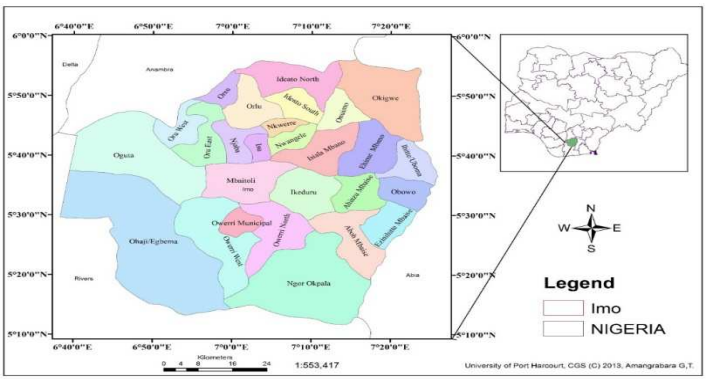

Figure 1: Imo State Showing the Local Government Areas

Geologically, Imo State is underlain majorly by the sedimentary sequences of the Benin Formation (Miocene to recent), and the Bende-Ameki Formation (Eocene). The Benin Formation is made up of friable sands with minor intercalations of clay. The sand units are mostly coarse –grained, pebbly, poorly sorted, and contain lenses of fine grained sands. In some areas like Okigwe, impermeable layers of clay occur near the surface, while in other areas, the soil consists of lateritic material under a superficial layer of fine grained sand (Ibe *et al.*, 1991; Onwueme and Asiabaka, 1992). In terms of relief, Imo State is characterized by three main landform regions: a highland region of elevation of 340m in the northern sections covering Orlu, Ideato, Okigwe and IhitteUboma local government areas;it is a low asymmetrical ridge or cuesta in the northern portion of the Awka Orlu/Okigwe Uplands, which trend roughly North West to North East, in line with the geological formations that underlie it. It is highest in the Northwest, about 340m above mean sea level, and gradually decreases in height to about 116m in the centre towards the northeast at the banks of the Imo River at IhitteUboma. The second region is a moderate elevation of about 175m which covers midway between the north and the southern sections of the State as well as the river valleys of the streams that rises in the highland regions of the State. The local government areas that are part of this moderate elevation relief include Nkwerre, Isu, IsialaMbano, Ehime Mbano, Obowo, Ahiazu Mbaise, Ikeduru and Njaba. The lowland regions cover the Southern areas of the State.

Questionnaire Administration

To understand from the peoples' perspective, the causes of erosion in the area and to shed light on the overall socio-economic impact of gully erosion on the population, a semi structured (closed ended) questionnaire made up of fourteen (14) questions addressing the issue of gully erosion occurrence, its impact and remedial measures was administered in each of the communities where gully erosion occurs and where morphological assessment was made. Essentially, the questionnaire contained age brackets of respondents, length of stay in the affected community, occupation of respondents, environmental condition of the area, common types of geo-hazard, occurrence and presence of gully erosion, when it started/became severe, perception of respondents to the causes and factors and the major impacts of erosion on the community.

On the basis of gully erosion density as determined from satellite imagery, thirty communities were selected from the twenty-seven Local Government Area of Imo State where One thousand, five hundred (1,500) copies of questionnaire were randomly administered (50 copies in each Community). Respondents fill/ticked the options available on the questionnaire. The filled questionnaire forms were collected from the respondents on the spot. This method was adopted as it appears to be the most convenient means of approaching respondents' perception of the socio-economic effects of the occurrence of gully erosion in the area.

