https://dx.doi.org/10.4314/dujopas.v8i2b.12
ISSN (Print): 2476-8316
ISSN (Online): 2635-3490
Dutse Journal of Pure and Applied Sciences (DUJOPAS), *Vol. 8 No. 2b June 2022*

Effects of Gully Erosion in Damagum Town and Environs, Fune Local Government Area, Yobe State of Nigeria

Maina, M. B
*Department of Geography,
Faculty of Social Sciences,
Yobe State University, Damaturu,
Yobe State Nigeria.

E-mail: muhammedbukarmaina@gmail.com

Abstract
Gully erosion has become a global topic of discussion because it is one of the most severe environmental problems affecting people in their social environment; it has caused the loss of Farmland, properties and life in many regions of the world. Similarly, the study area is also experiencing the problem of gully erosion. Therefore, this study assessed the effects of gully erosion in Damagum town and environs, examined the control measures, and mapped out areas affected by the menace. The study involved two sources of data, primary and secondary. The research found that Farmland and people residents are the most affected part of the social environment in the study area. Moreover, the study also revealed that people are applying Biological Control Measures and sandbagging to limit the destruction of the gully erosion. The Government uses Stones wall engineering control measures to mitigate the problem. But both control measures failed because the Biological control measures attract harmful insects to the environment while sandbagging demands money. In contrast, engineering control failed due to unqualified engineers and substandard construction materials. However, the mapping outcome shows that the first phase of the area is more affected by erosion than the second and last phases because the first phase has a gentle slope with less vegetation. Therefore the study concludes and recommends the following. First, the Government needs to enlighten people about environmental education to know the dos and don'ts of the environment to encourage people to continue their previous adopted methods to tackle the problem. Secondly, the NGOs have to provide pesticides to the community members so that they will protected from harmful insects resulting from biological control. Finally, government need to hire more qualified engineers to redo more effective Stones wall engineering control measures.

Keyword: Environment, Gully Erosion, Effects, Control, and Morphology

INTRODUCTION
Globally, environmental issues have become major concern to governments and citizens of various nations, including Nigeria. The environment, which is at the heart of economic, social, cultural and human activities, has been altered by man's neglect and abuse. Pollution, deforestation, erosion, flooding, landslides, global warming are some of the aftermaths of this abuse in and on the ecosystem. By virtue of Nigeria's spatial extent and its location in the tropical latitudes, the country encompasses of various climatic regimes and physiographical units, which have severely exposed the country to the destructive influences of climatically induced hazards including flooding, erosion, drought and desertification (Albert *et al.*,

*Author for Correspondence

2000).One serious geo-environmental hazard is soil erosion which results in the systematic removal of soil, including plant nutrients from the land surface by the various agents of denudation (Zheng, 2006).

Furthermore, the agents of denudation include wind, water and man (that is anthropogenic factor). Hence, relevant to this work as it affects the study area is soil erosion by water. The classification of water erosion includes sheet, rill, channel and gully erosion. Sheet erosion begins with slow and progressive removal of a thin but fairly uniform layer of topsoil from an area by flood or run-off. Rill erosion on the other hand occurs when run-off water laden with soil particles and debris erodes an area of land surface more than others (Igbokwe *et al.,* 2008). Channel erosion however, occurs when there is repeated rill erosion along a run-off path which creates a vertical bank not deeper than three meters. While, gully erosion is formed whereby runoff water accumulates in narrow channels and removes considerable amount of soil from this narrow channel over a short time period (Madu. 2009). Thus, gully erosion is a linear deep erosion feature with active head cut, unstable side walls, subject to mass movement, and nongraded longitudinal profile, with temporal water flow (Obiadi *et al.*, 2011). The major factor influencing erosion in the tropical region is rainfall and its attributes include intensity, duration, drop size, amount and frequency. Other considerable factors include topography, geology, soil types and characteristics (Mbaya, 2017).

