Gully Characterization and Soil Properties in Selected Communities in Ideato South Lga, Imo State, Nigeria

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Abstract: The study examined the soil properties and characterization of gully erosion in some selected communities (Isiekenesi, Umuaghobe and Umueshi) in Ideato LGA, Imo State, Nigeria. Gully measurements were done in situ whereby the gully lengths, gully width, gully depth and gully slope were determined. The cross sectional area, volume of soil loss and sediment loss were derived from the main morphometric characteristics using some formulae. Soil samples were collected using soil auger at the 0-15cm depth (topsoil) to investigate the status of soil physical and chemical properties. Findings show that the mean gully depth, mean gully width and mean gully length was 12.06m, 27.73m and 173.24m while the mean sediment loss was 15.25 m^3/m^2. The mean gully length, mean gully width and cross sectional area were highest in Isiekenesi with 225.97m, 32.41m and 234.86m while sediment loss was 21.08 m^3/m^2, 9.86 m^3/m^2 and 16.20 m^3/m^2 in Umueshi, Umuaghobe and Isiekenesi respectively. Findings show that the mean sand content was generally high (62.44%-74.64%). A significant relationship was observed between soil loss and gully slope ($r=0.710$, $p<0.05$). The study recommended that afforestation and planting of cover crops and pastures should be encouraged.

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1. Introduction

For some decades now, gully erosion which encompasses several geomorphologic processes shapes the slopes and floors of valleys all over the world has been an issue of concern in the southeastern part of Nigeria. A gully is a landform created by running water which erodes sharply into soil, typically on a hillside. Gullies are antecedents of the removal of soil by running water (Ibitoye et al., 2008) and the amount of erosion depends on a combination of the power of the rain to cause erosion and the ability of the soil to resist the rain impact (Hudson, 1957). However, Adediji et al. (2009) submitted that the mechanisms involved in soil erosion by water vary over space and time. Some of these mechanisms are rain drop splash, unconcentrated downslope wash (sheet erosion), concentrated downslope wash (rill and gully erosion), and a mixed process in which entrainment is by rain drop splash and downslope transport is by surface wash. Thus, gully resulting from accelerated soil erosion has been an issue of growing concern not only in the humid tropics but in many parts of the world (Adediji et al., 2009) and according to Nasri et al. (2009), gully erosion is a serious problem affecting many parts of the world particularly in the tropical region due to the climate, lithology, soils, relief and land use/cover characteristics. Unwise land use practice results in increased rates of soil erosion and sediment discharge to rivers (Ehiorobo and lzinyon, 2011). The issue with landuse/landcover in recent time is the most serious problem because of the urbanization phenomenon in which every community is making efforts to achieve. No wonder Adediji et al. (2009) affirmed that improper human land management can accelerate erosion which may result in the development of rill and gully. Moreso, the gully erosion area represents a wide area that may be eaten away gradually and continuously by the landslide cum gully advancement processes covering an entire watershed area (Ajaero and Mozie, 2011). Human activities give rise to removal of vegetation cover which leads to increase in the surface run off which in effect results to the increase in the rate of soil erosion. Topographic features such as ground slope, length and shape affect rill erosion. Rapid population growth creates extra pressure on lands in urban areas, agricultural lands give way to housing development and roads without adequate drainage facilities give rise to flooding and erosion problems (Ehiorobo et al., 2010).