Since the questionnaire is semi structured allowing respondents to give more than one answer, the observations therefore were ranked and the mean generated and simple percentage statistical tools were deployed to analyze the data so generated. On the Perception of Respondents on Impacts of Gully Erosion, Peoples' perception of the impacts of gully erosion in the area was categorized into two groups: Environmental impacts and Socio-economic impacts. To establish the criteria mean, upon which perception were assessed as significant or otherwise, the total number of factors considered as environmental or socio-economic were rated and added then divided by the option available for example for the perception of the people on the environmental impacts of gully erosion in the study area, there are seven perceived impacts (loss of land, loss of vegetation, groundwater pollution, surface water pollution, stream sedimentation, declining soil quality and landslides) to establish the criteria mean will apply the above as follows

7+6+5+4+3+2+1 = 28/7 = 4 (this becomes the criteria mean)

For the Socio-Economics, there are six perceived impacts so 6+5+4+3+2+1= 21/6 = 3.5 (criteria mean)

RESULTS AND DISCUSSIONS

Age Brackets: More than 79.90% of the total respondents are from within the ages of 25 years and above. A breakdown of this figure show that 20.70% are within the age bracket of 20 – 24 years. 28.30% within the age bracket of 25 – 29 years. 28.6% (30 – 34 years) and those above 35 years constitute 22.8% of the respondents (Figure 2). This outcome indicates that the respondents are adults and are knowledgeable enough to address the issue at hand.

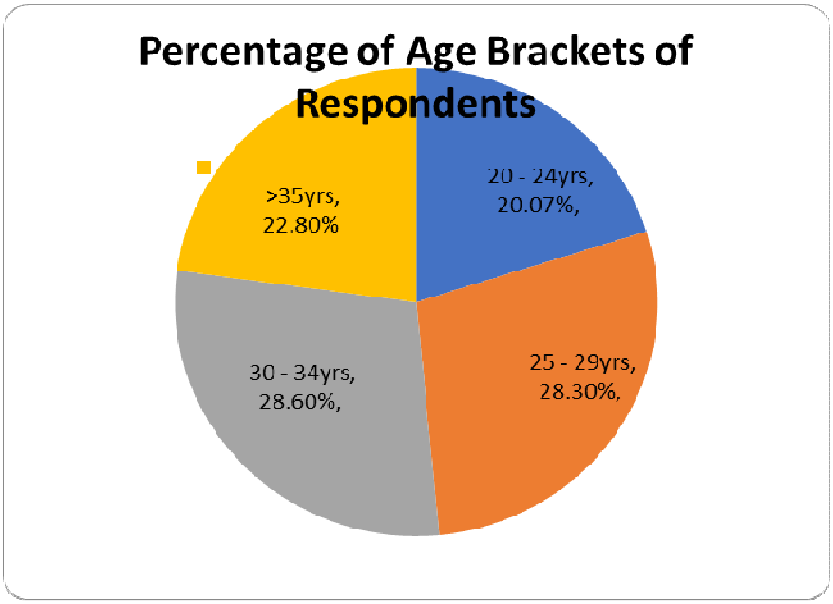

Figure 2: Age Bracket Distribution of Respondents

Length of Stay: On their length of stay in the affected communities' fig 3 shows that 14.20% have lived in the area for about 10 years. 27.6% have lived between 11 years and 20 years in the area 29.93% have lived in the area between 21 years and 30 years while 28.3% have lived in the area for more than 35 years.