In Nigeria, gully erosion is occurring in many parts of the country under different geologic, climatic and soil conditions. The degree of occurrence varies considerably from one part of the country to another, as well as the types and factors responsible for their initiation and development (Obi, 2017). Similarly, in Yobe state and zone B the study area precisely is among the areas that are seriously affected by the problem of gully erosion in the country. This is because the area is mixed up with both undulating and rugged topography. Although various local flood control mechanisms such as construction of embankments and planting of shrubs have been put in place but the land cover and land use of the areas were discovered to have changed due mainly to human activities (Oladimeji *et al.,* 2017). Many research studies have been conducted related to gully erosion elsewhere in Nigeria. For example, Nyanganji (2009) set a gully in the Ngadda basin to post mega Chad landform development through headwater erosion on the Bama Beach Ridge complex. Mala (2011) also appraised the process on the Ngaddabul plains under the influence of natural and human factors at four locations. Amangabara (2012), on the other hand, analyzed some selected failed gully erosion control works in Imo State. However, all these research works were conducted in different study areas and other locations. Hence there are differences between the rainfall, soil type, vegetation and landform of the mentioned areas and the study area of this research study. Although the work of Maina *et al.* (2020) was conducted in the same study area as this research work, they have almost the same environmental features. However, the research only looked at the control measures against gully erosion, but they did not assess the effects of the menace and they didn't mapped the areas affected by the problem. Therefore, this work bridges a gap in research by mapping out the areas affected by the menace and assessing the effects of the gully erosion in the study area.

METHODOLOGY

Study Area

Damagum town is the capital of Fune local Government area, Yobe State which is situated on longitude 11° 40′ 39″N and on latitude11° 20′ 04″ E, with area of about 4948km^2 and the population is 390523 .Damagum town is in 'the geomorphologic unit known as the 'Potiskum

plains and hills (Heinrich, 1994).The parent material consists of coarse grained sandstone of the kerikeri formation with extensive iron-pan overlain by fine Aeolian sands. To the east, along Damaturu road, are isolated residual hills called mesas. The steep to undulating plain of Potiskum region is bounded on the south-east by an abrupt escarpments descending from the rolling platform to the south into the Gongola valley (Heinrich, 1994).In addition Damagum town is having an elevation a of 436metres above sea level, in the east is a hill referred to as Molku in the south is the valley which contains aa seasonal stream that's drains into Gongola river (Mbaya, 2011).