Previous studies carried out on soil erosion in Nigeria especially in the southeastern Nigeria include Jeje and Agu (1990), Ofomata (1965), Ehiorobo et al. (2010), Okagbue and Uma, (1987) and Ogbukagbu (1976). These studies revealed that soil erosion is affected by vegetation cover, topography, soil characteristics (Ofomata, 1967), intensity and amount of rainfall; and human activities (Ehiorobo and Izinyon, 2011). Gully erosion is a highly noticeable form of soil erosion and can affect soil productivity and impair roads and water ways (Worrell, 2007). Soil properties and topography are often considered time independent due to the small temporal variation; while vegetation cover and land management vary over time as operations are performed that can influence runoff and erosion during different periods of the year. Capturing this dynamic behaviour at the field level is important since variations from field management activities influence how gullies form (Bingner et al., 2010). However, erosion problems arise mainly from natural causes but their extent and severity are increasingly being attributed to man's ignorance and unintentional action (Enabor and Sagua, 1988). The South-eastern part of Nigeria has been discovered as a major area being threatened with gully erosion which has accounted for losses of lives, infrastructural developments and properties (Ajaero and Mozie, 2011; Nwilo et al, 2011). Several studies have been carried out on the menace of gully erosion in the South-eastern Nigeria in various ways with various methods. Ajaero and Mozie (2011) discussed the Agulu-Nanka gully erosion in Anocha Local Government Area of Anambra State, Nigeria focusing on the impacts of this menace on the population of the area as well as the management and coping strategies adopted by individuals, community and the government. Nwilo et al. (2011) applied Geographic Information Systems (GIS) through the use of nearest neighbor analysis and geostatistics to determine the spatial variability map of gullies in Abia State. In a similar development, Adediji et al. (2009) used GIS to determine digital elevation models (DEMs) for gullies in Irele Local Government Area of Ondo State, Nigeria. However, there are little or no known studies on the gully situation in Ideato South LGA of Imo State, Nigeria especially in terms of gully parameters which include the gully slope, width, length with respect to soil properties. In this regard, this study focuses on the interrelationships between soil properties and gully parameters in some selected communities in Ideato LGA of Imo State, Nigeria.

2. Materials and Methods

The selected communities for the study were Isiekenesi, Umuaghobe and Umueshi in Ideato South LGA, Imo State, Nigeria. Among the communities, Isiekenesi is more developed while Umueshi is the most rural with least infrastructural development. Ideato South LGA is located between 7^o 2'E and 7^o 11'E and 5^o 46'N and 5^o 53'N (Figure.1).

