Perception of Gully Erosion and Conservation Practices in Agulu-Nanka-Oko and Ekwulobia

Ezeobi, Joseph Uche[1]*, Tambe, Enohetta Besong[2], Aso, Chukwuemeka Johnmark[1] and Ezeobi-Akpaidiok, Abigail Adaobi[3]

[1]Department of Environmental Management, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria
[2]Department of Environmental Management and Toxicology, Southern Delta University, Ozoro, Nigeria
[3]Federal University of Lafia, Nasarawa State, Nigeria

*Corresponding author: josephezeobi01@gmail.com

Abstract: Agulu-Nanka-Oko and Ekwulobia gully erosion is one of the largest of the many gullies in Anambra State. The purpose of this study was to identify and describe the perception of gully erosion and conservation practices in the study area. One hundred (100) questionnaires were purposively administered to local people in the four communities to determine the perceived causes, effects and conservation techniques practised. Household selection was carried out using a proximity-based sampling approach around the major gully sites. Data were collected from primary and secondary sources through the review of related documents, field observations, questionnaire surveys, Focus Group Discussions, and formal and informal interviews. Findings show that most local people recognise and have good awareness of the existence, causes, and impacts of soil erosion. Local people perceived that rainfall, flooding, deforestation, bush burning, sand mining, soil type, lack of drainage channels, and angry gods of the land contributed to gully formation and its effects on the environment and their livelihoods. Soil conservation measures adopted by the local people, such as digging sumps in compounds, have the highest practice in Ekwulobia (90%) and the least in Nanka (15%). Other techniques include tree planting, with high indications in Nanka (70%) and Agulu (68%). Forming a drainage channel was very popular in Oko (20%) and Nanka (14%). The differences in technique variation could be attributed to the choices and perceptions of local people in controlling gully erosion. The Chi-square test of independence was used to assess whether there is a significant association between the communities (Agulu, Nanka, Oko, and Ekwulobia) and the perceived effects of gully erosion. The result of Pearson's Chi-square (χ^2 = 11.914, df = 21, p = 0.942) shows no statistically significant relationship between the variables. This indicates that respondents across the four communities reported similar effects of gully erosion. This research has recommended that terrace management will reduce the slope length and, consequently, soil loss. There should be consistent consultation, advice and guidance on the practice of soil and water conservation measures.

Keywords: Gully Erosion, Community Perception, Soil Conservation, Livelihood Impacts, Rainfall

1. Introduction

Gully erosion is the removal of topsoil along drainage channels by surface runoff, consisting of an open, incised and unstable channel generally more than 0.30m deep (Brown 2020). Fluvial gully erosion is the most damaging type of soil erosion worldwide, causing lots of on-site and off-site adverse environmental and socio-economic impacts, exemplified by huge soil loss and siltation of low-lying areas and water bodies (Obi and Okekeogbu, 2017; Mezie and Nwajuaku, 2020; Dogo et al., 2023). Gully erosion is one of the most pervasive environmental issues in southeast Nigeria, causing severe land degradation and threatening local livelihoods (Emeh, et al., 2023).

Over 65% of the soil on Earth is said to have exhibited degradation phenomena as a result of soil erosion, salinity, and desertification (Abegunde et al., 2006). The highest concentration of severe gully erosion in Nigeria is found in the five South Eastern states of Anambra, Enugu, Abia, Imo, and Ebonyi. Anambra is famous for its Agulu-Nanka-Oko and Ekwulobia gullies. Gullies of about 120m depth and 2km width have been recorded in this area (Obi, and Okekeogbu, 2017). Anambra State is known to be under severe erosion problems with the Agulu-Nanka-Oko

and Ekwulobia gully as one of the epicentres of gully development in Nigeria. The State's records indicate that a significant portion of its land mass is continually at risk of soil erosion hazards. The Agulu-Nanka-Oko and Ekwulobia gully is one of the largest of the many erosion gullies in Anambra State, causing severe structural and environmental damage to the state and destroying homes, properties, and farmlands, as well as unprecedented siltation of rivers and community streams. The Agulu-Nanka-Oko and Ekwulobia gully have completely washed away several key inter and intra-community roadways within and around the communities of Agulu, Nanka, Oko and Ekwulobia. The destructive impacts of the Agulu-Nanka-Oko and Ekwulobia gully within the affected areas have continued to expand, causing significant infrastructural destruction within the catchment area with each cycle of the rainy season.