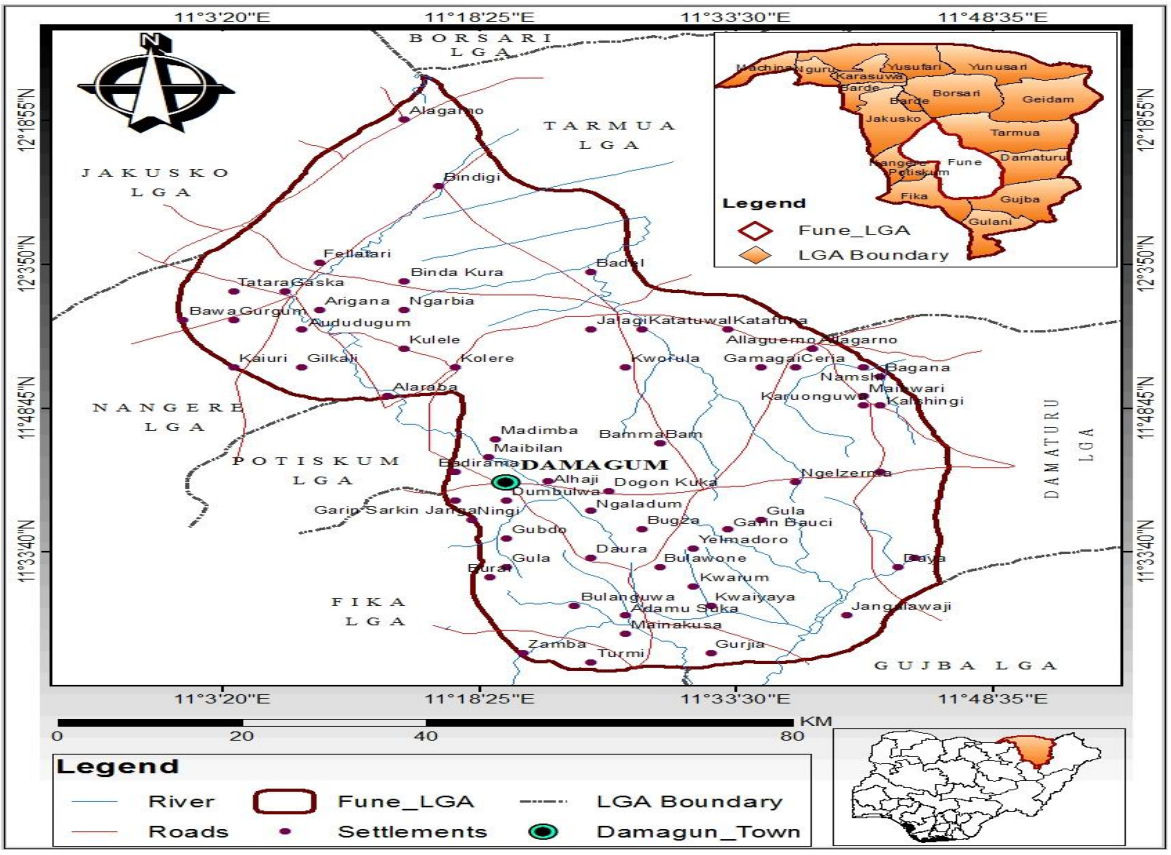

Figure 1: Fune Local Government showing Damagum
Source:-Modified from quick bird satellite imagery and Administrative Map of Yobe State

Damagum town lies the wet and dry sudano –s ahelian belt of Nigeria, West Africa. Damagum area receives an annual from between 600-800mm, which falls within four to five months. The mean annual rainy days are one hundred and six (106) days per annum, the onset of the rain varies from May to June and terminates around September to October (Ati *et al.*,2007).However the dry season is herald annually by the dry cold harmattan winds that start around November in each year till around March. Between the departure of the harmattan and the rains is the hot sunny period that usually lasts till the end of April and sometimes the beginning of May. In the dry season the humidity is low varying from 20-30% in the month of November to march. The Monthly mean humidity exceeds 75% in July to September (Bart, 2005). The annual average temperature is fairly high, exceeding 27^{0}C. In December and January, the Monthly mean temperature falls below the Annual mean by 5% in February the temperature begins to rise and hottest months are April and May when the monthly mean temperature may exceed 32^{0}C (Farauta *et al.*,2002).

Moreover, the study area falls within the Nigerian sector of Chard Basin which is the largest area of inland drainage in Africa. The depositional history of the Chad formation was believed to have started during the lower cretaceous period in which great amount of continental deposits were laid down. This was followed by series of marine transgression and regression from the Gulf of Guinea that persist in to Paleocene and Miocene of age (Farauta *et al.,* 2002). The resulted in the outcrop of different formations like the Fika shale, Gombe sand stone and the kerikeri formation as a stratigraphic sequence within the Chad formation (Bwala et al., 2015).In addition the Fika shale is believed to be the oldest formation, it is a marine strata deposited during upper turonian to senoniaun age as a result of transgression from the sea. The Gombe Sand stone is next in stratigraphic sequence made up of estuarine and deltaic sand stone, silt stone, mudstone and ironstones were formed as a result of withdrawal phase of the sea. Regression persist in to Paleocene – Miocene age with the deposition of kerikeri formation. It is a sequence of lacustrine deltaic strata of the continental origin. It underlies the kerikeri plateau, the high plain lands in the south near Potiskum and Daura and extends southwards beyond the Gongola River to Gombe (Mbaya. 2017). It is made up of conglomerate grits, sand stone, silt stone and clay (Odede and Adaikpoh, 2011).

