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Journal of Ecology and Natural Resources
ISSN: 2578-4994

Adaptation and Management Practices of Communities Vulnerable to Gully Erosion in Anambra and Imo States, Nigeria

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Research Article

Volume 6 Issue 2

Received Date: March 07, 2022

Published Date: April 21, 2022

DOI: 10.23880/jenr-16000276

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Abstract

This study is aimed at evaluating the adaptation and management practices of communities vulnerable to gully erosion in Anambra and Imo States, respectively. The study employed qualitative research methods involving a cross sectional research design using questionnaire survey and interviews. The information for the causes of gully erosion among sampled communities showed the following distribution: 13.1% respondents believed that it has been caused by deforestation; 25.2% of the respondents indicated infrastructural development causes; 20.5% of the sampled respondents indicated poor farming systems; 31.8% of the respondents were of the opinion that the misuse of land contributes more to the causes of gully erosion in the study area; while the remaining 9.4% of the respondents indicated mining as one of the causes of gully erosion in the study area. The distribution revealed that majority of sampled respondents indicated land misuses as a prominent factor leading to gully erosion formation in the study area. The study therefore noted that gullies have impact on depletion of the soil through constant action of erosion and these have several implications for food production which is the primary economic activity engaged on by the majority of residents in the study area. Thus, adaptive capacities of residents in affected gully erosion areas in Anambra and Imo States have not been effective. This will definitely lead to increased socio-economic effects which have several implications on their potential for growth and development in the study area.

Keywords: Gully Erosion; Vulnerability; Land Use; Soil Erosion; Adaptation; Remediation

Introduction

Gully erosion is the process by which gullies are formed. Hillsides are more prone to gully erosion when they are cleared of vegetation, through deforestation, over-grazing or other means Christensen PR, et al. [1]; Igbokwe T, et al. [2]. The eroded soil is easily carried by the flowing water after being dislodged from the ground normally when rain falls during short, intense storms such as during thunderstorms. A gully may grow in length by means of head ward (i.e. upstream) erosion at a knick point. This erosion can result from interflow as well as surface runoff. Gullies reduce the productivity of farmland where they incise into the land, and produce sediment that may clog downstream water bodies [3-5]. Thus, because of this, much effort is invested into the study of gullies within the scope of geomorphology, in the prevention of gully erosion, and in restoration of gullied landscapes [6]. The total soil loss from gully formation and subsequent downstream river sedimentation can be sizeable [3,7].

This study is limited geographically to Anambra and Imo states, Nigeria. Thus, the two states were the study areas whereby imageries of each state were used to perform geospatial analysis in relation to the objectives of the study. The scope of the research conducted in Anambra and Imo states therefore covers land use/land cover analysis; vegetation index (for crop management analysis); mean annual rainfall (mm); soil texture/particle size composition; elevation and contour surface analysis; analysis of soil loss (t/year) estimate and percentage erosion.

The perceived problems, challenges and management practices of communities vulnerable to gully erosion in Anambra and Imo states were also examined. Therefore, the questionnaire instrument was employed for data collection in this regard. Thus, copies of the questionnaire were administered at household level in communities vulnerable to gully erosion to obtain information concerning the challenges of gully erosion and their adaptations and management strategies overtime. That is, these communities are found in areas of depressions indicating strong gully sites (areas experiencing gully erosion overtime) due to their respective elevation.

Description of the Study Area

The study area is located geographically within latitudes 4° 47' 35"N and 7° 7' 44"N, and longitudes 7° 54" 26"E and 8° 27" 10"E (Figure 1) in the tropical rain forest zone of Nigeria, and is made up of Anambra and Imo States. The area covers about 29095 km^2 which is about 3.19 % of the total area of Nigeria [8].

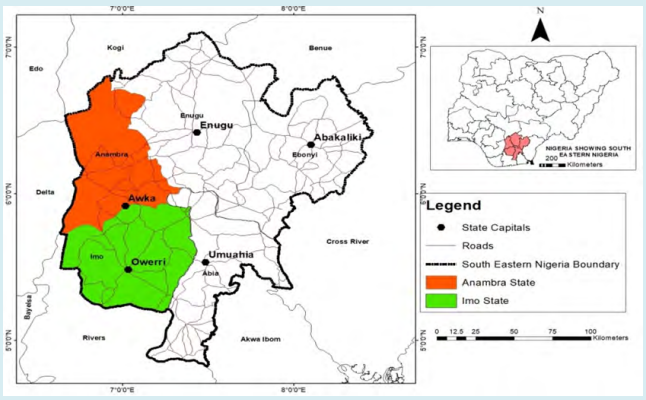

Figure 1: Map Showing Anambra and Imo States.