Over the years, several efforts have been made to address or contain the soil erosion menace in Anambra State. Despite these efforts, the menace has continued to progress in spatial distribution and severity. The Agulu – Nanka – Oko and Ekwulobia gully erosion complex was selected for this study due to its devastating nature, which has attracted widespread attention over the years. The gully complex has a large concentration of gullies within the same drainage basin and geologic formation and accounts for a significant loss of agricultural land in southeastern Nigeria (Osadebe et al., 2014). For successful soil conservation planning, it is necessary to identify communities' knowledge and perception of soil erosion and their contribution to soil conservation. The purpose of this study is to identify and describe the perception of gully erosion and conservation practices in the study area. Understanding community perception of soil erosion is important in promoting and implementing soil and water conservation practices.

Amadi et al. (2014) carried out a study on the effects of Agulu Nanka erosion (one of the most appalling gully devastations in Nigeria) on the socio-economic life of Agulu and Nanka communities of Anambra state. Results from the study showed that 35 per cent of the sampled respondents were displaced by the landslide, 2 domestic rivers silted, 235 Hectares of farmland were gulped, 80 houses collapsed, and 13 rural roads were cut off. Aliyu and Ray (2014) also assessed the socio-economic effects of gully erosion on land-use in Gombe Metropolis, Gombe State, Nigeria. Their findings showed that several buildings, farmland/plots, and other properties worth millions of Naira, as well as human lives, were lost due to the effects of gully erosion in the study area. Abdulfatai et al. (2014) also emphasized the causes and impacts of gully erosion, a case studied in Edo state, Nigeria. They reiterated that many lives have been lost due to gully erosion.

Gebremedhin (2004) conducted a study on community participation and sustainable Soil Water Conservation management in the Zala-Daget Project, Dogu'a Tembien district, Ethiopia. The results showed that every year, huge resources were invested in soil, water, and Conservation works. However, these activities did not meet the required level, and sustainability remained a point of discussion.

Dawit (2014) conducted a study on the impacts and impediments of community participation on soil water conservation for sustainable land resource management in Laelay Michew Woreda, Tigray, Ethiopia. The study results indicated that level of education, health status, income, and social facilities such as transportation and communication determine the community's participation in Soil and Water Conservation practices. Yusuf, et al. (2022) investigated farmers' perceptions of soil erosion and their soil conservation practices in the Zing Local Government Area of Taraba State, Nigeria. According to the study, 89.1% of farmers have farms on steep-to-mild slopes and do not consider soil erosion a specific issue on their property. Terracing, shaping ridges along contours, and mulching are soil conservation techniques that have long been employed and are advised to continue.

Gully erosion in Agulu-Nanka, Anambra State, Nigeria, resulted in the sedimentation of rivers, lakes and estuaries (Christian et al., 2018) similarly, gully erosion in Akko Local Government Council, Gombe State, Nigeria, has destroyed human shelter, leading to displacement and forced migration of residents (Jibo et al., 2020). Okwu-Dekunze et al. (2018) reported that one of the environmental impacts of gully erosion in Udi Local Government Area, Enugu State, was the loss of human lives. Among the problems caused by gullies in Southeastern Nigeria were damage to roads, footpaths, drainage, and transport infrastructure (Egboka et al., 2019). Oluyori and Ojo (2021) reported that gully erosion had destroyed roads and threatened properties in the Gwagwalada Area Council, Abuja, Nigeria. Gullies destroyed the flora, which acts as a sink for carbon dioxide (CO_2) and exposes soil carbon that oxidises to form CO_2, a potent greenhouse gas contributing to global climate change (Zang et al., 2020).

Simeneh, and Getachew, (2016) studied the perception of farmers toward physical Soil Water Conservation structures in Wyebla Watershed, Northwest Ethiopia. The majority of sampled respondents were aware of the problem of soil erosion on their farmlands, but they argued that soil erosion reduces crop production and that this could be solved through appropriate Soil Water Conservation measures. However, to achieve better sustainability, the critical areas to be concentrated on included the planning, implementation, and maintenance phases through awareness creation, capacity building, and motivating real community participation.

The reviewed literature demonstrates that gully erosion remains a major environmental challenge in southeastern Nigeria, with significant implications for land degradation, infrastructure loss, and community livelihoods. Previous studies have largely focused on the physical, geomorphological, and technical dimensions of gully formation and control. While some scholars have examined community-based responses, there remains limited empirical insight into how residents of Agulu, Nanka, Oko, and Ekwulobia perceive the causes, consequences, and effectiveness of existing conservation practices. In particular, few studies have provided a

comparative, community-specific analysis across these four highly affected locations.