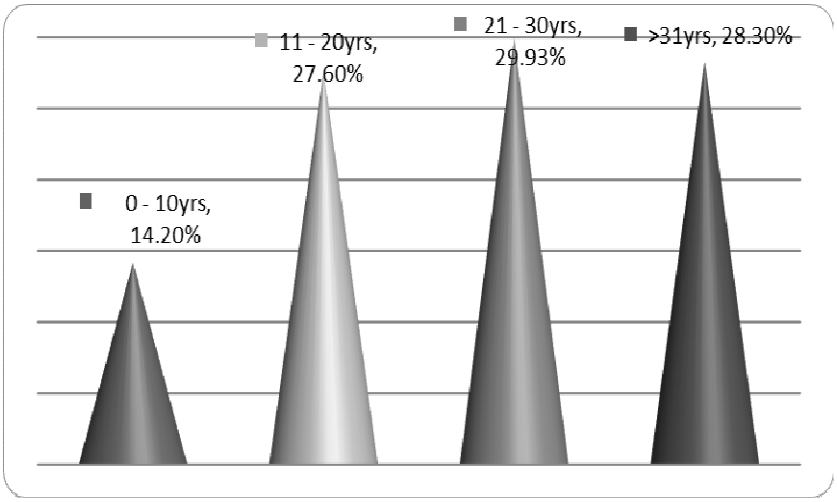

Figure 3: Length of Stay in the Community

Occupation: With respect to their occupation, 8.1% are students. Civil servants (Local Government Staff, teachers, State Government employees etc.) make up 10.6% of the respondents. While, 19.5% claimed that they are artisans (Bike riders, sandminers, builders, bicycle repairers, carpenters, cobblers, tailors (obioma)). Farmers constitute 28.9% and Business/Traders make up 32.9% of the total respondents (Figure 4)

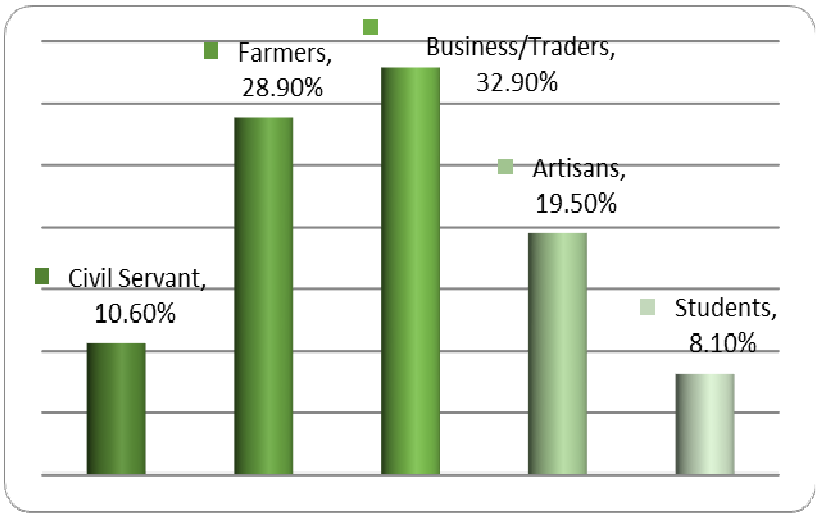

Figure 4: Occupation of Respondents

On the Common Geo-Hazards in the Area, Fig 5 Show respondents' perception of the common types of geo-environmental hazards in the area. Three primary geo-hazards were identified by respondents which include flood, erosion and landslide (Figure 5) Erosion is however, considered as the most serious of the three. It has a wider occurrence compared to flood and landslide looking at the perception of the people

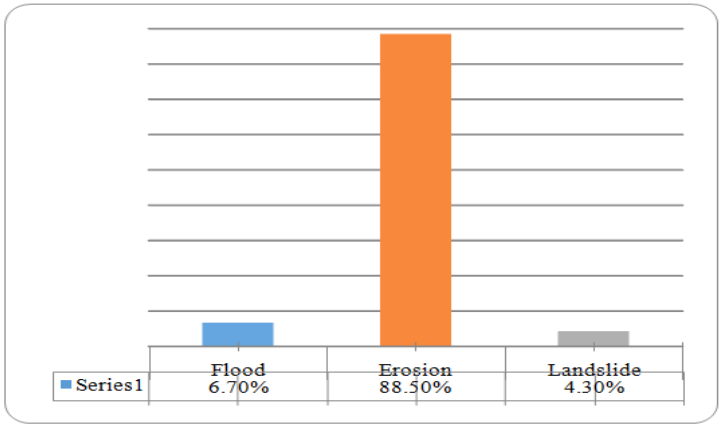

Figure 5: Perception of respondents on the common Geo-hazards in the Area

On the Knowledge of Occurrence of Gully Erosion, Figure 6 and **7** shows the perceived causes and factors that have aggravated the occurrence or severity of the gully erosion.

