Research Article **AJOERR (2018) 1:8**

American Journal of Engineering Research and Reviews
(ISSN:2637-3785)

Analysis and Assessment of Agulu-Nnaka Erosion Impact on Human Lives and Infrastructure

OTTI, V. I and EKENTA, D. E

Civil Engineering Department,Nnamdi Azikiwe University,Awka

ABSTRACT

The aim of this study was to rehabilitate the gully erosion site and reduce longer term erosion vulnerability in Agulu/Nanka Community. This activity was carried out through some civil works such as construction of concrete drainage system, culverts and silty basin, spikes, rock chutes and stabilization of gully. An engineering design was used for the erosion gully intervention which highlighted on the detailed civil works that were carried out. An environmental and social management plan study was implemented aimed at identifying potential and social impacts that were associated with the rehabilitation as proposed means of minimizing and mitigating them to acceptable level.

***Correspondence to Author:**
OTTI, V. I
Civil Engineering Department,Nnamdi Azikiwe University,Awka

How to cite this article:
OTTI, V. I and EKENTA, D. E. Analysis And Assessment Of Agulu-Nnaka Erosion Impact On Human Lives And Infrastructure. American Journal of Engineering Research and Reviews, 2018, 1:8

eSciPub LLC, Houston, TX USA.
Website: http://escipub.com/

Introduction

The ecological menace of erosion is a major disaster that continues to threaten landmass in Nigeria. Some of these erosion actions have resulted in devastation of economic properties due to natural and human causes stated by (Nnodu 2005) in his environmental renewal for sustainable development of Anambra State.

In Nigeria over 6,000km^2 of land are affected by erosion and about 3,400km^2 are highly exposed to the devastation. Erosion has a devastating effect on many peoples' lives and has destroyed infrastructures, essentially constructed for economic development and poverty alleviation.

Anambra state has some doses of the environmental devastation.The State has intimidating sizes of erosion sites, and is obviously threatened by physical environment that seems ever ready to slip into nothingness (Nwajide and Reijers 2007).

Onyeagocha (2003) with good understanding described erosion as an accelerated phenomenon which resulted from movement of soil by water, wind or other agents and deposition of such detached soil elsewhere. Erosion has caused horrendous and incalculable havoc in the communities affected, also erosion as a surface sculpture of the earth's landscape has constituted global environmental problem and requires peculiar attention because of the threat it poses to building and other structures that endanger human lives (Obiekezie et al, 2002). The gully erosion in Agulu/Nanka has posed numerous threats to the inhabitants of the area and has caused many residential building and worship centres to collapse, destroying roads net works, and other infrastructure and degrading land for commercial and agricultural purposes (Igbozurike, 2001), see figure (1).

Anambra State, the must devastated erosion state has been implementing the multi-sectoral Nigeria erosion and water shed financed by the world bank, Global facility, the special climate fund program in rehabilitation of Agulu/Nanka erosion gullies. Igbozurike (2001) observed that the program multi-sectorial Nigeria erosion and water shed was aimed at reducing vulnerability to soil erosion in targeted sub-catchment areas, like Anambra State as the activities were implemented by the state and federal government, see figure (2).

Figure (1) A section of gully in Agulu/Nanka both Aniocha/Orumba North LGAs

Figure (2) Gully at Agulu/Nanka showing some affected houses and tarred road.

Ndubude (2003) is of the opinion that Agulu/Nanka community gully erosion rehabilitation project was considered to be mainly site specification, and the project concentrated mainly on the rehabilitation which included the construction of a concrete culverts designed to convey the flow and links through Oko/Ekwulobia road to Ahommiri River. Moreso, filling and compacting of fill to reclaim part of the gully head and its finger gully,

construction of step-wise drop or rock chutes structure was to dissipate a large part of the energy of flow, and flat gabion mattress was laid on geotexttile material. The construction company also used reno/gabion mattresses where necessary in protecting the base from scouring and re-vegetation of the gully site with local grass and trees within the distance of the gully and its fingers, see figure (3).