This Outlined the Source of Data, Data Acquired, Sampling size/Sampling frame and Method of Data Analysis

Two broad sources of data have been used in this study, namely, primary source and secondary sources. The primary source involves field survey, measurements and the use of structured questionnaire. The information collected included socio-economic characteristics of the respondents, duration of their stay in the area, their awareness on gully erosion, the effects of the problem on them and the measures they have/are taking to manage the environmental problem while the secondary source included the use of Landsat satellite imagery and related literature to justify findings were necessary. Data set was acquired on the affected areas by gully erosion and morphology of the sites.

Moreover two areas namely Bakkati and Low-cost areas were selected purposively in Damagum town. This is because they are the most affected areas by the gully erosion. Thus, gathering information from the people in the areas provide answers to some of the study objectives. The 2022 projected population of the study area is 390523. Using Krejie and Morgan's (1970) formula with 95% confidence level with 5% margin of error 384 questionnaires were distributed. In addition, simple random sampling was adopted for this study. A total of 384 questionnaires were administered for both the two areas proportionally. Moreover, equal numbers of questionnaire were given to each area because there is insignificant difference in the size of their population between the two wards. The data collected were analyzed using statistical package for social sciences (SPSS), and results obtained was subjected to simple descriptive statistics in form of percentage.

Furthermore, the gully morphological attributes namely the length, depth and width of the gully were determined through physical measurements of the affected sites. The depth of the erosion was determined by subtracting the value of the altitude based on the bottom layer of the erosion out of the value of the altitude of the erosion at the top layer. The gully was divided in to three (3) parts that is divided to cross-sections. Distance for each part of gully is five hundred and sixty meters (560m) hence, the volume, area, and average depth and width of each part of the gully were calculated. In addition, tapes, ranging poles and GPS receiver have been used for the measurements. Readings were taken through the use of measuring tape (30m) which was stretched across the gully to the opposite band (Jimoh, 2001).However the gully morphology was determined using the formula adopted by Martınez, (2003)

Average width = $\frac{\sum W}{NI}$ ..... (1)

NI= Number of interval points
Length is the distance of the gully.
Breadth is the width of the Gully.

For calculating the Volume of the Gully this formula was used.
$V = A \times H$..... (2)
A= Area covered by the gully
H= is the depth of the gully.

RESULTS AND DISCUSSION

Socio-economic characteristics of the Respondents

(A) Figure 2 shows that 55% of the respondents in the study area were male, with 45% females. The percentage of a male is higher than the number of females because the majority of females in the North are shy to participate in such kind of research, and 2ndly due to the area's culture limit the involvement of females in such kind of research. In addition, **(B)** shows the marital status of the respondents in the study area, with 48% married, 34% single and 18 % widows, which implies that the majority of the people in the study area are married. Furthermore, **(C)** displayed the age of the respondents as 15% for 20 years of age, 31% for 21 to 40 years of age, 41 to 60 is 30% and 61 and above with 24% respectively. However, **(D)** shows respondents' literacy level in the study area with about 21% of people that attended primary school, secondary school with 39%, tertiary school with 25% and finally informal education with 15%. That justified that most of the respondents are literate, but most of them stopped their education at the secondary school level. In addition, **(E)** shows that most of the respondents are farmers with 40%, followed by civil servants with 30 %, then business men with 22% and lastly, other occupation that was not mentioned with 8%.Furthermore **(F)** shows people's duration of stay in the study area with 10% that leave for not more than five years, followed by 15% that stayed for a duration of 6 to 10 years, then 16% for the people that stayed for 11 to 15 years and lastly with 59% of people that stayed more than 16 years in the study area that means majority of the respondent have stayed for more than 16 years in the study area, that means majority of the respondents are aware of the existence of gully erosion in the study area.