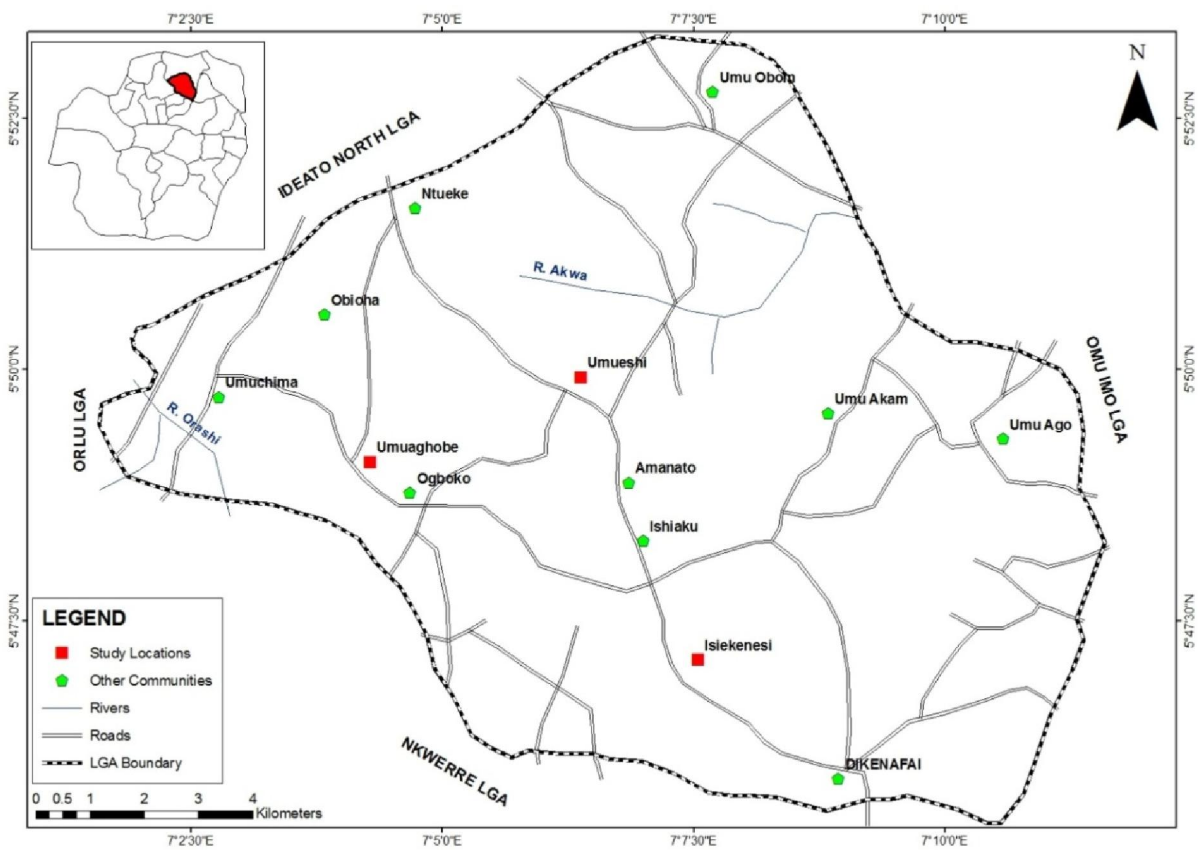

Figure.1: Map of Ideato South LGA showing the Study Locations

Source: Imo State Ministry of Land and Housing (2015)

Mapping of gully sites and measurement of gully parameters

An extensive fieldwork was embarked upon to extract the physical characteristics of the gully erosion through direct measurement. Forty gully sites were discovered in the selected communities and all of them were used for the analysis. The location of each gully in terms of their latitudes (Y coordinates) and longitudes (X coordinates) was determined using Global Positioning System Garmin Etrex 10.0 version from which averaged area for each catchment was determined. The gully parameters that were determined in situ were depth, width and length and gully slope. The height (depth) of gully from the head to the terminal point of the gully was determined using leveling staff while the width and length were measured using a measuring tape (Ibitoye et al, 2008). The catchment of each gully was delineated based on the slope gradient and the gully distribution pattern. The slope or gradient was determined using the abney level. The gully cross sectional area was determined using the formula for calculating triangle:

Cross sectional area (m^2) = ½ width of gully (m) x depth of gully (m) (Ibitoye et al, 2008)

The volume (m^3) of soil lost from the gully was determined using the formula:

Volume of soil lost (m^3) = Cross-sectional area (m^2) x Length of gully (m)

The volume of soil loss to a per meter equivalent in a catchment area was determined using the formula:

Sediment Loss (m^3/m^2) = Volume of soil lost (m^3) ÷ Catchment Area (m^2)

Soil Sampling

Random sampling technique and quadrat approach were used for soil sampling. In each community, ten sample plots of 10m x 10m quadrats were randomly established at 100m apart at both the gully sites (affected sites) and the control sites (forest landuse). A control site was used for all the communities because of the similarity in the forest composition and soil type in the three communities and thus, 40 soil samples were collected altogether. Soil samples were collected at the center of each quadrat with the use of soil auger at 15cm depth of soil profile which represents the topsoil of the soil profile into well-labelled polythene bags and brought to the laboratory for some physical and chemical analyses. The soil samples were air-dried and carefully sieved with 2mm diameter mesh in order to separate the soil from stones. Thereafter, the soil samples were taken to the laboratory for analysis to determine the concentration of the physical and chemical properties of soils. Soil particle size composition (sand, silt and clay) was analyzed using the hydrometer method of Bouyoucos (1926), bulk density and total porosity using core method and water holding capacity as described in Dutta and Agrawwal (2002). Organic carbon was determined by Walkey and Black's rapid titration method (Walkey and Black, 1934) while total Nitrogen was determined using Kjeldahl steam distillation (Aweto and Enavrube, 2010).

Statistical analysis and data presentation

Descriptive statistics was employed in this study to explain the means of gully parameters and soil parameters in the study area. Inferential statistics such as correlation, simple regression and analysis of variance were used. Correlation statistics was used to determine the relationship between the gully parameters and soil parameters; and between gully depth and gully width while simple regression was used to determine the model connecting the gully width and depth. These analyses were performed using Statistical Package for Social Scientists (SPSS) 16.0 Version. Results of the data were presented in tables and maps.