Figure (3) Step wise drop, chutes and spikes

The civil works was concentrated at the areas closed to the erosion site and ensured negligible adverse impacts on livelihood. Okafor (2002) was of the view that the adverse impacts were largely reversible, indirect and short term. Ofomata (2000) in his classification of soil erosion with specific reference to Anambra State in environmental review stated that Agulu/Nanka area consist of loose laterite and sandy material under a superficial layer of fine grained sand which are unstable and poorly consolidated and generally over saturated, prone to leaching due to the heavy rainfall experience in the area. This particular action led to sheet and gully erosion as experienced in many parts of the state.

Erosion devastation is a progressive albatross in the Southeast, which some geologist attributed to the unsavoury development to war activities, such as indiscriminately digging of trenches by soldiers as well as detonation of explosive and bombs in the South East in Biafran War; (Ezechi and Okagbue, 2004).

Aim and Objectives

The aim of this study was to consider the environmental and social management plan development for the rehabilitation of Agulu/Nanka gully erosion and to ensure the effective long-term protection of the area. The objectives of this study development of erosion control program were to:

- Improve erosion management and gully rehabilitation.
- Examine the major activities and identify the aspects associated with construction works which generated environmental impacts.
- Identify the environmental issues associated with the major activities.
- Develop mitigation measures for the aspects identified as having adverse environmental impacts.
- Incorporate environmental mitigation measures into activities and develop corrective actions and ensure monitoring, define the specific actions required, roles and responsibilities for these actions, and associated costs.

Purpose of Study

The exact purposes were to;

- define a proposed institutional structure to govern the implementation of environmental and social management plan development and its monitoring.
- increase incomes for rural households from improved agricultural and forest practice through the use of conservation agriculture, agro foresting, natural regeneration.
- gain efficiency in public administration and public spending through improved knowledge base, analytical, multi-sectorial coordination and stakeholder dialogue.

- define a proposed institutional structure to govern the implementation of environmental social management plan and its monitoring. Also reduction in mortality/morbidity from landslide and social interaction.

Scope of Study

The scope of this erosion project control was based on proactive protection, from flood, erosion and storm surge. Erosion control techniques using good works were applied in controlling runoff waters effectively, reduced erosion and sediment problems in the affected area; also reduced environmental impacts.

This techniques involved construction and rehabilitation erosion gullies in Agulu/Nanka communities which entailed civic works, as culverts, drainage systems, spikes, rock chute filling and laying of reno/gabion materials against scouring, also stone-pitching of wall against sliding.

Literature Review

Erosion is one of the surface processes that sculpture the earth's land scape and constitutes one of the global environmental problems. Soil erosion is perhaps the most serious mechanism of land degradation in the tropic (Eze, 2000). However, gully erosion is visually the most impressed of all types of erosion highly visible and affects soil productivity, restricts land use and can threaten roads, fences, building and human life (Afegbua et al, 2016). It has been described as a well-defined water worn channel (Ezechi and Okagbue, 2004) a recently extended drainage channel that transmits ephemeral flow, steep side, steeping sloping or vertical head scarf with a greater than 0.3m and a depth greater than 0.6m (Egboka, 2007). A V or U shaped trench in unconsolidated materials with a minor channel in the bottom but not necessarily linked to a major stream (Najide Hague, 2009) as well as a relatively deep, vertical-walled channel recently formed within a valley where the well-defined channel previously existed (Onwuka, 2008). Gully erosion is an advanced stage of rill erosion where surface channels have been eroded to the point, where they cannot be smoothened over by normal tillage operation.

Like in other parts of the world, gully erosion is one of the major environmental challenges facing Nigeria. The menace is more predominant in the south eastern region, regarded as a gully erosion region (Igbokwe et al 2008), and some part of south west, probably due to susceptibility of the soils in southern part of the country to erosion as well as varied underlying geology.

Agulu-Nanka sand is lateral equivalence of Ameki formation dominated by a generalized sequence of unconsolidated, unstable, loose friable and poorly cemented sand with intercalating clay layer according by (Osadebe and Enuvie, 2008).

Ezechi and Okagbue (2004) stated that the Agulu-Nanka communities are of the opinion that the gully erosion caused impairment of relationship, when people left their homes and became refugees in the neighbouring towns, which could lead to pour health condition and increase in crime rate. A total of 787 houses and 325 hectares of farmland belonging to the 567 affected households were gulped by the landslip as a result of gully erosion in the area as observed by Igbokwe et al (2008).