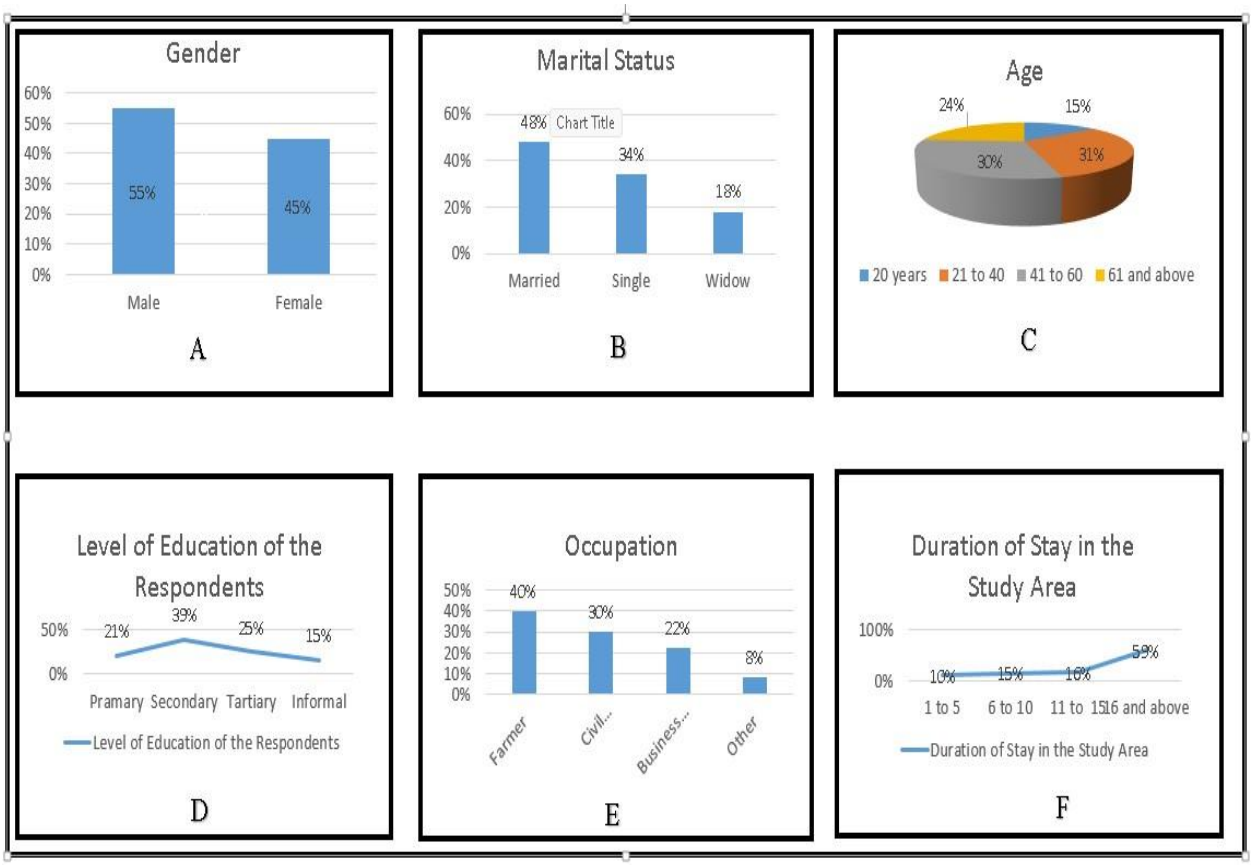

Figure 2:- Demographic Characteristics of the Respondents

However, **(G)** in figure 3 shows people's responses on whether they are affected by the menace or not. The majority of the people in the study area notified that they are affected by the gully erosion, with 69%, while a minor of 31% justifying that they are not affected by the problem. **(H)** Shows how the gully erosion has affected the 69%. About 40% of the respondent notified that their farmland was being affected by the gully erosion because they used to produce so many agricultural products before the effects. However, the agricultural product has been reduced due to a decline in soil fertility, which agrees with the work mala. (2011) asserts that gully erosion can alter soil's organic matter with time. However, about 30% of the people also notified that the gully erosion had affected their houses, with another 13% saying it affected their schools. Finally, a few respondents said the gully had affected their business places 12%, and 5% said they were affected but did not mention how the menace affected them.

(I) shows people's responses on whether they are doing something to tackle the menace, with 67% saying yes, they are doing something to tackle the problem. In comparison, the remaining 33% said no, they are not doing anything to control the problem. Moreover **(J)** shows the reason why the 33% of the people are not making any effort to manage the problem, 30% out of 33% respondents saying that it is the responsibility of governments to tackle the problem, while 25% saying its requires money to tackle the problem, another 15% notifying that because its demand much time to tackle the menace that's why they are not doing anything to manage it and lastly 30% of the respondent have no reason for not cooperating with the other respondents that are tackling the problem, maybe because they do not know the do and donts of environmental management that's why their behaving that way. However, **(K)** shows the efforts made by the 67% of the respondents that say yes, their making an effort to control the problem, about 40% applying Biological Control Measures (*Planting Datura Stramonium Plant*),

while 55% are filling the gully affected areas with sandbags and scrap tires, and lastly, none of the respondents notified that there doing Stones wall engineering control measures to tackle the problem this is because it requires so much money this can only be done by Government or Non-Governmental Organizations