Topography and Geology

The area lies in the Anambra and Niger River basins. The Anambra River Basin is a NE-SW trending syncline that is part of the Central African Rift System which developed in response to the stretching and subsidence of major crustal blocks during a lower Cretaceous break-up phase of the Gondwana super-continent [9]. The tectonic movements for the formation of the Anambra Basin and the other areas were reactivated by further plate activity in lower Tertiary soon after the intermittent Upper Cretaceous rifting [9]. The separation of the African and South American plates left the Benue Trough as an Aulacogen. Geologic formations such as hills that elongate in the north east to south westerly directions include Missions hill and Abakaliki hill. The hills are generally of volcanic rocks and sandstones. It is found that from these hills that a number of streams that recharge the rivers that drain the area originated. In Ebonyi, the outcrops of folded Cretaceous limestone and shale are found in so many places [10].

The Geology of the area is a major factor in gully erosion causation and massive landslides that occur in several communities. The sandy members of the Ajalli Sandstone, Ameki Formation and Nanka Sands are very prevalent to denudation where they become exposed as sandy outcrops. Sometimes these sandy Formations have overlying and underlying shaley members that may bind the sandy unit's together [11]. These Geologic Formations contain saturated groundwater members or aquifers whose pore water pressures enhance groundwater flows and movement of sedimentary materials. Sedimentary units of these Formations sometimes form escarpments or cuestas that may be folded and faulted with fractures of joints and faults all of with planes of weaknesses which facilitate the incidences of gully erosion and landslides. Blocks of sedimentary units of rocky sands and shales may break out and slide downslope into the gully valleys [11].

Drainage

The area is well drained. The notable lakes, rivers and streams that are found draining the area in this zone include Rivers Niger, Imo, Nike Lake, Anambra, Idemili, Njaba, Oguta Lake, Nkisi, Ezu, Oji etc. [11]. The River Niger Basin forms part of the almost north-south trending River Niger that catches up with the tributary dissections of the Anambra, Idemili and Njaba Rivers as well as their distributaries that flow from east to the west as they forcefully-empty into the River Niger that flows southwards into the Atlantic Ocean. Similarly, in the eastern area, the Imo and Cross Rivers together with their tributaries flow southwards and discharge their waters into the Atlantic Ocean [12].

The natural flow patterns of the rivers and their tributaries form dendritic kind of drainage pattern in the area [12]. The waters of these rivers, lakes, tributaries and distributaries together with their groundwater components, their flows and fluxes contribute immensely to the origins,

growth and dynamics of gullies and landslides all over southeastern Nigeria [11].

Vegetation

The forest flora in the southeastern part of Nigeria is the richest and very diverse, with many families in it being represented by small numbers of species. In the grassland flora the majority of species belong to a few well-represented families. The transition zone vegetation is poorest in species but in other respects intermediate between the forest and the grassland [13]. However, by way of classification, the vegetation iin the southeastern states consists mainly of rain forest and woodland and tall. Thus, geographically, Imo state as one of the states is located within the rainforest zone while the remaining states fall under the wood land and tall grass zone [14].

Population, Urbanization & Socio-economy

The population figures for Anambra and Imo according to the 2006 population census were 4,182,032 and 3,934,899 respectively. Anambra State with a landmass of 4,844km^2 has the highest population density (863 people per km^2). As more rural areas in the Southeastern Nigeria acquire urban status, there is generally improved standard of living, job opportunities and increased literacy level, exposure to people from different parts of the world and improved medical facilities which orchestrate rural-urban migration. However, urbanization results in high cost of living, environmental pollution, deforestation, high population density, high crime rate, impersonality, high rate of accidents and a host of other socioeconomic problems. The increase in demographic growth in population and urbanization put a lot of stress on the system that may result in some of the environmental disasters of floods, soil and gully erosion, landslides, environmental pollution and contamination all compounded by the incidence of global climate change [11].

Methods of Study

The study employed qualitative research methods involving a cross sectional research design using questionnaire survey and interviews. Cross sectional research design aim to provide data on the entire population under study. Cross-sectional studies involve information obtained at a specific time. It may also describe the characteristics of a particular population under study, like the frequency of a particular case study, or it might be based on outcomes of a relationship between phenomenon's [15]. Thus, the cross sectional sample of the population was targeted for questionnaire survey for data collection as regards the perceived problems, challenges and management of gully erosion in the study area.

The questionnaire instrument was employed for data collection in this regard. Thus, copies of the questionnaire were administered at household level in selected communities vulnerable to gully erosion. That is, these communities are found in areas of depressions indicating strong gully sites (areas experiencing gully erosion overtime) due to their respective elevation characteristics.

Population of the Study

The population of the study for questionnaire survey involved all communities in the selected states facing the menace of gullies in their environment. However, due to the difficulty in sampling the entire population from communities facing gully erosion challenges; the study therefore systematically obtained a sample size for the questionnaire survey. Thus, based on classifications by areas of depressions and vulnerability analysis conducted for the study, five (5) LGAs for Anambra State and four (4) LGAs for Imo State were carved out (Table 1). From the 5 LGAs under Anambra state 9 communities with high vulnerability to gullies were delineated while 8 communities were delineated under the 4 LGAs in Imo state (Table 1).