3. Results

Morphometric Parameters of Gullies and Soil Loss in the Selected Communities

Table 1 shows the morphometric parameters of gullies in the selected communities of Ideato South LGA of Imo State and the mean value of the depth of gullies was 12.06m with a range between 0.50m and 41.80m while the mean gully width was 27.73m which ranged between 1.20m and 100.20m. The mean value of the length was 173.24m while the mean value of the cross-sectional area was 212.64m^2. The total mean value of the volume of soil loss in the study area was 58745.57m^3 while the mean value of soil loss was 15.25m^3/m^2. The total mean slope of gullies was 19.1m with a range between 0.8m and 58.4m.

The number of gullies and morphometric parameters of gullies in each of the selected communities is presented in Table 2. The number of gully points in Umueshi was 13 while 16 were discovered in Umuaghobe and 11 in Isiekenesi with Umueshi located at the elevation of about 255m above sea level which was the highest among the study locations (Figure. 2). The mean length of gullies in Umueshi was 174.2m with a range between 2.50m and 30.10m while in Umuaghobe and Isiekenesi was 136.21m with a range between 2.70m and 371.20m and 225.97m with a range between 179.00m and 300.10m respectively. Moreso, the mean depth of gullies was 8.60m, 14.48m and 12.5m in Umueshi, Umuaghobe and Isiekenesi respectively while the mean width of gullies was 25.97m, 25.93m and 32.41m in Umueshi, Umuaghobe and Isiekensi respectively. The mean cross-sectional area of gullies in Umueshi was 182.19m while it was 222.10m and 234.86m in Umuaghobe and Isiekenesi respectively.

The cross-sectional area was highest in Isiekenesi among the selected communities in Ideato South LGA.

Table 1: Morphometric parameters of gullies and soil loss in the entire study area

	Range	Mean±S.D.
Depth (m)	0.50-41.80	12.06±9.5
Width (m)	1.20-100.20	27.73±19.3
Length (m)	2.50-600.50	173.24±132.2
Cross-sectional Area (m^2)	0.3-1508.01	212.64±279.9
Gully Slope (m)	0.8-58.4	19.1±12.3
Volume of Soil Loss (m^3)	0.75-905560.00	58745.57±14632.00
Sediment Loss (m^3/m^2)	0.0002-224.704	15.25±36.59

Source: Researcher's Fieldwork, 2014; Note: S.D. - Standard Deviation

Table 2: Variations in Morphometric Parameters of Gullies in the selected communities

Locations	No of Gullies	Length (m)		Depth (m)		Width (m)		Cross-sectional area (m^2)	
		Mean±SD	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	Range
Umueshi	13	174.2±178.18	2.50-600.50	8.60±9.36	0.50-30.10	25.97±26.41	1.20-100.20	182.19±405.52	0.30-1508
Umuaghobe	16	136.21±124.44	2.70-371.20	14.48±11.18	0.80-41.80	25.93±15.70	1.20-52.80	222.10±201.03	0.50-608.72
Isiekenesi	11	225.97±39.81	179.00-300.10	12.5±5.62	8.10-25.80	32.41±14.47	12.00-58.70	234.86±213.59	52.20-697.89