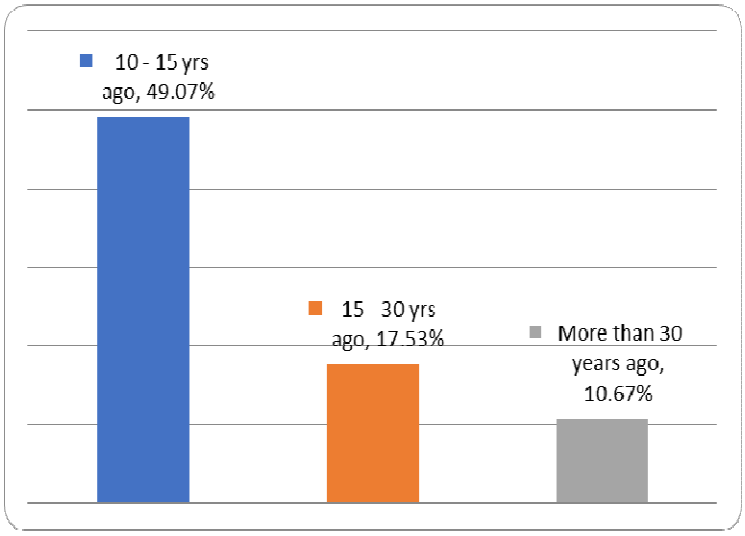

Figure 6: Perception of Respondents to the time of Occurrence of Gully erosion

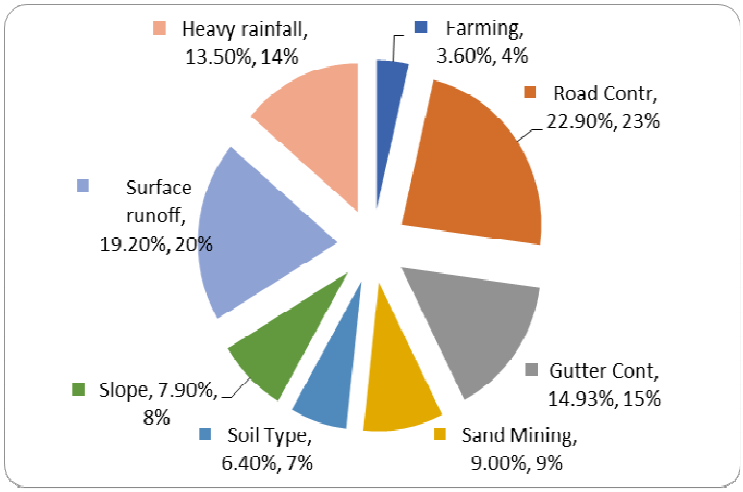

Figure 7: Perception of Respondents to the causes of Gully Erosion in Imo State

The result (Figure 6 & 7) on the perception of the people on the causes and impacts of gully erosion show that 49.07% are of the opinion that most of the gullies in the area started or became very severe and life threatening from about 10 to 15 years ago. 17.53% says it is about 15 – 30 years ago while 10.67% says the occurrence of gully erosion is more than 30 years ago. Respondents who claimed that gully erosion have occurred between 15 years and up to 30 years are respondents who live in Ideato, Orlu and Njaba areas. This perception agrees with the works of Grove, (1949) and Oformata (1987), who reported that gully erosion have occurred in these places (Orlu and Ideato) as far back as 1948. The current prevalent rate of gully erosion formation may have been enhanced by on-going urbanization which is reflected in road/gutter construction and sand mining. The geologic Formation which outcrops as gravely, and coarse soil in the area and predominantly sandy accelerate the current rate of gully development in the study area.