This gap is further heightened by the scarcity of research linking local perceptions to actual conservation behaviours, community participation, and the socio-cultural realities that shape environmental decision-making in the region. Moreover, most existing works do not fully integrate indigenous knowledge or community experiences into discussions of sustainable gully control strategies.

Therefore, this study builds on the existing body of scholarship by providing a detailed, perception-based

2. Materials and methods

2.1. Description of the Study Area

The study area (Agulu - Nanka - Oko and Ekwulobia gully complex) islocated in the Southeastern part of Anambra state. It is situated between latitudes 6° 10' and 6° 05' north of the Equator and longitudes 7° 05' and 7° 10' east of the Greenwich meridian, covering an area of about 1709 km^2 within the Anambra Basin. Agulu town is situated within the Anaocha Local Government Area; Nanka and Oko towns are in the Orumba North Local Government Area, while Ekwulobia is in the Aguata Local Government Area.
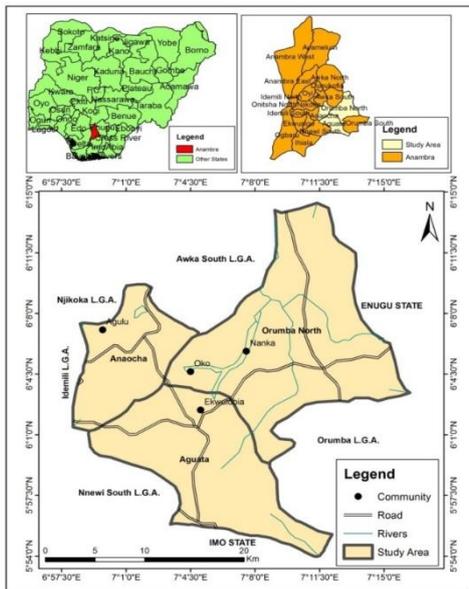

Figure 1: Study Area (Anambra State Showing Agulu, Nanka. Oko and Ekeulobia Communities)

2.4. Sampling and Data Analysis

Purposive and stratified buffer sampling techniques were employed in this study. The gully sites at Agulu, Nanka, Oko, and Ekwulobia were purposively selected because they are among the areas most at risk of gully erosion in

assessment of gully erosion and conservation practices across the four selected communities. By foregrounding community voices, comparing variations in perception, and examining how local understanding influences conservation action, the research offers a more holistic and socially grounded perspective. Ultimately, this study fills an important gap by generating context-specific evidence that can inform more effective, community-driven erosion management policies and interventions in Anambra State and beyond.

The study area was situated within the sub-equatorial south climatic region, characterised by uniformly high temperatures, a seasonal distribution of precipitation, and high relative humidity. The climate is humid tropical (Okoro et al., 2010). The geologic formation of the study area is the Eocene Nanka unconsolidated or poorly consolidated sands. The sand is poorly sorted, cross-bedded, medium- to coarse-grained, and porous, making it easily erodible. The highland region is a low asymmetrical ridge or cuesta in the northern portion of the Awka Orlu Uplands, which trends roughly southeast to northwest, in line with the geological formations that underlie it (Okoro et al., 2010). The Agulu Nanka, Oko, and Ekwulobia soils are typified by the characteristics of coastal plain sands and are highly susceptible to erosion. The types of vegetation found include freshwater swamp forest, grass-dominated species, and lowland rain forest.

2.2. Research Design

This study used both quantitative and qualitative data and methods. A field survey method, which involved administering a questionnaire, conducting interviews, and holding focus group discussions (FGD) to identify soil conservation perceptions and practices in the community, was adopted.

2.3. Data Types and Sources

The primary data were obtained from field observation, respondents selected for this study in the study area with the use of a questionnaire and Focus Group Discussion. The quantitative data were collected through a questionnaire, observations, and a checklist. Coordinates of the gully sites were obtained from GPS device (Germin 76 model).

Anambra State, characterised by extensive and severe gullies. This approach ensured that households included in the study were located at varying distances from the gullies, enabling the collection of first-hand information on the causes, effects, and local conservation practices.

Household selection was carried out using a proximity-based sampling approach around the major gully sites in

the study area. Concentric buffer zones were created to guide sampling: 0–50 m (adjacent households), 51–300 m (nearby households with first-hand experience), and 301–1000 m (community households). The primary sample was drawn from the 51–300 m band because households within this distance are close enough to observe the causes and effects of gully erosion, yet not situated directly at the gully edge where habitation may be unsafe. Additional households were selected from the 0–50 m and 301–1000 m bands to capture both direct impact experiences and broader community perceptions. In total, 100 households were selected using this stratified distance-based approach. Distances were measured in the field using a handheld GPS device to ensure accurate classification of households within each buffer zone. Data collected from questionnaire were inputted in SPSS software. The data were sorted and coded and percentage was obtained.