	LGA	Town/Community
Anambra	Anaocha	Agulu
		*Akwaeze
	Aguata	*Naka
		Igbo Ukwu
		Nkpologwu
	Isu (Orumba South)	*Eziagu
	Idemili North	*Umuoji
		Abatete
	Njikoka	*Abagana
Imo State	**LGA**	**Town**
	IsialaMbano	*UmuOkpukapra
		Umueke
	Ideato South	*Isiekenesi
		DikenafaiUmudi
	Orlu	*Obibi
		Ogbelulu
	Ideato North	*Akukwa
		Ndizilogu

*Selected Communities

Table 1: Study Areas in Anambra and Imo States.

Sample Size Determination

The sample size for the study was determined from the total population of the nine (9) LGAs selected purposively for the study. The population figures projected in year 2019 by

National Bureau of Statistics (NBS) [16] as projected from the population figure from the National Population Commission [17] for each LGA was utilized (Table 2). A total population of 32654 from 9 communities selected for the study was subjected to Yamane T, et al. [18] formula for reducing large population sizes. The Yamane T, et al. [18] formula is expressed as follows:

$$n=\frac{N}{1+N(e)^2} \quad (1)$$

Where,
n = sample size required
N = total population
1 = constant
e = level of significance $(0.05)^2$
That is;
N = 32654; e = 5% = 0.05
When substituted in the equation;
n = 32654 / 1 + 32654 $(0.05)^2$
n = 32654 / 1 + 32654 (0.0025)
n = 32654 / 1 + 81.635
n = 32654 / 82.635
n = 395.169 = 396 (approx.)

Therefore, the sample size of 396 was rounded up to 400 and this was proportionally distributed among selected communities using the respective projected population figure for each Town/community in the study area.

State	LGA	Selected Towns/ Communities	Number of Copies Administered	Number of Copies Returned
Anambra	Njikoka	Abagana	25	25
	Anaocha	Akwaeze	79	73
	Isu (Orumba South)	Eziagu	31	30
	Aguata	Naka	60	58
	Idemili North	Umuoji	86	77
Total			281	263
Imo	Ideato North	Akukwa	20	20
	Ideato South	Isiekenesi	36	36
	Orlu	Obibi	33	32
	Isiala Mbano	UmuOkpukapra	30	30
Total			119	118
Overall Total			400	381

Table 2: Details of Sample Size Determination for the Study.

Sampling Procedure

The study employed multistage sampling techniques for questionnaire administration. First, purposively the areas of high vulnerability to gully erosions were grouped into clusters of LGAs whereby one community was selected for each LGA for questionnaire survey. Thereafter, random sampling technique was employed for questionnaire administration to respondents for the study. The respondents were household heads who are either a male or female representative at the time of sampling. That is, a male or female head that is economically responsible for his/her household in the study area or an over aged persons or individuals who also occasionally contribute to the income of that household. The characteristics of respondents are mostly farmers and others like traders and artisans (preferences were given to farmers to ensure their participation and contribution to the research).

Sampling Techniques

The sampling techniques employed for the study were purposive and random sampling techniques. The study purposively delineated LGAs mostly affected by gullies and selected one community from each for questionnaire administration. The study employed random sampling technique to administer 400 copies of the questionnaire among targeted respondents in the study area. The random sampling techniques was carried out by administering copies of the questionnaire based on land use types like farmland, residential, transportation and commercial/ business areas in the study area. This was done to ensure that the respondents for the study are representation of the study population and have equal chances of being selected for sampling/field survey exercise.

Results and Discussion

Socio-economic Characteristics of Sampled Respondents

The information for the socio-economic characteristics of sampled respondents was presented on Table 3a. The distribution revealed that 65.9% respondents were male while the remaining 34.1% were females. Therefore, most respondents for the study were males. The age status of sampled respondents for the study showed that 25.7% of sampled respondents fall between 35-40 years of age, 36.0% respondents were between 41-45 years of age; 26.5% of the respondents falls between 46-50 years of age; while the remaining 11.8% were 51 years and above. The information for the level of education for the sampled respondents showed that 39.6% respondents had primary education; 49.9% respondents had secondary education; while the remaining 10.5% respondents have tertiary education.

Characteristics	Response	Percentage (%)
Gender	**Frequency**	
Male	251	65.9
Female	130	34.1
Age		
35-40	98	25.7
41-45	137	36
46-50	101	26.5
51 and above	45	11.8
Level of Education		
Primary	151	39.6
Secondary	190	49.9
Tertiary	40	10.5
Occupation		
Civil Servant	71	18.6
Trading	100	26.2
Business/Self employed	24	6.3
Farmer/Fisherman	122	32
Artisan/Crafts	46	12.1
Unemployed	16	4.2
Others	2	0.5
Average Monthly Income (#)		
5,000-15,000	126	33.1
16,000-30,000	140	36.7
31,000-45,000	43	11.3
46,000-60,000	28	7.3
61,000-80,000	31	8.1
81,000 and above	13	3.4
Household Size		
2-Jan	93	24.4
4-Mar	184	48.3
6-May	85	22.3
7 and above	19	5

Table 3a: Socio-economic Characteristics of Sampled Respondents.