Agulu-Nanka erosion complex has posed a big challenge to foresting, companies, local population and the State in general, regarding deforestation of this as the menace continue to gulp the area. The problem has defied all efforts to control it as the erosion is spreading like wildfire to other neighborhood, like Umuchima-Ekwulobia, Oko and others. The landslide has become more potent and active, gulping everything in its course. People are retreating, abandoning homes, livestock, economic trees, and farm lands. The devastating conditions have led to untold social-economic problems.

Apart from destruction of houses, farmlands and economic trees, the erosion has caused siltation of rivers, streams and consequent loss of biodiversity and water supplies for domestic purpose, Albert et al (2000). There is also the destruction of aquatic life in the affected Odor River in Nnanka and Agulu Lake. The gullies are nuisance interrupting communication as well as spoiling farmlands. Moreso, there is the impoverishment of soil over wider areas resulting from deforestation and its replacement by open tussocky grassland. It also led to the problem of finding alternative plots for those whose houses and farm lands had disappeared in the landslide and those whose lands were put out of cultivation as a result of conservation regulation passed by the local authority. If compensation and resettlement are to be made to the displaced persons, the source of such compensation presents a problem.

There is the problem of population explosion of the neighbourhood town and villages because those land have been gulped by the erosion, some dropping to other areas in search of new homes and means of sustaining life. The erosion has further hindered infrastructural development of the area.

Erosion and flood, especially in both urban and rural areas are fast becoming the most reoccurring disaster in many communities in Anambra State. Many communities infrastructure and farmlands have been destroyed by these hazards.

Gully erosion is a single major process responsible for the lost of vast amount of soil in the State as seen in the study of Akpokodje et al (2010).

Nnodu (2005) observed that one kilometer of gully would produce 10,000 cubic meters settlement per km^2 of land. He further emphasized that such happens for a gully aged 100years the mean annual rate erosion would be 1.5tonnes per hectare per year.

Obidimma and Oluruntemi (2011) were of view that Anambra State is besieged by serious environmental degradation, resulting in gully erosion due to very high intensive rainfall resulting in heavy runoff and soil loss. The problem have adversely affected agricultural productivity and thus casting doubt of food scarcity in the zone. The ecological and social settings in the zone are often distorted sometime leading to losses in human and material capital. Most often high torrential rainfall of the South Eastern States of Nigeria creates enabling environment of catastrophic soil erosion in the region (Ndubude, 2003). Surely erosion is the greatest threat to environmental setting of South eastern Nigeria. It is gradually and constantly dissecting the landscape on Agulu-Nnaka area.

Study Area

Agulu/Nanka lies between 7º and 7º30E and 6º and 5º30[1] North of the equator. The erosion complex itself lies about 95 kilometeres Southwest of Enugu and about 52 kilometers east of Niger River. Although the site lies within the moist rainfall belt of Southern Nigeria, the vegetation is predominantly derived savanna dominated by a continuous occurrence of oil palm trees (Okafor, 2001). The rainy season is between April and October. The soil of Agulu/Nanka consist of acid sand, laterite and alluvial. These laterite and sandy material which are unstable and poorly consolidated. These soils are easily eroded by storm water runoff and are generally over saturated during extended rainfall period. The people of Agulu/Nanka area are occupationally farmers, businessmen and traders. The agricultural crops cultivated include cassava, yam, maize, banana, plantain and vegetable see figure (4) below

A section of the main gully is about 2.3km long and is progressing. The remaining 5.2km has a relatively mild slope and wider bed width. The gully has shallow depth at its tail and is deeper in the middle and head section up to 45 meters depth. The width of the fully varies from 75 meters at shallower area to 175meters at the deeper sector. The shape of the gully in

generally V-shape gully at the head with a slide slope ranging from 30º to 50º and U-shape gully at the middle.

Methodology

The rehabilitation works of Agulu/Nanka gully erosion is part of the intervention programme of the World Bank, which aimed at reclaiming of the already degraded part of the area for subsequent utilization for either agricultural purpose or other developmental projects. The consulting and construction firm, RONASCO Nig Ltd carried out a reconnaissance exercise first got a visual understanding of the project area. Subsequently, a more detailed assessment was carried out and was integrated in the report. The environmental and social sensitivities of the project area and its surrounding environs were ascertained, stakeholder public consultations were carried out.