Table 1: The population of household heads sampled

S/N	Community Sampled	Number of household sampled	Sample Size
1	Agulu	25	25
2	Nanka	25	25
3	Oko	25	25
4	Ekwulobia	25	25

Source: Researcher's field survey, 2024

3. Results and discussion

3.1. Community's Perception on Causes of Gully Erosion

Figure 2 shows the local people's perceptions of the causes of gully erosion. These are mainly physical factors, such as climatic elements (especially rainfall), soil type, and human factors, mainly deforestation, bush burning, and sand mining. Other reasons include inadequate drainage channels and spiritual reasons.
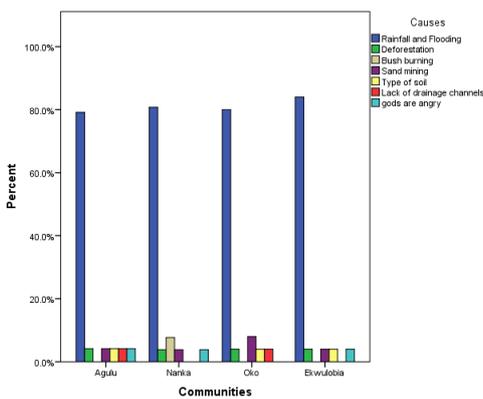

Figure 2: Perceived causes of gully erosion in the study area

Figure 2 reveals that rainfall and flooding are the main causes of gully in Ekwulobia (83%) and the least in Oko and Agulu, with 78% each. Other causes include sand mining, which is more common in Oko (13%) than in the other three areas, with 5% recorded in each of the other three areas. Bush burning was perceived to cause gully erosion in Nanka (8%) while other areas did not believe that it could trigger erosion. The local people in the four communities expressed concern over deforestation as a cause of erosion, with (6%) recorded in all the locations. Another cause of soil erosion identified by local people was related to the nature of the soil in their community. The local people in Agulu, Oko and Ekwulobia believed in the nature of soil as the cause of erosion (5%) in each of the three areas. The Nanka community disagree (0%) with the type of soil as a cause of erosion. Lack of drainage channel was perceived as the cause of gully erosion in Agulu and Oko areas, with (5%) in each of the two areas, while Nanka and Ekwulobia people did not indicate that lack of drainage channel could trigger gully erosion.

Respondents in Agulu, Nanka and Ekwulobia communities believed that angry gods of the land could be responsible for the land degradation ravaging their communities, as a respondent and member of a focus group discussion (FGD) lamented, "The gods of the land are angry with us"

The household's perception of the causes of soil erosion is in line with Igwe (2012), who worked on gully erosion in southwestern Nigeria and noted the role of soil properties and environmental factors in the soil erosion menace in southeastern Nigeria. The study is also consistent with prior studies. Tititola, (2008) and Descoroix et al. (2008) who reported that the most frequent cause of land degradation and soil erosion in the Dank micro-watershed of Ethiopia stem from poor management of the land and deforestation are the main culprits

3.2. Perceived Effects of Gully Erosion and Badland on the Environment and Livelihood

Figure 3 shows respondents' views on the effects of gully erosion on people's livelihoods. The majority of the respondents in the four communities reported that their

livelihoods were seriously affected. It is clear that the effects of gully erosion on the livelihoods of the people in the communities vary (Figure 3). Similarly, all participants of the Focus Group Discussion confirmed that the major effect of gully erosion in their community is the loss of their farmlands. This is clearly shown in figure 5. An indigene of Nanka, Uche okofar lamented. "All my farmlands have disappeared"
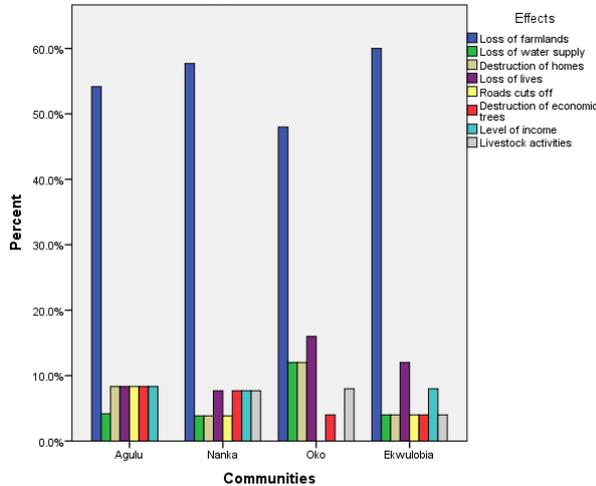