The occupational status of sampled respondents revealed that 18.6% of sampled respondents were civil servants; 26.2% respondents are into trading; 6.3% of respondents are into business or are self- employed; 32.0% of the respondents are farmers and fishermen; 12.1% of respondents are into crafts or artisanship; 4.2% of sampled respondents are

unemployed, while the remaining 0.5% respondents are into other forms of business like commercial driving. The survey revealed that most of the respondents for the study were farmers. The information for the average monthly income of respondents showed that 33.1% respondents earns between #5,000 and #15,000; 36.7% respondents earns between #16,000 and #30,000 on the average per month; 11.3% respondents earns between #31,000 and #45,000 averagely per month; 7.3% respondents claimed they earn between #46,000 and #60,000; 8.1% of sampled respondents earn between #61,000 and #80,000; while the remaining 3.4% of the sampled respondents earn between #81,000 and above on the average monthly.

The information for the household sizes among sampled respondents indicated that 24.4% of the respondents have household size between 1 and 2. It was also revealed that 48.3% of the respondents have household sizes between 3 and 4; 22.3% of the respondents have household sizes between 5 and 6; while the remaining percentage of the respondents of 5.0% have household sizes of 7 and above in the study area. The causes of gully erosion in the area are shown in Table 3b.

Communities	Causes					Total
	Deforestation	Infrastructural Development	Poor Farming Systems	Misuse of Land	Mining	
Abagana	7	2	7	9	0	25
	1.80%	0.50%	1.80%	2.40%	0.00%	6.60%
Akwaeze	9	19	13	24	8	73
	2.40%	5.00%	3.40%	6.30%	2.10%	19.20%
Eziagu	2	8	7	10	3	30
	0.50%	2.10%	1.80%	2.60%	0.80%	7.90%
Naka	8	19	7	18	6	58
	2.10%	5.00%	1.80%	4.70%	1.60%	15.20%
Umuoji	7	22	16	23	9	77
	1.80%	5.80%	4.20%	6.00%	2.40%	20.20%
Akukwa	0	7	5	5	3	20
	0.00%	1.80%	1.30%	1.30%	0.80%	5.20%
Isiekenesi	9	4	13	9	1	36
	2.40%	1.00%	3.40%	2.40%	0.30%	9.40%
Obibi	5	7	6	13	1	32
	1.30%	1.80%	1.60%	3.40%	0.30%	8.40%
UmuOkpukapa	3	8	4	10	5	30
	0.80%	2.10%	1.00%	2.60%	1.30%	7.90%
Total	50	96	78	121	36	381
	13.10%	25.20%	20.50%	31.80%	9.40%	100.00%

Table 3b: Causes of Gully Erosion.

Effects of Gully Erosion among Sampled Communities

The information for the causes of gully erosion among sampled communities in the study area is displayed on Table 4. The distribution showed that 13.1% respondents believed that it has been caused by deforestation; 25.2% of the respondents indicated infrastructural development causes; 20.5% of the sampled respondents indicated poor farming systems; 31.8% of the respondents were of the opinion that the misuse of land contributes more to the causes of gully erosion in the study area; while the remaining 9.4% of the respondents indicated mining as one of the causes of gully erosion in the study area. The distribution revealed that majority of sampled respondents indicated land misuses as a prominent factor leading to gully erosion formation in the study area.

State	Communities	Responses					Total
		No Impact	Slight Impact	Moderate	Severe	Very Severe	
Anambra	Abagana	0	4	0	11	10	25
		0.00%	1.00%	0.00%	2.90%	2.60%	6.60%
	Akwaeze	0	13	10	22	28	73
		0.00%	3.40%	2.60%	5.80%	7.30%	19.20%
	Eziagu	0	5	6	12	7	30
		0.00%	1.30%	1.60%	3.10%	1.80%	7.90%
	Naka	0	5	5	27	21	58
		0.00%	1.30%	1.30%	7.10%	5.50%	15.20%
	Umuoji	1	21	7	24	24	77
		0.30%	5.50%	1.80%	6.30%	6.30%	20.20%
	Akukwa	0	6	1	5	8	20
Imo		0.00%	1.60%	0.30%	1.30%	2.10%	5.20%
	Isiekenesi	0	3	5	15	13	36
		0.00%	0.80%	1.30%	3.90%	3.40%	9.40%
	Obibi	0	3	7	9	13	32
		0.00%	0.80%	1.80%	2.40%	3.40%	8.40%
	UmuOkpukapa	0	5	3	14	8	30
		0.00%	1.30%	0.80%	3.70%	2.10%	7.90%
Total 0.30%		1	65	44	139	132	381
		17.10%	11.50%	36.50%	34.60%	100.00%	

Table 4: Effects of Gully Erosion.