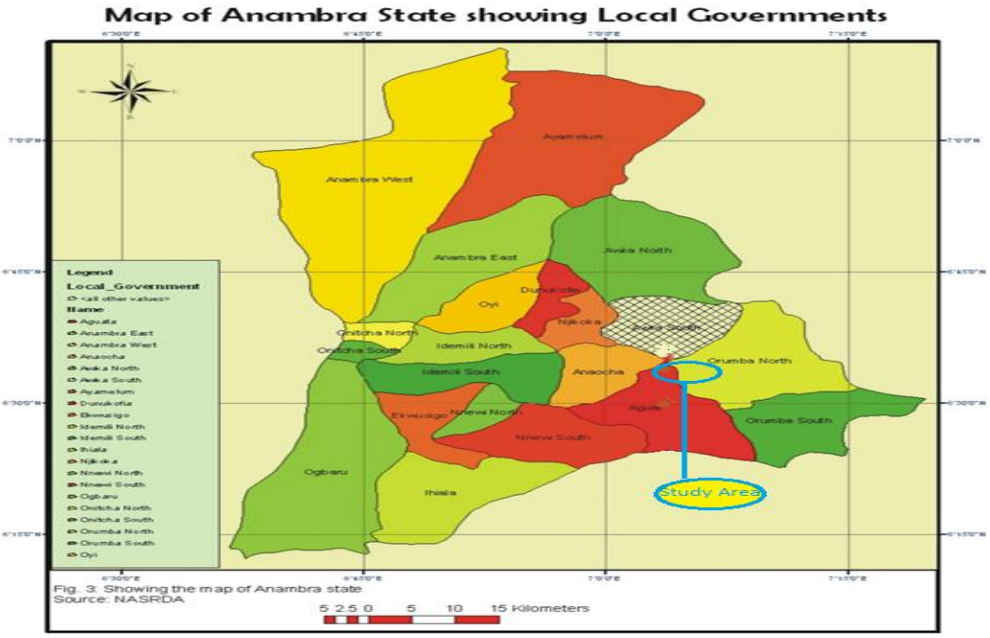

Figure (4) Map of Anambra State showing the study Area

The principle components of the design works for Agulu/Nanka gully erosion site were mainly the design of box culvert concrete channel, cascade drops, rock chute and stilling basin, gabion retaining wall, check dam and outlet structure.

The gully also involved the design of concrete canal, cascade drops, chuke and stilling basin, junction structure with the gabion retaining wall and outlet structure from Agba village end. Moreover, the gully bank was largely provided with bio-remediation and in some cases stone pitching works, as this section of design covered the design of bank treatment works interceptor and collector drain on the gully, see figure (5).

Figure (5) Gabions and Reno Mattresses used to protect infrastructure in vulnerable site

The design engineering structure resulted in the reduction of adverse impacts of the project. A sustainable engineering design for the intervention using gabion retaining walls and interlocked blocks over filtered materials at critical areas near the gully corridor was employed. This will help retain the existing structure thereby preventing possible demolition of the structure. Also geotextile was also employed in some area. The design for the catchment pit was realigned to avoid the project engulfing valuable building as well as other structures.

The work carried out at the intervention site as in the engineering design layout was to rehabilitate degraded lands longer-term erosion vulnerability in the area included among others.

- Stabilization of existing/or rill erosion activity to reduce run off concentration.
- Provision of grade control structures such as check dams at suitable intervals to retain sediments and naturally filling the gully channel.
- Re-contouring and re-grading of the gully wall to achieve stable slopes.
- Construction of concrete channel cannal and other structures to safely discharge runoff to appropriate discharge location.
- Provision of appropriate interceptor drains to prevent further runoff concentration and safety discharge runoff from the adjoining environs into the main channel.
- Provision of access to enhance future maintenance of the structure for sustainability.
- Introduction of Gabions and Reno Mattresses at the floor of the gully.

Moreover, in the construction segment of the project from Umuowelle village in Agulu towards Agulu Lake, were construction of set of side drains at both verge of the roads, also construction of concrete culvert designed to convey the flow and links to Agulu lake. There were also filling and compacting to reclaim part of the gully head and its fingers gully construction of stepwise drop structure were made to dissipate a large part of the energy of flow.