Source: Researcher's Fieldwork, 2015

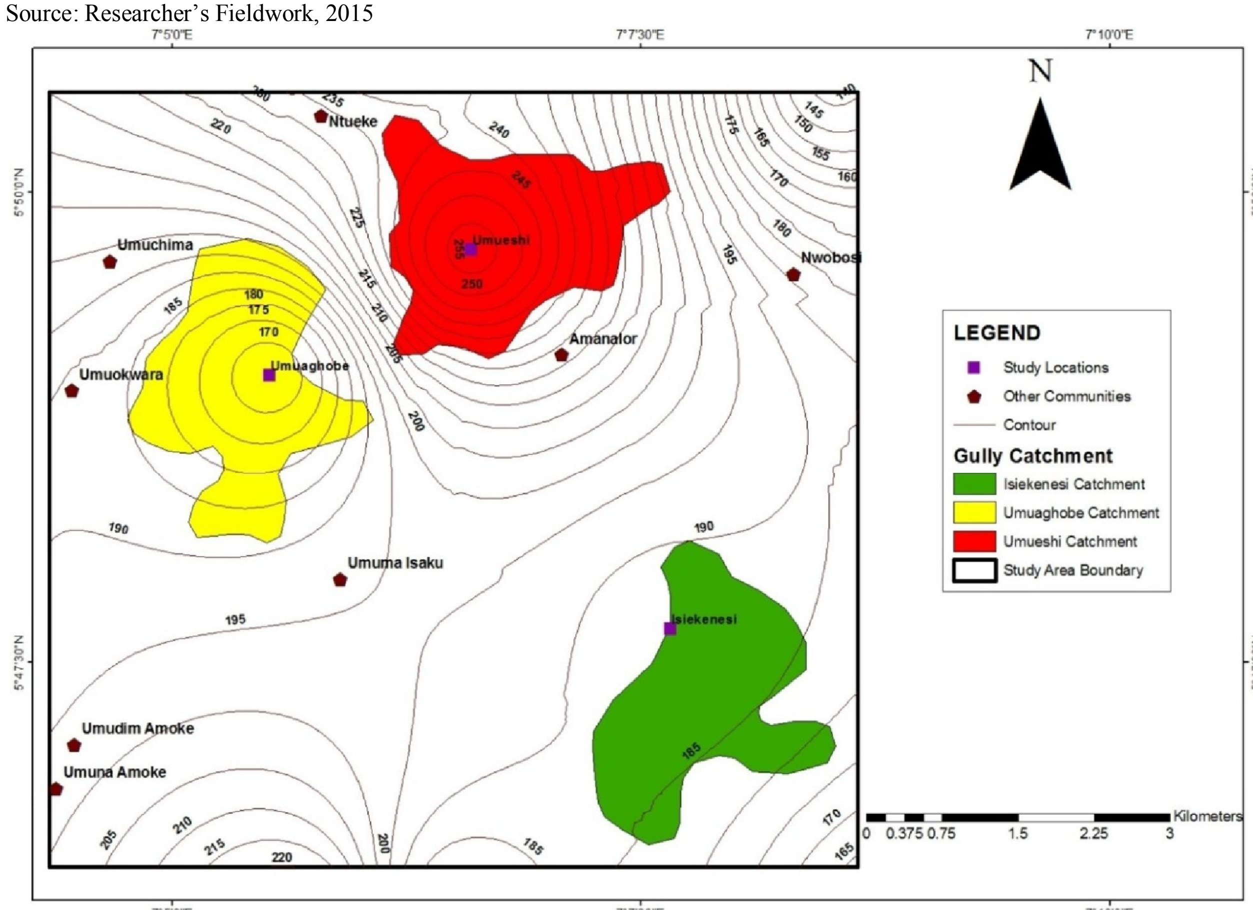

Figure. 2: Contour map of the study area

Loss of soil among the selected communities in the study area

The variation in volume of soil loss (m^3), sediment loss (m^3/m^2) and the gully catchment area among the selected communities is presented in Table 3. It is observed that the gully catchment area in Umueshi, Umuaghobe and Isiekenesi was 4030.00 m^2, 3780.00 m^2 and 3640.00 m^2 respectively. The mean sediment loss was highest in Umueshi with a mean value of 21.08 $m^3/m^2$and least in Umuaghobe with a mean value 16.20 m^3/m^2.

Table 3: Variations in soil loss due to gullies in the selected communities

Locations	Gully Catchment Area (m^2)	Volume of Soil Loss (m^3)		Sediment Loss (m^3/m^2)	
		Mean±SD	Range	Mean±SD	Range
Umueshi	4030.00	84939.37±247662.00	0.75-905560.00	21.08±61.45	0.0002-224.70
Umuaghobe	3780.00	37300.59±54089.81	2.16-198944.64	9.86±14.31	0.0006-52.63
Isiekenesi	3640.00	58981.97±62286.43	10206-181730.56	16.20±17.11	2.80-49.93