Gully Erosion as a Threat

The information for the percentage number of respondents that perceived gully erosion to be a threat is displayed on Table 5. It was revealed that 85.3% of the sampled respondents for the study agreed that gully erosion is a threat to their existence; while the remaining 14.7% of the respondents did not agree that they are threatened by gully erosion. Thus, majority of the respondents are threatened by gully erosion in the study area.

States	Communities	Responses				Total
		Strongly Disagree	Disagree	Agree	Strongly Agree	
Anambra	Abagana	0	0	18	7	25
		0.00%	0.00%	4.70%	1.80%	6.60%
	Akwaeze	1	15	37	20	73
		0.30%	3.90%	9.70%	5.20%	19.20%
	Eziagu	2	1	14	13	30
		0.50%	0.30%	3.70%	3.40%	7.90%
	Naka	2	3	31	22	58
		0.50%	0.80%	8.10%	5.80%	15.20%
	Umuoji	5	10	41	21	77
		1.30%	2.60%	10.80%	5.50%	20.20%
	Akukwa	2	2	7	9	20
Imo		0.50%	0.50%	1.80%	2.40%	5.20%

	Isiekenesi	2	1	21	12	36
		0.50%	0.30%	5.50%	3.10%	9.40%
	Obibi	3	2	14	13	32
		0.80%	0.50%	3.70%	3.40%	8.40%
	UmuOkpukapa	3	2	17	8	30
		0.80%	0.50%	4.50%	2.10%	7.90%
Total 5.20%		20	36	200	125	381
		9.40%	52.50%	32.80%	100.00%	

Table 5: Perceived Number of People seeing Gully Erosion as a threat.

Direct Impacts of Gully Erosion

The direct impacts of gully erosion in the study area are displayed on Table 6. It was revealed that 6.6% respondents with indicated land shortage and depletion; 11.5% respondents indicated the destruction of buildings; 29.4% of respondents indicated the destruction of public facilities; 44.4% of the respondents have also indicated the impacts as leaching of the top soils exposing the land for further degradation. The others which were 0.8% have indicated other types of worries created by gully erosion impacts. The study therefore noted that gullies have impact on depletion of the soil through constant action of erosion and these have several implications for food production which is the primary economic activity engaged on by the majority of residents in the study area.

State	Communities	Impacts					Total
		Land Depletion/ Shortage for Agriculture	Destruction of Houses	Destruction of Public Utility Facilities like Water Pipelines	Leaching of Soils	Others	
Anambra	Abagana	2	0	7	14	2	25
		0.50%	0.00%	1.80%	3.70%	0.50%	6.60%
	Akwaeze	3	0	23	39	8	73
		0.80%	0.00%	6.00%	10.20%	2.10%	19.20%
	Eziagu	1	8	11	7	3	30
		0.30%	2.10%	2.90%	1.80%	0.80%	7.90%
	Naka	4	24	19	11	0	58
		1.00%	6.30%	5.00%	2.90%	0.00%	15.20%
	Umuoji	7	11	19	35	5	77
		1.80%	2.90%	5.00%	9.20%	1.30%	20.20%
	Akukwa	0	0	6	11	3	20
Imo		0.00%	0.00%	1.60%	2.90%	0.80%	5.20%
	Isiekenesi	2	0	14	16	4	36
		0.50%	0.00%	3.70%	4.20%	1.00%	9.40%
	Obibi	2	0	6	21	3	32
		0.50%	0.00%	1.60%	5.50%	0.80%	8.40%
	UmuOkpukapa	4	1	7	15	3	30
		1.00%	0.30%	1.80%	3.90%	0.80%	7.90%
Total 6.60%		25	44	112	169	31	381
		11.50%	29.40%	44.40%	8.10%	100.00%	

Table 6: Direct Impact of Gully Erosion.

Knowledge of Time period for Gully Erosion Experience

The menace of gully erosion has been evident overtime. However, the knowledge of time period varied among sampled respondents. The results showed that 25.7% of sampled respondents have been experiencing the menace of gully erosion for a period of at least 5 years; 32.0% have been noticing it for at least 10 years. 21.8% of sampled respondents have been battling with it for a period between 11 years and 20; 14.7% of sampled respondents claimed evidence of the menace of gully erosion for at least 20 years while the remaining 5.8% respondents have 20 years and above experience of gully erosion (Table 7). Therefore, majority of respondents have experienced gully erosion for at least 15 years in the study area.