The result further showed that 22.90% of total respondents in all the communities where gully erosion occurs attributed the cause of gully erosion to road construction, 14.93% to road side gutter construction while19.20% are of the view that total impervious cover in the form of tar roads, cemented pavements, roofing sheets etc are the principal causes as these generates surface runoff which washes the soil off. Contrary to expectation, only 3.60% of total respondents attributed gully erosion to farming. 6.40% (Soil type), 7.9% (Slope failure) and sand mining/excavation (9%). One of the serious causes of accelerated erosion in Imo State from field observation and confirmed by the perception of the people in the study area is the enormous civil engineering works associated with economic development and population pressure. It was found out that a number of roads were constructed without adequate control of the runoff generated by this activity especially in the high relief regions in Orlu, Ihitte-Uboma and Ideato. Rainwater overflow from concrete gutters at the side of highways, leading to erosion — particularly at the point where the gutter and the road meet — this destabilizes hillsides and undermines roadbeds. In places where gutters are constructed, they are not properly terminated, no spill way and gabions to reduce the concentrated flow to non-erosion velocities, because many gullies represent re-adjustment of a landscape to a new equilibrium after some sort of threshold of resistance to erosion has finally been exceeded, they may grow astonishingly quickly once they have been initiated. For the same reason, they are not easily stopped until they have extended to the upslope limit of concentrated or rapid flow, or have re-graded to the new base level, or both. As a result, gullies are easier to prevent than to cure, at least until the impetus for growth has been exhausted, at which time the gully will begin to stabilize and to heal itself. (Very long gullies may be healing at the downstream end while the head end is still expanding) this accounts for the reason why many gully mouths are filled up e.g. Arondizuogu gully, Umuomi-Ikeduru gully etc.

The observation that most gullies in Imo State are initiated as a direct result of poor civil engineering works rather than farming practices or footpath was also reported by Ofomata (1987), Onu and Opara (2010), and Hudec*et al.,* (2006). Thus, preventing or curing a gully requires understanding of its stage of growth and its specific proximate causes and growth processes. For example, if the gully is growing by headward retreat of a waterfall, then upslope management of run-off is required, such as diversion ditches and re-grading the channel floor with loose broken stone (rip-rap). If unchannelled slope wash is the problem, then the best solutions would be to promote infiltration relative to run-off by contour-ploughing of the watershed, diverting flow into blind trenches, and planting trees and other vegetation. In contrast, to cure a gully that has grown largely by seepage and sapping, diversion ditches are irrelevant and increased infiltration is undesirable; one should instead stabilize the gully floor and rebury the zone of seepage. In lateritic terrain, where the soil surface hardens in the sun but the underlying saprolite becomes increasingly moist and soft downward (at least until the

transition into fresh bedrock), ploughing or otherwise breaking the surface and destroying vegetative cover may actually make a bad situation much worse