Figure 3: Percentage of the perceived effects of gully erosion and badland on the environment and livelihoods in the study area
Source: Researcher's field survey, 2024

The greatest effect of gully erosion in the four communities is the loss of farmland (the highest in the four communities). Others include loss of source of water supply, destruction of homes, loss of lives, roads cut off, destruction of economic trees, reduced level of income and destruction of livestock activities. In the Agulu community, the perceived effects of gully erosion received similar responses, including loss of homes and lives, destruction of economic trees, and reduced income. Similar trends in responses were observed in the Nanka community, with the loss of lives, destruction of economic trees, reduction in income, and destruction of livestock activities, all at the same level across the area. The local people indicated that lives have been lost in their various communities while others are forced to relocate to other

communities. Most of the communities had been cut off from their neighbours. This is evident in Agulu, Nanka and Ekwulobia. The results revealed that the major effects of gully erosion in Agulu community were loss of farmland (50.0%), then destruction of homes, loss of lives, roads cut off, destruction of economic trees and a reduction in the level of income, while the least affected was the water supply (5%). In the Nanka community, 58% of people maintained and perceived that the loss of farmland is the greatest effect of gully erosion in their community. Loss of lives, destruction of economic trees, and level of income and livestock activities had 8% of respondents' views, while the least were destruction of roads, homes, and loss of water supply (5%). At Oko and Ekwulobia communities, respondents indicated that loss of farmlands was the main effect of gully erosion in their various communities with 57% and 60% responses. Both communities reported that lives had been lost as a result of gully erosion which gulped homes and thus livelihoods. Households in the Oko and Ekwulobia communities reported that the least impact of gully erosion was in the areas of destruction and loss of economic trees, roads, forests, homes, and livestock (5%). During the FGD, an indigene of Nanka, Ozubulu Obi made the following comment:
"The people of the area are not safe anymore, some people relocated to other communities"
According to an elderly man in Nanka,
"Already my fence has been consumed by the erosion, if the menace finally takes my building, I do not have any place to run to with my family"

Statistical Analysis
The Chi-square test of independence was used to assess whether there is a significant association between the communities (Agulu, Nanka, Oko, and Ekwulobia) and the perceived effects of gully erosion. The result of Pearson's Chi-square ($\chi^2 = 11.914$, df = 21, p = 0.942) shows no statistically significant relationship between the variables. This indicates that respondents across the four communities reported similar effects of gully erosion.

Table 2: Summary of the Results of Chi-square Test of Association on Hypothesis that addressed the perceived effects of gully erosion and badland on the environment and livelihoods in the study area

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	11.914[a]	21	.942
Likelihood Ratio	14.861	21	.830
Linear-by-Linear Association	.082	1	.774
N of Valid Cases	100		

a. 28 cells (87.5%) have expected count less than 5. The minimum expected count is .96.

Amadi et al. (2014) showed similar results to this study that erosion leads to the destruction of farms, the collapse

of buildings, thereby rendering inhabitants homeless for varying periods of time. The result concurs with Bassey (2023), who investigated the potential health risks

associated with gully erosion, as well as environmental effects, in Calabar Municipal. Results discovered that the effects of gully erosion included Loss of farmland, threat to vegetation and biodiversity, loss of properties, increase in poverty and famine, expansion of degraded land, increase in surface runoff, and low agricultural production with significant health implications. Okwu-Delunzu et al. (2013), in their work of Monitoring Gully Erosion at Nyaba River of Enugu State, Southeastern Nigeria, found that most people who engage in agricultural activity at the river corridor have reported that gully erosion has degraded their farmlands. Obi and Okekeogbu (2017) in Nanka reported similar results to this study, showing that erosion had led to considerable loss of soil structure, resulting in loss of agricultural productivity and disruption of socio-economic activities in the study area. Kusimi and Yiran (2011) in Ghana showed that soil erosion results in socio-economic problems such as overgrazing, fuel wood collection, land clearance for farming, food insecurity, low income, and drought. Therefore, there was an increase in erosion without a subsequent increase in agricultural productivity.