Source: Researcher's Fieldwork, 2012

Soil Physical Properties in the Selected Communities

The status of physical properties of soil in the gully erosion affected areas and the gully erosion less-disturbed area is presented in Table 4. The bulk density of soil in Umueshi was 1.14 g/cm^3 with a range between 1.09 g/cm^3 and 1.22 g/cm^3 while the bulk density in Umuaghobe was 1.25 g/cm^3 which ranged between 1.12 g/cm^3 and 1.59 g/cm^3 and it was 1.26 g/cm^3 in Isiekenesi with a range between 1.13 g/cm^3 and 1.40 g/cm^3. At the control site, the bulk density was 1.18 g/cm^3 ranging between 1.11 g/cm^3 and 1.27 g/cm^3. The bulk density was insignificantly varied but it was least in Umueshi and highest in Isiekenesi. Total porosity in Umueshi ranged between 53.89% and 58.94% with a mean value of 56.69% while total porosity ranged between 40.04% and 65.02% with a mean value of 54.73% in Umuaghobe while the total porosity in Isiekenesi ranged between 47.13% and 57.40% with a mean value of 52.77%. The total porosity among the selected communities was not significantly different. The particle size composition comprising of sand, clay and silt was also determined at the selected gully sites. It was revealed that the percentage composition of sand in Umueshi, Umuaghobe and Isiekenesi was 62.64%, 74.05% and 62.44% respectively while the sand content was 74.64% in the control site. This shows that the area was predominantly sandy but the sand content was more in Umuaghobe than the other two communities. The clay content was the same in Umueshi and Isiekenesi which was 16.64% and 12.44% in Umuaghobe while it was 11.84% in soils under the control site. In addition, the silt content was 20.7%, 13.51% and 20.92% in Umueshi, Umuaghobe and Isiekenesi respectively while it was 13.51% in the control site. The mean value of water holding capacity of soils in Umueshi was 382.0 ml/l and 404.0 ml/l in Umuaghobe while it was 396.0 ml/l in Isikenesi and 378.0 ml/l at the control site. It was observed that the mean value of water holding capacity did not vary significantly in the study area.

Table 4: Soil physical properties

Locations	Bulk Density (g/cm$^{3)}$		Total Porosity		Sand		Clay		Silt		Water holding capacity	
	Mean±SD	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	Range
Umueshi	1.14±0.05	1.09-1.22	56.69±2.07	53.89-58.94	62.64±9.14	49.64-73.64	16.64±4.72	12.04-24.04	20.7±4.56	14.32-26.32	382±58.05	320-450
Umuaghobe	1.25±0.19	1.12-1.59	54.73±9.13	40.04-65.02	74.05±6.19	67.64-83.64	12.44±2.88	8.04-15.04	13.51±3.34	8.32-17.32	404±57.71	310-460
Isiekenesi	1.26±0.11	1.13-1.40	52.77±3.97	47.13-57.40	62.44±20.02	35.64-85.64	16.64±9.18	6.04-30.04	20.92±10.99	8.32-34.32	396.0±45.61	350-470
Control Site	1.18±0.06	1.11-1.27	55.39±2.42	51.96-58.26	74.64±1.41	72.64-76.64	11.84±0.84	11.04-13.04	13.51±0.83	12.32-14.32	378±8.37	370-390

Source: Researcher's Fieldwork, 2012

Soil Chemical Properties in the Selected Communities

Table 5 reveals the status of two chemical properties in soils of the selected communities in Ideato South LGA. It was revealed that the mean value of organic carbon in Umueshi was 0.68 %, Umuaghobe 0.40 % while it was 0.70% in Isienekesi. The mean value of organic carbon in soils under control site was 0.54%. The organic carbon in the study area was generally low and insignificant but it was highest in Isienekesi. The mean value of total nitrogen in Umueshi, Umuaghobe and Isiekenesi was 0.02%, 0.01%, 0.02% respectively while it was 0.02% in the control site. Similar to organic carbon, the total nitrogen was generally low and varied slightly.