Table 1: Environmental Perception Descriptive Statistics

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Omundan-Okwabli	50	4.2600	2.35441	.33296	3.5909	4.9291	1.00	7.00
Acharaba	50	4.2800	2.23187	.31563	3.6457	4.9143	1.00	7.00
IkpezeArondizougu	50	**3.7800**	2.11206	.29869	3.1798	4.3802	1.00	7.00
UmuakaUbiri	50	**3.5600**	1.69224	.23932	3.0791	4.0409	1.00	7.00
Umuazalla-Obibi	50	**3.4600**	1.70486	.24110	2.9755	3.9445	1.00	7.00
UmuokeUbiri	50	**3.8600**	1.82958	.25874	3.3400	4.3800	1.00	7.00
Umuagwo	50	**3.3000**	2.21544	.31331	2.6704	3.9296	1.00	7.00
Umuaka	50	**3.9000**	2.02283	.28607	3.3251	4.4749	1.00	7.00
Nnenasa	50	4.1200	1.98607	.28087	3.5556	4.6844	1.00	7.00
Amucha	50	4.1000	1.83225	.25912	3.5793	4.6207	2.00	7.00
NkwensiOru Ward	50	4.2600	1.83848	.26000	3.7375	4.7825	2.00	7.00
Mgbenle	50	**3.8400**	1.44787	.20476	3.4285	4.2515	2.00	7.00
UmuehiUzurumu	50	5.3000	1.56818	.22177	4.8543	5.7457	3.00	7.00
Mgbidi	50	4.5200	2.17818	.30804	3.9010	5.1390	2.00	7.00
Akwakwuma	50	4.5800	2.07108	.29290	3.9914	5.1686	1.00	7.00
Ihiagwa	50	4.9200	1.72426	.24385	4.4300	5.4100	3.00	7.00
Nekede	50	5.5000	1.51523	.21429	5.0694	5.9306	3.00	7.00
Eziala/Avatu	50	5.3800	1.58938	.22477	4.9283	5.8317	3.00	7.00
Osina	50	5.7800	1.75301	.24791	5.2818	6.2782	2.00	7.00
Umuoshi	50	5.7000	1.80984	.25595	5.1856	6.2144	2.00	7.00
UmuomiUzoagba	50	4.8800	1.85868	.26286	4.3518	5.4082	2.00	7.00
Ihetti-Owerre	50	4.4200	1.87453	.26510	3.8873	4.9527	2.00	7.00
IsialaUmuozu	50	4.4200	2.00092	.28297	3.8513	4.9887	2.00	7.00
UmuzealaObowo	50	5.7000	1.43214	.20253	5.2930	6.1070	3.00	7.00
Okigwe	50	5.2200	2.16927	.30678	4.6035	5.8365	2.00	7.00
Umuowulbe	50	4.1200	2.03680	.28805	3.5411	4.6989	1.00	7.00
Ogwa	50	4.1000	1.83225	.25912	3.5793	4.6207	1.00	7.00
AmainyiUkwu	50	5.4000	1.64130	.23212	4.9335	5.8665	3.00	7.00
EziamaEgbe	50	4.9200	2.05873	.29115	4.3349	5.5051	2.00	7.00
Umueneke	50	4.8600	1.88452	.26651	4.3244	5.3956	2.00	7.00
Total	1500	4.5480	1.99926	.05162	4.4467	4.6493	1.00	7.00

The environmental perception for each gully is significant if the mean > criteria mean (4.00)

Table 2: Socio-Economic Perception, Descriptive Statistics

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Omundan-Okwabli	50	4.0200	1.50496	.21283	3.5923	4.4477	1.00	6.00
Acharaba	50	3.9600	1.57739	.22308	3.5117	4.4083	1.00	6.00
IkpezeArondizougu	50	3.8800	1.53384	.21692	3.4441	4.3159	2.00	6.00
UmuakaUbiri	50	3.8600	1.56505	.22133	3.4152	4.3048	2.00	6.00
Umuazalla-Obibi	50	3.5800	1.51307	.21398	3.1500	4.0100	1.00	6.00
UmuokeUbiri	50	3.6000	1.47080	.20800	3.1820	4.0180	1.00	6.00