3.3. Perceived Effects of Gully Erosion and Badland on the Environment and Livelihood

Direct observation coupled with FGD and interviews with local households in the four communities indicated that there were some initiatives and intervention in the past to control erosion, but still not effective. Figure 4 shows soil conservation measures adopted by the local people such as digging of sumps in compound which has the highest practice in Ekwulobia (90%) and least in Nanka (15%) other techniques include planting of trees, with high indication in Nanka (70%) and Agulu (68%). It was very low in other two areas. Forming drainage channel was very popular in Oko (20%) and Nanka (14%). There was almost non practice of drainage channel in Ekwulobia (0%). The differences in the variation of techniques could be attributed to choice and perception of the local people in controlling gully erosion.
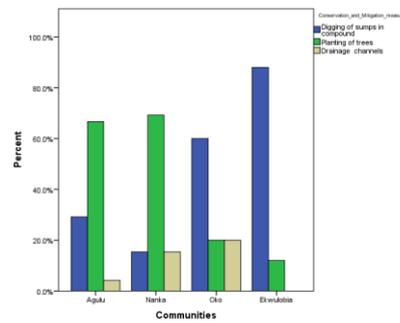

Figure 4: Some Attempted Soil Conservation Prac tices in the four communities
Source: Researcher's field survey, 2024

Mariara et al. (2012) in Morang's, Maragua and Narok observed that listening to extension agents affected the willingness to invest in soil conservation. Okoba, and De Graaf, (2005) in Runyenjes found that the main constraints to the adoption of soil conservation measures were lack of money, insufficient labour force, lack of tillage tools and poor knowledge about the benefits of soil conservation measures. Barungi et al. (2013) in Uganda, reported that access to extension services increase the likelihood of adopting soil erosion technologies. Fentie et al. (2013) in Ethiopia found that extension education motivated the use of soil conservation.

Gulling has persisted despite efforts by the federal government, state government, local government, towns/community unions as well as individuals; the gullies are huge with width and depth in hundreds of meters. The gully sites investigated are still very active despite the control measures already in place. Drainage channel constructed along the gully sites were the only visible sign of government's intervention. These interventions by Government largely helped to control the erosion problem. From the interaction with the authorities, the following intervention has been carried out in the area. The implementation of the measures has achieved some success in slowing down the ferocity of the scourge or steaming the inception of new ones. However, so much is waiting to be done.

Table 3: Historical Background on Erosion Control Measures in Agulu-Nanka-Oko and Ekwulobia communities.

Intervention	Period (Time)	Gully Areas	Assessment and Remark
Afforestation using cashew (*Anacardium occidentale*) and Bamboo (*Bambusa vulgaris*)	Early 1960s	Eastern Nigeria Region	The oldest method, used cashew and bamboo; may protect ungullied areas but easily undermined by deep gullies; tree roots tend to disrupt soil structure
Enlightenment	1970s	Agulu-Nanka-Oko and Ekwulobia	Ineffective due to inadequacy of agricultural extension services, rural farmers distrust of new methods
Drainage channels	1970s	Agulu-Nanka-Oko and	Little success

Ekwulobia

Source: National Geo-hazards Monitoring Centre Awka, Anambra State

Table 3 presents the historical background on erosion control measures in Agulu-Nanka-Oko and Ekwulobia communities. Afforestation has had a qualified success as a prevention measure. It has nevertheless remained the primary means of assessing the onset of gullies in the vast areas underlain by highly erodible geologic formations (plate 4). The cashew plant Anacardium occidentale, by virtue of being a fast-growing medium-sized tree with a luxuriant canopy and broad leaves, has been the arboreal species of choice for prevention purposes (Plate 3). The tree usually has low branches and effectively breaks the force of a raindrop. It hardly allows undergrowth of other plants, even grass, such that a dense cashew forest still has wide open spaces on the ground below the luxuriant canopy. In the early 1960s, the Eastern Nigeria Regional Government established a cashew nut canning factory. The enlightenment campaign was ineffective due to the inadequacy of agricultural extension services and rural farmers' distrust of new methods. Drainage channels constructed in the 70's had little success (Plate 1). Other erosion control measures employed by the local people include using gullies as refuse dumps and placing sandbags on the road surface (Plate 2).

Plate 1: A section of the concrete drain channel around the head of the Ududonka gully, Agulu, constructed in 1970s from Nanka through Oko
Source: Researcher's field survey, 2024
Plate 2: Sand bags used as a means of erosion prevention at the individual level at Oko

Plate 3: A cashew (Anacardium occidentale) tree stand - evidently a protector of the soil, Agulu, Anambra State
Source: Researcher's field survey, 2024

Plate 4: Use of bamboo (Bambusa vulgaris) as a gully combat crop, Oko, Anambra State
Source: Researcher's field survey, 2024