Table 5: Chemical Properties of Soil

Locations	Organic C (%)		Total Nitrogen (%)	
	Mean±SD	Range	Mean±SD	Range
Umueshi	0.68±0.16	0.42-0.82	0.02±0.01	0.01-0.03
Umuaghobe	0.40±0.14	0.22-0.60	0.01±0.00	0.01-0.02
Isiekenesi	0.70±0.22	0.38-0.96	0.02±0.01	0.01-0.03
Control Site	0.54±0.16	0.32-0.76	0.02±0.01	0.01-0.02

Source: Researcher's Fieldwork, 2012

Relationships between the gully parameters and soil parameters in the study area

Table 6 reveals the relationships between gully parameters and soil physical parameters. Generally, it was discovered that the correlation coefficients between gully parameters and soil parameters were low and most of them were inversely proportional. However, the correlation coefficients between gully cross sectional areas and bulk density; sand; clay and silt were higher though the relationships were inversely proportional with clay and silt. Nevertheless, examining the relationships within the gully parameters showed that gully width and gully length had 0.653 while gully depth, gully width and gully length had a relationship with gully cross sectional area with correlation coefficients of 0.711, 0.881 and 0.607 respectively. This shows that gully width had highest relationship with gully cross sectional area suggesting that gully width is an important gully parameter. Within the soil parameters also, the relationship between bulk density and porosity was high though negative with correlation coefficient of -0.893. Among the particle size composition (sand, silt and clay), it is observed that all of them exhibited high correlation coefficient but it was clay and silt that exhibited positive relationship of correlation coefficient of 0.957. Gully slope had slightly high correlations with the gully depth and gully cross sectional area with correlation coefficient (r) of 0.637 and 0.585 respectively while the gully width, gully length, cross sectional area were also slightly correlated with soil loss. Finally, the soil loss was significantly correlated with gully slope and the correlation was direct and high suggesting that the higher the gully slope, the higher the soil loss in the area.

Table 6: Correlation matrix between gully parameters and soil physical parameter

	Gully Depth	Gully Width	Gully Length	Gully Cross Sectional Area	Bulk Density	Porosity	Sand	Clay	Silt	Water holding capacity	Gully Slope	Soil Loss
Gully Depth	1											
Gully Width	0.512*	1										
Gully Length	0.433	0.653**	1									
Gully Cross Sectional Area	0.711**	0.881**	0.607**	1								
Bulk Density	0.098	0.132	-0.042	0.304	1							
Porosity	-0.080	-0.107	0.000	-0.290	-0.893**	1						
Sand	0.199	0.235	-0.026	0.374	0.304	-0.250	1					
Clay	-0.243	-0.265	-0.056	-0.400	-0.276	0.234	-0.987**	1				
Silt	-0.159	-0.206	0.092	-0.346	-0.321	0.258	-0.991**	0.957**	1			
Water holding capacity	-0.164	-0.077	-0.136	-0.204	-0.369	0.363	-0.166	0.207	0.130	1		
Gully Slope	0.637**	0.472	0.407	0.585	0.135	-0.081	0.225	-0.267	-0.187	-0.107	1	
Soil Loss	0.331	0.540	0.518	0.689	-0.108	-0.356	0.384	-0.405	-0.359	-0.215	0.710**	**1**

Source: Researcher's Fieldwork, 2012; *Significant at p=0.05; **Significant at p=0.01