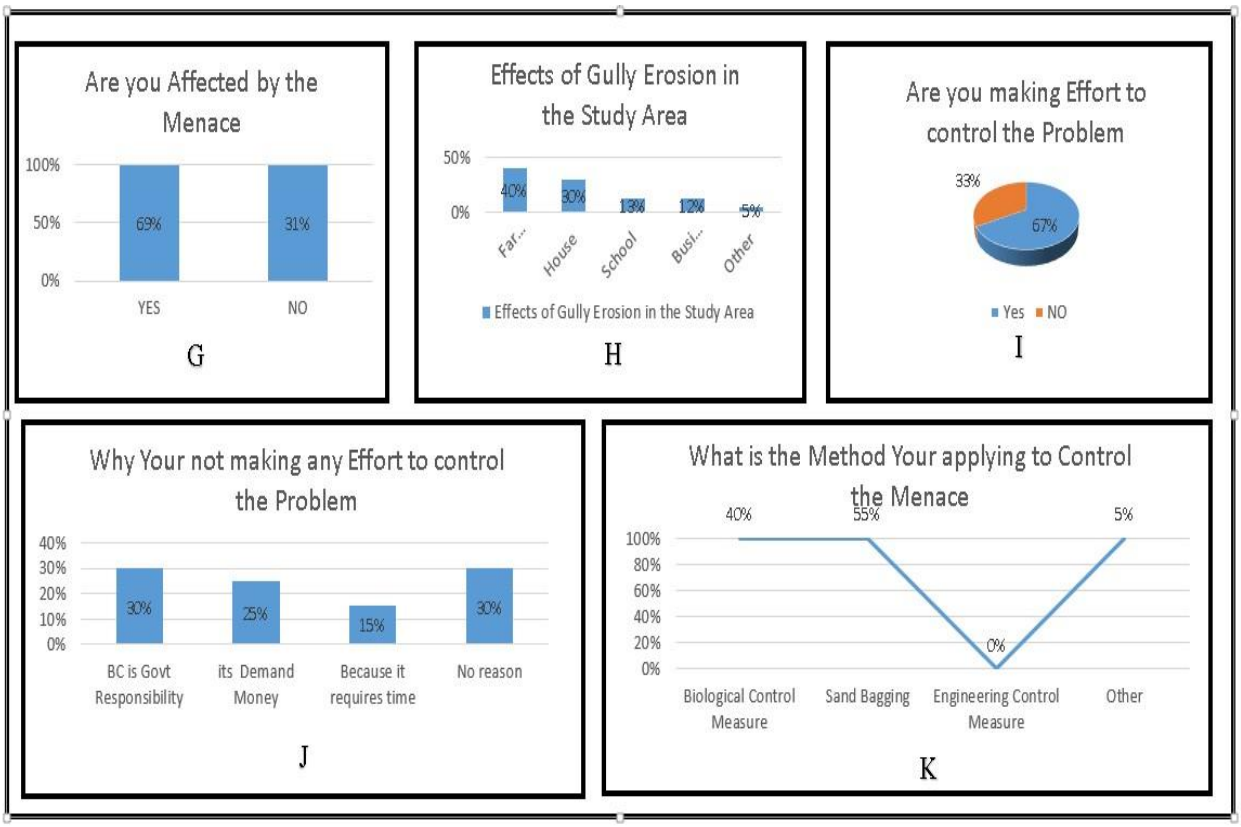

Figure 3:- Effects and Control of Gully Erosion in Study Area

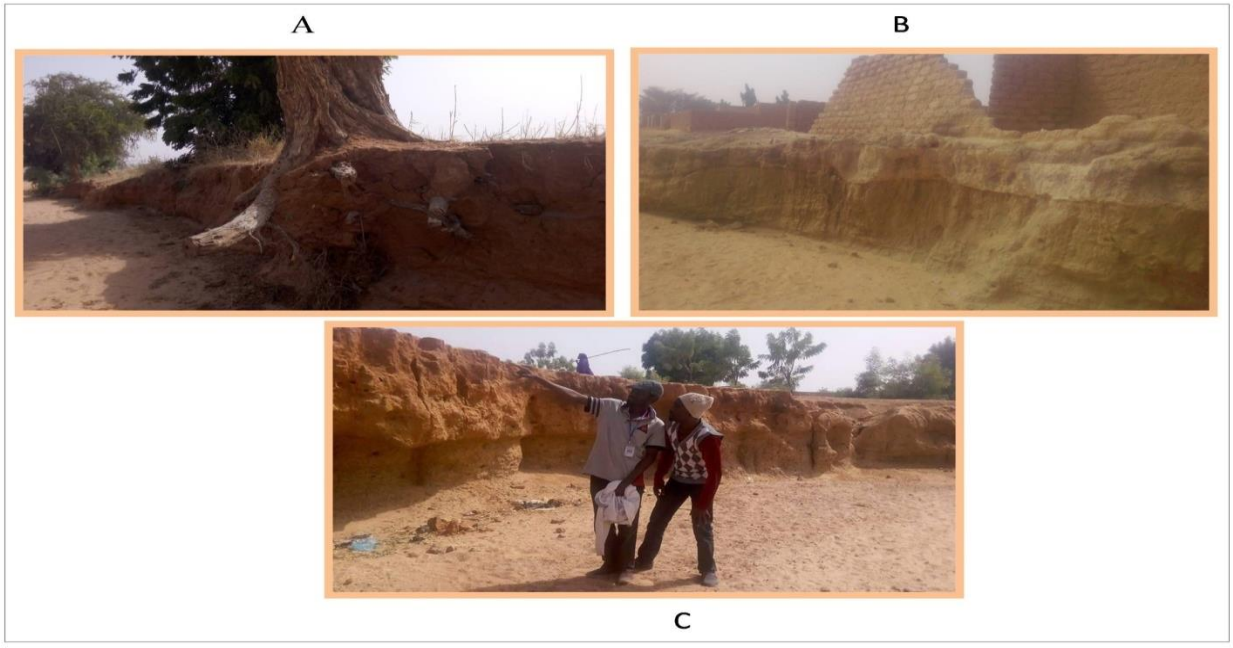

Plate 1**: -** Effects of Gully Erosion in the Study Area

(A) plate 1 shows how the tress have been affected by the impact of gully erosion very close to law cost area in Damagum, while **(B)** Plate1 shows some houses that were destroyed by the effects of the gully erosion around Bakkati Area