4. Conclusion

Soil erosion is a major threat to natural resources worldwide. The views and perceptions of the local people in the study area indicated that the greatest causes of gully erosion are mainly physical factors (80%), comprising climatic elements such as rainfall, soil type, and human factors, mainly deforestation, bush burning, and sand mining. Other reasons are inadequate drainage channels, as well as spiritual reasons. The cashew plant, *Anacardium occidentale*, by virtue of being a fast-growing medium-sized tree with a luxuriant canopy and broad leaves, has been the arboreal species of choice for prevention purposes. Erosion control measures employed by the local people include using gullies as refuse dumps and placing sandbags on the road surface. The low use of soil conservation measures in the study area could have contributed to negative effects on livelihood activities. The effects of gully erosion in the study area are indeed huge. Government, communities and individuals have continued to combat this monster with little or no success. This research has recommended that terrace management will reduce the slope length and, consequently, soil loss. There should be consistent consultation, advice and guidance on the practice of soil and water conservation measures.

Acknowledgements

References

Abdulfatai, I. A., Okunlola, I. A., Akande, W. G., Momoh, L. O., and Ibrahim, K. O., (2014). "*Review of gully erosion in Nigeria: causes, impacts and possible* solutions. *Journal of Geosciences and Geomatics, 2*(3), 125 – 129.

Abegunde, A. A., Adenyinka, S. A., Olawuni, P. O. and Oluodo, O. A. (2006). *An assessment of the socio economic impacts of soil erosion in South eastern Nigeria, Special valuation situations shaping the change.* Paper presented at the XXIII Congress, Munich, Germany, October 8-13.

Aliyu, D., and Ray, H. H., (2014). *Socio-economic effects of gully erosion on land use in Gombe Metropolis, Gombe State, Nigeria.* Retrieved from http://www.researchgate.net.

Amadi, D. C. A., Damascus, A. I., and Maiguru, A., (2014). The effects of Agulu-Nanka erosion on socio-economic life of Agulu Nanka communities of Anambra State. International *Journal of Engineering Research and Development, 9(*12), 01 – 04.

Barungi, M. Ngongola, D.H., Edriss, A., Mugisha, J., Waithaka, M. and Tukahirwa, J. (2013). Factory influencing the Apottion of Soil Erosion Control Technologist by farmers along the slopes of Mt. Elgon in Eastern Uganda. *Journal of sustainable development, 6*(2) 9-25

Bassey J. B. (2023). Causes, effects and potential health risk of gully erosion menace in Calabar Municipal: Residents' perspective. *International Journal of Environmental Sciences 6* (1), 54 – 67

Brown, R. (2020). *Gully erosion: Definition, causes, effects and prevention.* Retrieved March 22, 2021, from https:// www.jotscroll.com

Christian C. N., Emmanuel C. D, Kelechukwu, D. and Andrew A. O. (2018). Spatial monitoring of the Extent Gully Erosion in Agulu-Nanka and its Environs in Anambra State using Geo-information Technologies. *International Journal of Current Research, 10* (02) 66787-66793

Descoroix, L., Barrios, G. Viramontes, D., Poulenard, J., Anaya, E., Esteves, M., Estrada, J. (2008) Gully and sheet erosion on sub-tropical mountain slopes: Their respective roles and the scale effect. *Catena 72* (3), 325-339. https://doi.org/10.1016/j.catena.2007.06.015

Dogo, S., Joseph, W. E., and Olatayo, J. (2023). Evaluation of gully erosion effects in Gidan Waya, Jama'a L.G.A. of Kaduna State, Nigeria, International *Journal of Innovation Research and Advanced Studies, 20*(2): 107-118.

Egboka, B. C. E., Akudo, E. O., and Nwankwoala, H. O. (2019). Gully erosion and landslides in southeastern Nigeria: Causes, consequences and control measures. *Research Journal of Earth Sciences, 11*(1): 1-13.

Emeh, C., Igwe, O., and Ugwoke, T. A. (2023). Geospatial analysis of factors driving gully erosion: a case study from Southeastern Nigeria. *Natural Hazards, 117*(3), 2903-2933. https://doi.org/10.1007/s11069- 023-05971-6

Fentie, D., Fufa, B. and Bekele, W. (2013). Determinants of the use of soil conservation technologies by smallholders' farmers: the case of Hulet Eju Enesie District, east Gojjam Zone., Ethiopia, *Asian Journal of Agriculture Food Sciences, 1*, 119-138

Gebremedhin, Y. (2004). Community Participation and Sustainable SWC management: The case of Zala Daget project: Dogu'a Tembien Woreda- Tigray Highlands, *(Master's thesis).* Addis Ababa University, Addis Ababa, Ethiopia.