4. Discussions

Findings show that the mean value of gully length varied among the three selected communities and the more the number of gullies the decrease the mean gully length and mean gully width. The gully length in the study area can be classified very high. Desta and Adugna (2012) classified gully based on size-depth to small gully (<1.5m), medium gully (1.5 and 3.0m) and large gully (>3.0m).The number of gullies did not influence the cross-sectional area as Isiekenesi which had the lowest number of gullies had the highest gully cross-sectional area. The mean gully width in the study area ranged between 25.93m in Umueshi and 32.41m in Isiekenesi. The higher mean gully width in Isiekenesi may be due to the developmental projects going on in the community which is unsustainably. Akinbode et al. (2008) submitted that impact of urbanization growth rate is often achieved unsustainably in Nigeria with a probability of causing environmental problems. The gully may be much in Isiekenesi due to the higher gully catchment which may in effect produce higher runoff watershed. According to Desta and Adugna (2012), the larger the watershed, the greater will be the amount of run-off and as a result, large watersheds have greater chances of gully erosion than small watersheds. The mean gully depth, gully width, gully length and gully cross-sectional area in the entire study area were 12.06m, 27.73m,173.24m and 212.64m^2 respectively. The gully depth and gully width are well above the gully depth and gully width that was observed in the Southwestern Nigeria by Ibitoye et al (2008). This justifies the assertion that Southeastern Nigeria is more prone to gully erosion (Ofomata, 1985). Except gully depth and gully length that had a low correlation (R=0.433), the relationship between every other gully parameters was significant. This finding is different from the result gotten by Ebisemiju (1988) in the Southwestern Nigeria whereby the gully length has no effect on gully cross-sectional area (R=0.15) and that the rate of increase in gully depth with length is almost constant. Gully slope had a significant correlation with gully depth (R=0.637) and soil loss (R=0.710). The relationship was different in Ebisemiju (1988) as gully length has extremely low correlation with mean bed slope (R= -0.08). The sediment loss among the selected communities was not significantly varied. The reason may be due to the fact that the parent material among the communities was similar and that the whole study area was sandy. Desta and Adugna (2012) affirmed that a soil with a coarse textured highly permeable surface horizon with an abrupt transition to slowly permeable subsoil is normally prone to gully erosion. The high rainfall and steep slope may also bring about the rate of sediment loss. Previous studies on gully in the Southeastern Nigeria have shown that gully is often initiated by rainfall events on surfaces whose vegetation cover has been removed for agricultural purposes. Studies also showed that the Southeastern Nigeria is permanently under the influence of the Tropical Maritime Air Mass and thus wet season throughout the whole year (Ofomata, 1985; Umeuduji, 2001; Ibitoye et al, 2008). Thus, the rainfall might have initiated the extent of sediment loss end eventually, gully erosion. Similarly, Ajaero and Mozie (2011) believed that the emphasis on high rainfall and topography can be attributed to the high rainfall experienced in the humid tropics while the steep slopes existing in the area might have also aided the high speed of surface runoff leading to rapid washing away of the soil surface and the weakening of soil strata (Ajaero and Mozie, 2011). The soil loss was highest in Umueshi and Umuaghobe and this may be due to the inappropriate construction of drains along the streets and concrete channels which are able to enhance the formation of gullies. Particle size composition of the area was dominated by sand content (>70%) confirming that the Southeastern Nigeria soils is predominantly sandy (Ofomata, 1985; Umeuduji, 2001) and as a result, this region is more prone to erosion especially with the presence of high rainfall.

The textural properties of the surficial deposits and horizontal to gently inclined bedrock make them susceptible to erosion (Hudec et al., 2006). According to FAO (1976), this type of soil belongs to irrigable class of the Modified US Bureau of Reclamation Land Suitability Class specifications, and therefore, this soil is erodible (Ibitoye et al, 2008). The mean bulk density values ranged between 1.14 and 1.26 g/cm^3 in the study area. These values according to Babalola (1988) in Ibitoye et al. (2008) are far above 1.0-1.3 g/cm^3 considered for a well-aggregated forest. Jespen et al. (1997) affirmed that erosion rate is a unique function of the bulk density and can be expressed as a product of powers of the shear stress and bulk density. The high bulk density suggests that soil erosion is very evident in the selected communities. Hudec et al (1998) described the results of gradation analysis and measurements of the dry bulk density, dispersivity and moisture content of samples from the main geological units, to make Southeastern part of Nigeria to be susceptible to gullying. Total porosity was high in the area and thus can be attributed to the predominance by sand content in the area. The soil organic carbon in the study area ranged between 0.22% and 0.96% in the gully sites while that of control site ranged between 0.32% and 0.76%. This shows that organic carbon was very low in the study area. The total nitrogen was also generally low. This may be due to leaching which might have resulted from high rainfall and the predominance of sand.

5. Conclusion and Recommendations

It can be concluded that relationships existed between gully erosion and soil properties in Umueshi, Isienekesi and Umuaghobe in Ideato South LGA, soil loss and gully slope exhibited highest relationship. Moreso, the gully and soil parameters varied among the three communities but the variations were insignificant. Based on the findings from this present study, it is recommended that afforestation and planting of cover crops and pastures should be more encouraged in Ideato South LGA and government should assist by giving the affected communities aids/facilities to prevent and cope with the occurrence of gully erosion.

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