States	Communities	Responses					Total
		0-5 years	6-10 years	11-15 years	16-20 years	Above 20	
Anambra	Abagana	6	10	1	6	2	25
		1.60%	2.60%	0.30%	1.60%	0.50%	6.60%
	Akwaeze	23	28	14	7	1	73
		6.00%	7.30%	3.70%	1.80%	0.30%	19.20%
	Eziagu	11	12	1	5	1	30
		2.90%	3.10%	0.30%	1.30%	0.30%	7.90%
	Naka	9	11	24	12	2	58
		2.40%	2.90%	6.30%	3.10%	0.50%	15.20%
	Umuoji	17	21	20	15	4	77
		4.50%	5.50%	5.20%	3.90%	1.00%	20.20%
	Akukwa	3	5	10	1	1	20
Imo		0.80%	1.30%	2.60%	0.30%	0.30%	5.20%
	Isiekenesi	9	11	4	4	8	36
		2.40%	2.90%	1.00%	1.00%	2.10%	9.40%
	Obibi	11	15	2	3	1	32
		2.90%	3.90%	0.50%	0.80%	0.30%	8.40%
	Umu Okpukapa	9	9	7	3	2	30
		2.40%	2.40%	1.80%	0.80%	0.50%	7.90%
Total 25.70%		98	122	83	56	22	381
		32.00%	21.80%	14.70%	5.80%	100.00%	

Table 7: Knowledge of Time Period Respondents have been Experiencing Gully Erosion.

Socio-Economic Impacts of Gully Erosion

The information for the socio-economic impacts of gully erosion is presented on Table 8. The identified impacts as perceived by respondents were reduced accessibility (8.1%); displacement of people (17.8%), ravaged farmlands (21.5%); threatened food production (31.2%); Loss of livelihood (10.8%); loss of properties (3.1%); and loss of income (7.3%). However, majority of sampled respondents indicated threatened food production as the major socio-economic impact of gully erosion in the study area.

Communities	Responses							Total
	Reduced accessibility	Displacement of people	Ravaged farmlands	Threatened food production	Loss of livelihood	Loss of Properties	Loss of income	
Abagana	1	1	6	12	4	0	1	25
	0.30%	0.30%	1.60%	3.10%	1.00%	0.00%	0.30%	6.60%
Akwaeze	3	4	18	30	10	3	5	73
	0.80%	1.00%	4.70%	7.90%	2.60%	0.80%	1.30%	19.20%

Eziagu	3	10	7	7	3	0	0	30
	0.80%	2.60%	1.80%	1.80%	0.80%	0.00%	0.00%	7.90%
Naka	4	24	11	11	4	0	4	58
	1.00%	6.30%	2.90%	2.90%	1.00%	0.00%	1.00%	15.20%
Umuoji	4	8	16	31	7	4	7	77
	1.00%	2.10%	4.20%	8.10%	1.80%	1.00%	1.80%	20.20%
Akukwa	3	1	5	8	3	0	0	20
	0.80%	0.30%	1.30%	2.10%	0.80%	0.00%	0.00%	5.20%
Isiekenesi	1	7	11	11	4	0	2	36
	0.30%	1.80%	2.90%	2.90%	1.00%	0.00%	0.50%	9.40%
Obibi	5	8	5	6	4	1	3	32
	1.30%	2.10%	1.30%	1.60%	1.00%	0.30%	0.80%	8.40%
UmuOkpukapa	7	5	3	3	2	4	6	30
	1.80%	1.30%	0.80%	0.80%	0.50%	1.00%	1.60%	7.90%
Total 17.80%		68	82	119	41	12	28	381
		21.50%	31.20%	10.80%	3.10%	7.30%	100.00%	

Table 8: Socio-economic Impacts of Gully Erosion in the Study Area.

Agent of Support

The information for the agent of support for employed remediation measures are displayed on Table 9. It revealed that individual (21.5%) and community (58.8%) efforts are the major agents of support for employed remediation measures to manage gully erosion in the study area. However, only 16.0% of sampled respondents indicated that they received efforts from the government and another 3.7% of sampled respondents claim they receive efforts from the companies and non-profit organizations. The study therefore concludes that community efforts were the most received efforts in combating the menace of gully erosion in the study area.

States	Communities	Responses				Total
		Individual Effort	Community Effort	Government Support	Companies/ NGOs	
Anambra	Abagana	11	14	0	0	25
		2.90%	3.70%	0.00%	0.00%	6.60%
	Akwaeze	14	44	13	2	73
		3.70%	11.50%	3.40%	0.50%	19.20%
	Eziagu	0	21	9	0	30
		0.00%	5.50%	2.40%	0.00%	7.90%
	Naka	18	26	14	0	58
		4.70%	6.80%	3.70%	0.00%	15.20%
	Umuoji	13	49	7	8	77
		3.40%	12.90%	1.80%	2.10%	20.20%

Imo	Akukwa	0	13	6	1	20
		0.00%	3.40%	1.60%	0.30%	5.20%
	Isiekenesi	14	19	2	1	36
		3.70%	5.00%	0.50%	0.30%	9.40%
	Obibi	5	21	6	0	32
		1.30%	5.50%	1.60%	0.00%	8.40%
	UmuOkpukapa	7	17	4	2	30
		1.80%	4.50%	1.00%	0.50%	7.90%
Total 21.50%		82	224	61	14	381
		58.80%	16.00%	3.70%	100.00%	

Table 9: Agent of Support for Employed Measures.