Additional flat gabions mattresses were laid on the geotextile material and reno/gabion mattresses were used to protect the base from scouring.

Finally, re-vegetation with local grasses and trees within the distance of the gully and its finger site, see figure (6).

Figure (6) Spikes preventing undue acceleration of flow and dissipating energy.

Results and Discussion

The poor drainage systems in Agulu/Nanka communities were insufficient to cope with run-off at peak rainfall. The excess water flow became trapped in some concentrated streams and begun to erode channels in the ground surface and created gullies. This called for environmental protection through an engineering solution to erosion and addressed the loss of almost one hundred sites included Agulu in Aniocha Local Government Area and Nanka in Orumba North Local Government Area.

The erosion menace threatened households as huge gullies developed in susceptible areas and threatened to destroy household schools,

road links, and industrial facilities in Anambra. A 4800 square kilometer area in South East of Nigeria has lost so much ground to erosion as the area's rapidly shrinking due to soil erosion and became the smallest state of Nigeria due to erosion menace.

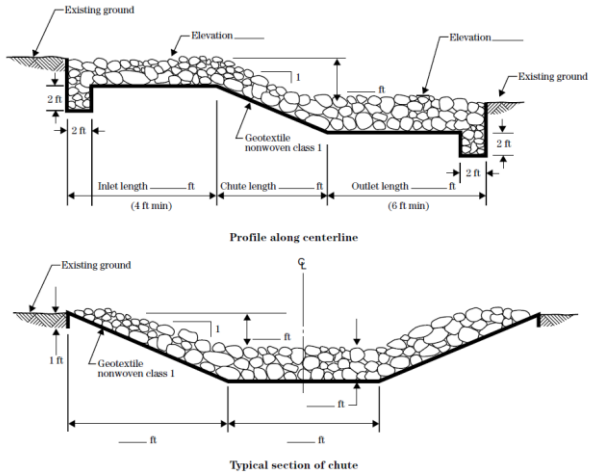

Figure (7)

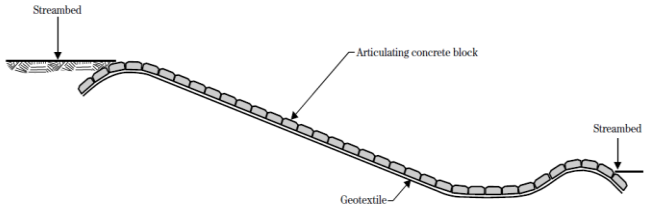

Figure (8) Articulated concrete block system in preventing erosion

Obviously, with the residents of Agulu/Nanka community are in danger of losing their houses, farmland and major roads to gully erosion have cried out to the government, making serious for the rehabilitation these erosion sites

Moreover the state government under the world bank financed and addressed the severed erosion as well as land degradation by construction of concrete channel to take the flow of water away from different catchments around Agulu/Nanka and were channeled to stilling basins in order to reduce the velocity/turbulence of the flow.

Moreso, the construction of check dams and spikes at intervals using Maccaferr's gabions,to further reduce the velocity and assist in gradual deposition and reclamation of the gully. In the stabilization of the gully bed, Maccaferr's reno-mattresses and geotextile's were used to reinforce the exposed soil surface and prevented scouring by water flow velocity in the gully.

Finally, the project has started yielding results as erosion management improved and loss of infrastructure has greatly reduced.

Conclusion

Anambra State, typically with most states of the south-east is faced with similar ecological issues such as gully and sheet erosion, flooding and landslides. These actions have often cut off various communities and hundreds of development in the same part of the state.

The erosion in Anambra State has also led to the destruction of properties ancestral land and homes, living little space and land for agricultural practice. Obviously, erosion control involved effective creation of physical barrier such as drains culverts, stilling basin, break water, slop-wise drop structure in dissipating large part of the energy of flow.

The beneficial environmental and socio-economic impacts associated with the rehabilitation works included provision of employment opportunities for skilled and non skilled workers, reintegration of communities and diversification of sources of livelihood, promotion of afforestation programmes with its benefits, reduced fear perception of loss of property, in habitation and ancestral origin of the communities and reduction in mortality/morbidity from landslides social interaction in the affected areas has correspondingly increased.