Igwe, C. A. (2012). Gully erosion in southeastern Nigeria: Role of soil properties and environmental factors. In Soil erosion issues in agriculture. 157-171. *InTech Open Science*, https://doi.org/10.5772/51020

Igwe, P. U., Ajadike, J.C. and Ogbu, S. O. (2023). Assessment of Gully Erosion Problems for its Remediation in Eastern Nigeria. *Journal of Environmental Management and Safety 14*, (2) 72 – 88.

Jibo, A., Laka, S.I., Ezra, A. (2020). The effect of gully erosion on physical and socio-economic activities in Akko Local Government Area of Gombe State, Nigeria. International *Journal of Environmental Design and Construction, 14*(2), 42-50.

Kusimi, J. M. and G. A. B. Yiran, G.A.B. (2011). Application of local knowledge in land degradation assessment in the Bawku East Municipality. Ghana. *Journal of Geography, 3*, 88-125.

Mariara, J. K., Linderhof, V., Kruseman, G. Atieno R. and Mwabu, G. (2012) Poverty- environmental links: The impact of soil and water conservation and tenure security in household welfare in Kenya, *Journal of Development and Agricultural Economics, 2*(1), 41-53. https://doi.org/10.5897/JDAE.9000078

Mezie, E. O., and Nwajuaku A. I. (2020). Investigation into the causes of gully erosion in parts of Anambra State. *Journal of Science and Technology Research, 2*(1): 132-142.

Nwakanma, C. C., Dike, E. C., Dimkpa, K., and Obafemi, A. A. (2018). Spatial monitoring of the extent of gully erosion in Agulu-Nanka and its environs in Anambra State using geo-information technologies. International *Journal of Current Research, 10*(03): 66787-66793.

National Geo hazards Monitoring Centre Awka, Anambra state. (n.d.).

Obi, N. I. and Okekeogbu, C. J (2017). Erosion problems and their impacts in Anambra State of Nigeria: A case of Nanka community. International *Journal of Environment and Pollution Research, 5*(1), 24-37.

Okoba, B. O. and De Graaf, J. (2005). Farmers' knowledge and perceptions of soil erosion and conservation measures in the Central Highlands, Kenya, *Land Degradation and Devlopment, 16*(5), 475-487 https://doi.org/10.1002/Idr.678

Okoro, E. I., Egboka, B. C. E. and Onwuemesi, A. G. (2010). Evaluation of the aquifer characteristics of Nanka Sands Using hydrological method in combination with vertical electrical sounding (VES), *Journal of Applied Science and Environmental Management, 14*(2), 5 – 7. https://doi.org/10.4314/jasem.v14i2.57801

Okwu-Delunze, V. U., Iwueke, N. T., and Aniagolu, C. O. (2018). Gully erosion and its environmental impacts in Eke, Udi Local Government Area of Enugu State. *Environment and Ecology Research, 6*(5): 507- 517. https://doi.org/10.13189/eer.2018.060503

Okwu-Delunzu, V. U., Enete, I. C., Abubakar, A. S. and Lamidi, S. (2013). *Monitoring gully erosion at Nyaba River of Enugu State Southeastern Nigeria, using remote sensing. Paper presented at the International Conference on Remote Sensing*, SPIE, Dresden, Germany.

Osadebe, C. C., Abam, T. K. S. Obiora, F. I. and Sani, R. O. (2014) Evaluating the stability of gully walls in Agulu-Nanka-Oko gully erosion complex area of Anambra State, Nigeria, using empirical approach, *ScienceWeb Publishing, 2*(1), 1-9

Simeneh, D. and Getachew, F (2016). Perception of farmers toward physical SWC structures in Wyebla Watershed, Northwest Ethiopia, *World Journal of Agricultural Sciences, 12*(1), 57-63

Tititola, T. (2008). Environmental degradation and its implication for agricultural development: The issue of land erosion, *Journal of Sustainable Development in Africa, 10*(2), 1-31

Yusuf M. B., Abdullahi, I., Thomas, E. and Ojeh, V. N. (2022). Assessment of farmers' perceptions on soil erosion and soil conservation techniques in Zing Local Government Area of Taraba State, Nigeria. *Annal of Environental Science and Toxicology, 6*(1) 74 – 86

Zang, H., Lauerwarld, R., Regnier, P., Ciais, P., Yuan, W., Naipal, V. Cuenet, B., Van Oost, K., and CaminoSerrano, M (2020). Stimulating erosion-induced Soil and carbon delivery from uplands to rivers in global land surface model. *Journal of Advances in Modelling Earth Systems, 12*(10). https:// doi.org/10.1029/2020ms002121.