Adaptive/Remediation Measures Employed to manage Gully Erosion Problems in the Study Area

The remediation measures employed by sampled residents in the study area are displayed on Table 10. The information for the remediation measures employed indicated that 16.0% of the respondents have improved their farming systems; 65.4% of the respondents have created rain water channels/drains; 10.0% of the respondents have installed sandbags; 3.4% of respondents are into planting of trees while 5.2% are engaged in other measures like construction of fences and sand filling of gully channels. The study discovered that majority of sampled respondents are creating drains to help manage water flow movements in the study area.

States	Communities	Improved Farming System	Creating Rain Water Channels/ Drains	Installation of Sandbags	Tree Planting	Others	Total
Anambra	Abagana	3	19	3	0	0	25
		0.80%	5.00%	0.80%	0.00%	0.00%	6.60%
	Akwaeze	11	45	7	4	6	73
		2.90%	11.80%	1.80%	1.00%	1.60%	19.20%
	Eziagu	6	21	3	0	0	30
		1.60%	5.50%	0.80%	0.00%	0.00%	7.90%
	Naka	9	40	6	1	2	58
		2.40%	10.50%	1.60%	0.30%	0.50%	15.20%
	Umuoji	14	47	6	4	6	77
		3.70%	12.30%	1.60%	1.00%	1.60%	20.20%
Imo	Akukwa	2	15	3	0	0	20
		0.50%	3.90%	0.80%	0.00%	0.00%	5.20%
	Isiekenesi	4	27	5	0	0	36
		1.00%	7.10%	1.30%	0.00%	0.00%	9.40%
	Obibi	5	21	3	3	0	32
		1.30%	5.50%	0.80%	0.80%	0.00%	8.40%
	UmuOkpukapa	7	14	2	1	6	30
		1.80%	3.70%	0.50%	0.30%	1.60%	7.90%
Total 16.00%		61	249	38	13	20	381
		65.40%	10.00%	3.40%	5.20%	100.00%	

Table 10: Remediation Measures Employed for Gully Erosion Management.

The information for the adaptive measures employed by sampled community residents to cope with gully erosion is displayed on Table 11. The diversification of income was indicated by 18.1% of sampled respondents; changing of farmlands was indicated by 28.6% of respondents; selling of property was indicated by 18.4% of sampled respondents; 24.7% of respondents switched occupation; 8.1% of respondents have faced total relocation; 1.0% are practicing change in farming methods; while other respondents (1.0%) have claimed they abandoned their lands or left it to fate.

Communities	Responses						Others	Total
	Diversification of Income	Changing of Farmlands	Selling of Property	Switched Occupation	Total Relocation	Change of Farming Methods		
Abagana	6	3	7	7	0	2	0	25
	1.60%	0.80%	1.80%	1.80%	0.00%	0.50%	0.00%	6.60%
Akwaeze	11	19	8	19	10	2	4	73
	2.90%	5.00%	2.10%	5.00%	2.60%	0.50%	1.00%	19.20%
Eziagu	4	8	6	10	2	0	0	30
	1.00%	2.10%	1.60%	2.60%	0.50%	0.00%	0.00%	7.90%
Naka	16	22	7	10	3	0	0	58
	4.20%	5.80%	1.80%	2.60%	0.80%	0.00%	0.00%	15.20%
Umuoji	11	28	13	16	9	0	0	77
	2.90%	7.30%	3.40%	4.20%	2.40%	0.00%	0.00%	20.20%
Akukwa	0	7	6	4	3	0	0	20
	0.00%	1.80%	1.60%	1.00%	0.80%	0.00%	0.00%	5.20%
Isiekenesi	9	4	13	9	1	0	0	36
	2.40%	1.00%	3.40%	2.40%	0.30%	0.00%	0.00%	9.40%
Obibi	5	9	6	11	1	0	0	32
	1.30%	2.40%	1.60%	2.90%	0.30%	0.00%	0.00%	8.40%
UmuOkpukapa	7	9	4	8	2	0	0	30
	1.80%	2.40%	1.00%	2.10%	0.50%	0.00%	0.00%	7.90%
Total	69	109	70	94	31	4	4	381
	18.10%	28.60%	18.40%	24.70%	8.10%	1.00%	1.00%	100.00%

Table 11: Adaptive Measures Employed by Communities to Cope with Gully Erosion.

The implication for all the highlighted measures are the drastic changes it will cause among residents especially on their socio-economic livelihood; loss of income, and most importantly reduction in food production. For example, this means that farmers especially with ravaged farmland will have no farmlands to cultivate and might incur more on their spending when they reach for new farmlands.

Level of Effectiveness of Adaptive Capacities

The level of effectiveness of adaptive capacities of communities to gully erosion is displayed on Table 12. The measures employed by residents were not effective as majority of sampled respondents (67.2%) indicated; however, 23.9% of sampled respondents rated it as fairly effective; while the remaining 8.9% of respondents believed their employed measures to be effective. Thus, adaptive capacities of residents in affected gully erosion areas in Anambra and Imo States have not been effective. This will definitely lead to increased socio-economic effects which have several implications on their potential for growth and development in the study area.