Recommendations

- There must be policy to examine the various regulation and legal documents as it concerns erosion mitigation.
- There must be examination and evaluation of World Bank safeguards guidelines relevant in erosion mitigation.

- There must be an environmental impact assessment before the commencement of project implementation.
- There must be incorporation of environmental mitigation measures into activities and the development of corrective action and ensuring monitoring.

REFERENCES

1. Akpokodje E.G., Tse A.C. and Ekeocha N (2010). Gully Erosion Geohazards in Southeastern Nigeria and management implications. Scientia Africana 9(1) pp.20-36.
2. Albet A.A., Samson A.A. Peter O.O. and Olufunmilayo A.O. (2000). An Assessment of Socio Economic Impacts of Soil Erosion in South Eastern Nigeria, Shaping the change, XXIIFIG Congress Munich Germany pp.12.
3. Egboka, B.C.E (2007). The Raging War. A publication of Anambra State Government of Nigeria, Awka. Ministry of Environment (2006). Landforms in Anambra State. Vol. 17 Anambra State.
4. Eze, A.N. (2000). Strategies for Enhancing the Adoption of Soil Conservation Technologies in School Farms in Anambra State. In Environmental Review Vol.3 No.2.
5. Ezechi, J.I. and Okagbue, C.A. (2004). Genetic Classification of Cullies in Eastern Nigeria and Its implication on control measure. Journal of African Earth Science (8) pp716.
6. Igbokwe, J.I. Akinyede, J.O. Dang, B. Alaga, T. Ono, M.N. Nnodu, V.C. and Anike, L.O. (2008). Mapping and Monitoring of the Impact of Gully Erosion in South Eastern Nigeria with Satellite Remote Sensing and Geographic information system. The International Archives of the Photogrammetry. Remote Sensory and Spatial Information Sciences Vol. XXXVII Part B8 Beiging.
7. Igbozurike, U.M. (2001). Erosion in the Agulu-Nanka Eastern Region of Nigeria. Suggestion on Control Measures Paper. Presented at the Conference of the soil Science Society of Nigeria, Nsukka.
8. Ndubude, R.K. (2003). Soil Erosion in Anambra State. A Document Prepared for the (Guideline) Guideline of UNESCO Visiting erosion Sites in Anambra State (Unpublished).
9. Nnodu, V.C. (2005). Environmental Renewal for Sustainable Development of Anambra State". A Special Paper Presented at 3 Day Stakeholders workshop on Environment By Ministry of Environment Awka pp.15-17.
10. Nwajide, C.A. and Hogue (2000). Gullying Processes in South-Eastern Nigeria: The Field Journal Vol. 44 No.2 pp 65-74.
11. Nwajide, C.S. and Reijers, T.J.A. (2007). Geology of the Southern Anambra Basin, In: Reijers T.J.A (Ed) Selected Chapters on Geology. SPDC, Warri pp 133-148.
12. Obidimma, C.E. and Olurunfemi, A. (2011). Resolving the Gully Erosion Problem in South-Eastern Nigeria Innovation Through Public Awareness and Community-Based Approach, Journal of Soil Science and Environmental Management pp286-287.
13. Obiekezie, S.O. Ono, M.N. and Igbokwe, J.I. (2002). Monitoring and Auditing of Impacts of Environmental Degradation. In Environmental Review Vol.3 No.2.
14. Ofomata, G.E.K. (2000). Classification of Soil. Erosion with specific reference to Anambra State in Environmental review Vol. 3 No.2 August 2000.
15. Okafor, J.C. (2002). Soil Erosion in Anambra State Paper Presented at the Geological Science Seminar at Anambra State University of Technology Enugu.
16. Onwuka, S.U. (2008). Urban Erosion Problem In Nigeria, Enugu 2008 pp.139-142. Rex Charles and Patrick Ltd.
17. Onyeagocha, S.C. (2003). The role of forestry in Erosion Control and Watershed management in Nigeria. A Report Working Document No.4 of August 1980 FDF Lagos.
18. Osadebe, C,C. and Enuvie, G. (2008). Factor Analysis of Soil Variability in Gully Erosion Area of Southeastern Nigeria: Case Study of Agulu-Nanka, Oko Area. Scientia Africana Vol.7 (No.2) pp.45.