Table 2 Cond.,								
Umuagwo	50	3.9200	1.99837	.28261	3.3521	4.4879	1.00	6.00
Umuaka	50	4.8400	1.60814	.22743	4.3830	5.2970	2.00	6.00
Nnenasa	50	4.8200	1.66218	.23507	4.3476	5.2924	2.00	6.00
Amucha	50	4.4800	1.66892	.23602	4.0057	4.9543	2.00	6.00
NkwensiOru Ward	50	5.0600	1.50387	.21268	4.6326	5.4874	2.00	6.00
Mgbenle	50	4.8000	1.59079	.22497	4.3479	5.2521	2.00	6.00
UmuehiUzurumu	50	3.9600	1.67770	.23726	3.4832	4.4368	2.00	6.00
Mgbidi	50	4.4600	1.68074	.23769	3.9823	4.9377	2.00	6.00
Akwakwuma	50	4.3200	1.46301	.20690	3.9042	4.7358	2.00	6.00
Ihiagwa	50	4.8600	1.66611	.23562	4.3865	5.3335	2.00	6.00
Nekede	50	4.1000	1.59399	.22542	3.6470	4.5530	2.00	6.00
Eziala/Avatu	50	4.2400	1.63582	.23134	3.7751	4.7049	2.00	6.00
Osina	50	4.6800	1.58359	.22395	4.2299	5.1301	2.00	6.00
Umuoshi	50	5.0800	1.17526	.16621	4.7460	5.4140	3.00	6.00
UmuomiUzoagba	50	4.5600	.88433	.12506	4.3087	4.8113	4.00	6.00
Ihetti-Owerre	50	4.3200	1.01900	.14411	4.0304	4.6096	2.00	6.00
IsialaUmuozu	50	4.6200	1.49680	.21168	4.1946	5.0454	2.00	6.00
UmuzealaObowo	50	4.1000	1.59399	.22542	3.6470	4.5530	2.00	6.00
Okigwe	50	4.6800	1.64677	.23289	4.2120	5.1480	2.00	6.00
Umuowulbe	50	3.8600	1.56505	.22133	3.4152	4.3048	2.00	6.00
Ogwa	50	4.0000	1.27775	.18070	3.6369	4.3631	2.00	6.00
AmainyiUkwu	50	4.6400	1.36666	.19327	4.2516	5.0284	2.00	6.00
EziamaEgbe	50	4.6000	1.57791	.22315	4.1516	5.0484	2.00	6.00
Umueneke	50	4.6200	1.41263	.19978	4.2185	5.0215	2.00	6.00
Total	1500	4.3507	1.57311	.04062	4.2710	4.4303	1.00	6.00

The socioeconomic perception is significant for each gully if the mean > criteria mean (3.5).

The result of the perception of the people on the environmental impacts (Table 1) showed that the mean of all respondents in the study area is 4.54; This is greater than the criteria mean which is 4, thus showing that the environmental perception of the people across Imo State (the Study Area) on the impacts of gully erosion in the area is very significant i.e. It is generally considered by the people that gully erosion is a major environmental hazard in Imo State.

Assessing the perception of the people on community basis, it showed that communities in the high relief region namely Ikpeze-Arondizougu, UmuakaUbiri, Umuazalla-Obibi, UmuokeUbiri, Umuagwo, Umuaka and Mgbenle) did not really consider gully erosion as environmental challenge. The result (Table 1) showed that for any significant relationship to exit the perception mean must be greater than the criteria mean which in this case is 4. Ikpeze-Arondizougu (3.78) is less than the criteria mean of 4 and this is also the case for Umuaka-Ubiri (Orlu LGA) (3.46); Umuazalla-Obibi (Orlu LGA) (3.86), Umuagwo (Ideato North (3.30) Umuaka (Njaba LGA) (3.90) and Mgbenle (3.84). On the Socio-Economic implications of gully erosion on the people, the overall perception is significant. Table 2 showed that the respondents mean is 4.35 while the criteria mean is 3.5 thus showing a very strong significant relationship on how the people consider gully erosion on their social and economic livelihood