States	Communities	Responses			Total
		Effective	Fairly effective	Not Effective	
Anambra	Abagana	0	4	21	25
		0.00%	1.00%	5.50%	6.60%
	Akwaeze	4	18	51	73
		1.00%	4.70%	13.40%	19.20%
	Eziagu	3	15	12	30
		0.80%	3.90%	3.10%	7.90%
	Naka	2	14	42	58
		0.50%	3.70%	11.00%	15.20%
	Umuoji	16	15	46	77
		4.20%	3.90%	12.10%	20.20%
Imo	Akukwa	0	7	13	20
		0.00%	1.80%	3.40%	5.20%
	Isiekenesi	5	4	27	36
		1.30%	1.00%	7.10%	9.40%
	Obibi	3	4	25	32
		0.80%	1.00%	6.60%	8.40%
	Umu Okpukapa	1	10	19	30
		0.30%	2.60%	5.00%	7.90%
Total 8.90%		34	91	256	381
		23.90%	67.20%	100.00%	

Table 11: Level of Effectiveness of Adaptive Capacities of Communities to Gully Erosion.

Constraints to Level of Effectiveness of Adaptive Measures Employed

The information for the constraints or reasons for level of effectiveness of employed adaptive measures are displayed on Table 13. The distribution showed that 53.3% of sampled respondents indicated the lack of finance; 24.1% of sampled respondents indicated high cost of land; 3.1% of sampled respondents indicated the need to relocate; 13.1% of sampled respondents indicated low pay for other menial jobs; while the remaining 6.3% of sampled respondents indicated migration problems. Thus, lack of finance is a major constraint affecting level of effectiveness of employed adaptive measures to cope with the challenges of gully erosion in the study area.

Lack of Finance		Responses					Total
		High Cost of Land	The need to Relocate with Family	Low Pay for other Menial Jobs	Migration Challenges		
Anambra	Abagana	19	6	0	0	0	25
		5.00%	1.60%	0.00%	0.00%	0.00%	6.60%
	Akwaeze	34	17	3	13	6	73
		8.90%	4.50%	0.80%	3.40%	1.60%	19.20%
	Eziagu	20	8	0	2	0	30
		5.20%	2.10%	0.00%	0.50%	0.00%	7.90%
	Naka	27	14	3	8	6	58
		7.10%	3.70%	0.80%	2.10%	1.60%	15.20%
	Umuoji	43	18	1	10	5	77
		11.30%	4.70%	0.30%	2.60%	1.30%	20.20%

Imo	Akukwa	8	6	2	3	1	20
		2.10%	1.60%	0.50%	0.80%	0.30%	5.20%
	Isiekenesi	24	7	0	5	0	36
		6.30%	1.80%	0.00%	1.30%	0.00%	9.40%
	Obibi	14	8	1	4	5	32
		3.70%	2.10%	0.30%	1.00%	1.30%	8.40%
	UmuOkpukapa	14	8	2	5	1	30
		3.70%	2.10%	0.50%	1.30%	0.30%	7.90%
Total 53.30%		203	92	12	50	24	381
		24.10%	3.10%	13.10%	6.30%	100.00%	

Table 13: Constraints to Level of Effectiveness of Employed Adaptive Measures.

Summary and Conclusion

This study revealed that the remediation measures employed indicated that 16.0% of the respondents have improved their farming systems; 65.4% of the respondents have created rain water channels/drains; 10.0% of the respondents have installed sandbags; 3.4% of respondents are into planting of trees while 5.2% are engaged in other measures like construction of fences and sand filling of gully channels. The study discovered that majority of sampled respondents are creating drains to help manage water flow movements in the study area.

The diversification of income was indicated by 18.1% of sampled respondents; changing of farmlands was indicated by 28.6% of respondents; selling of property was indicated by 18.4% of sampled respondents; 24.7% of respondents switched occupation; 8.1% of respondents have faced total relocation; 1.0% are practicing change in farming methods; while other respondents (1.0%) have claimed they abandoned their lands or left it to fate.

The implication for all the highlighted measures are the drastic changes it will cause among residents especially on their socio-economic livelihood; loss of income, and most importantly reduction in food production. For example, this means that farmers especially with ravaged farmland will have no farmlands to cultivate and might incur more on their spending when they reach for new farmlands.

The level of effectiveness of adaptive capacities/ measures employed by residents were not effective as majority of sampled respondents (67.2%) indicated; however, 23.9% of sampled respondents rated it as fairly effective; while the remaining 8.9% of respondents believed their employed measures to be effective. Thus, adaptive capacities of residents in affected gully erosion areas in Anambra and Imo States have not been effective. This will definitely lead to increased socio-economic effects which have several implications on their potential for growth and development in the study area.

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