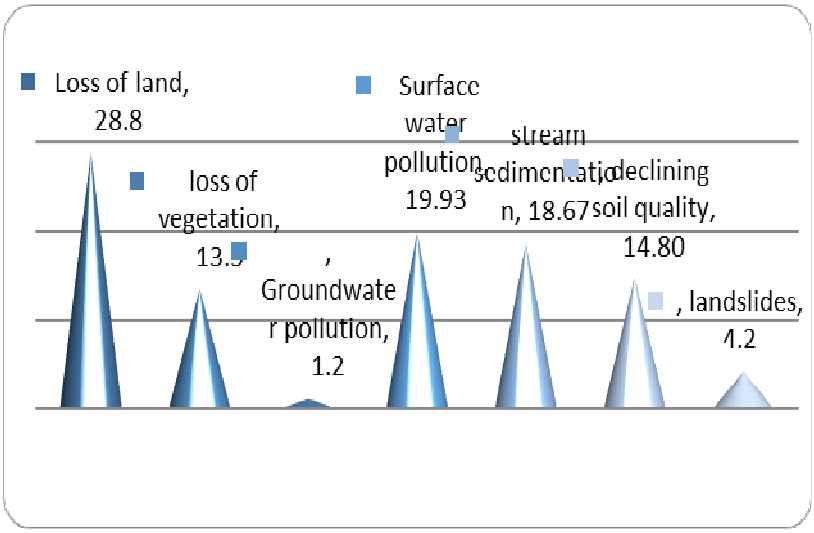

Figure 8: Environmental Impact of Gully Erosion in Imo State

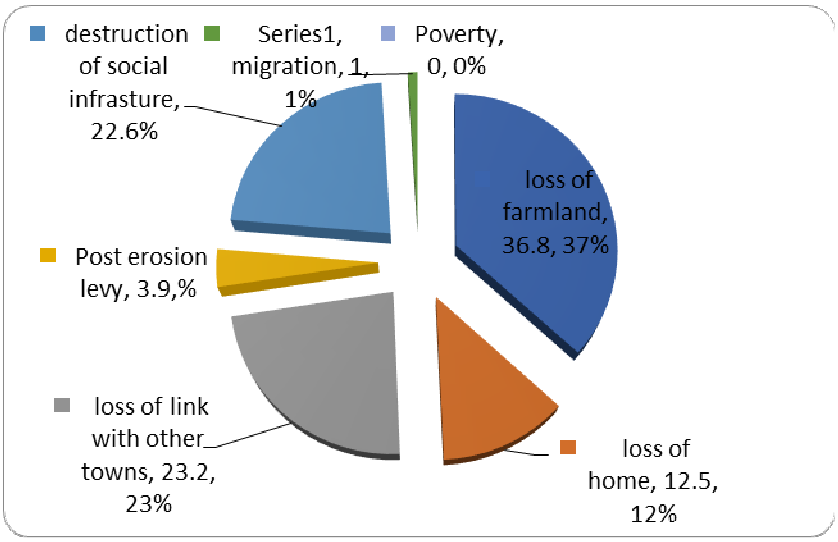

Figure 9: Socio-Economic Impact of Gully Erosion in Imo State

From figures 8 & 9, land especially for farming is considered the major economic impact of gully erosion. People considered surface water pollution and sedimentation (siltation) of stream as major environmental impact, especially in communities that depend on water from streams and rain harvested waters for domestic use (e.g. Ikeduru, Orlu, Ehime Mbano, Nwangele, Nkwerre and Mbaitoili). Declining soil quality is also a major environmental impact by gully erosion. On the socio-economic impacts, loss of farmland is considered the worst as most farmland or the path leading to the farmland are washed away. Loss of link (e.g. Roads) was seen as a significant impact. Many complained that their products could not be moved to the markets due to roads being cut off by the gullies. Other social infrastructures impacted upon include electricity, pipe-borne waters, undermining of market places etc. Loss of home and payment of erosion control taxes/levies are seen as in-cumbrances on already impoverished people and as such the respondents see them as socio-economic impacts

CONCLUSIONS

The study investigated community's perception of soil erosion in Imo State. Results of the study indicate that all the communities where erosion occurs consider it as a serious environmental and economic challenge. However, land especially for farming is considered the major economic impact of gully erosion.

The people considered surface water pollution and sedimentation (siltation) of stream as major environmental impact, especially in communities that depend on water from streams and rain harvested waters for domestic use.

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