in Damagum town**, (C)** displayed how gully erosion has destroyed farmland very close to Damagum Cemetery. These plates justified Damagum town, and environs have been affected by the menace

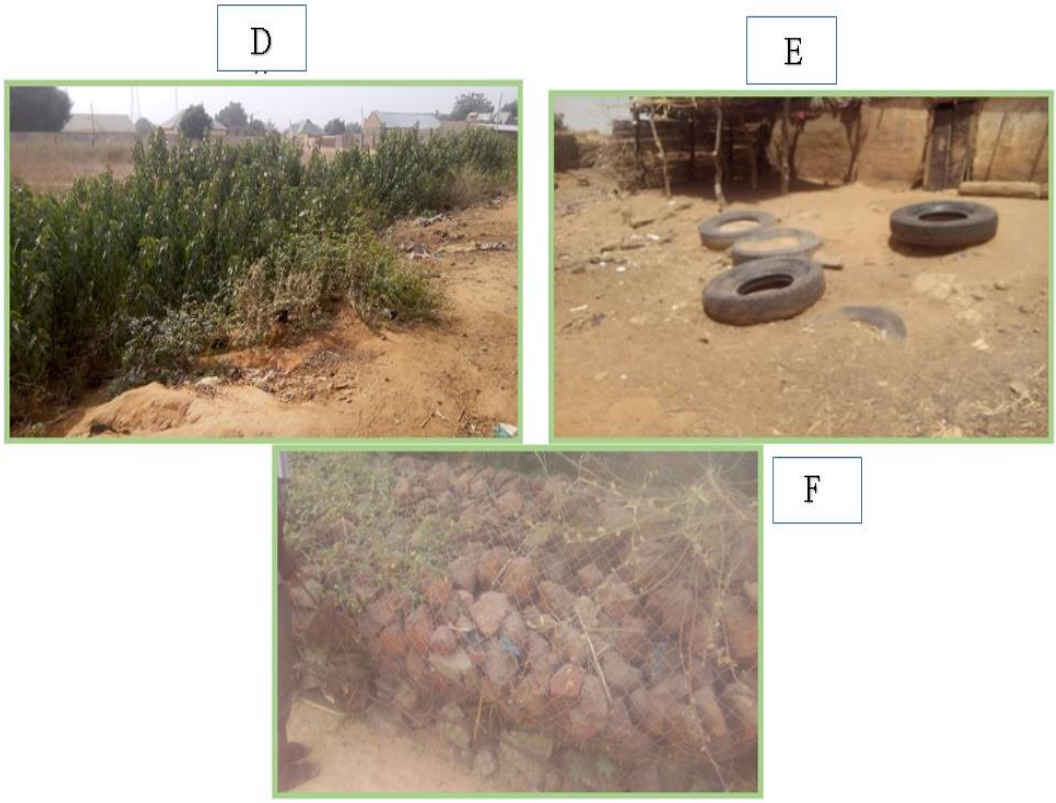

Plate 2: - Control Measures put in place in the Study Area

However**, (D)**, **(E)**, and **(F)** in Plate 2 present the various control measures that were put in place by both the community and the government in order to limit the menace of gully erosion in the study area. The control measures are grouped based on engineering, biological and local control measures. Moreover, the Damagum community-engaged themselves in Biological and local control measures to tackle or reduce the menace because it is less cost implication that individuals and the community can afford it. More so **(D)** shows the biological control measures, community-engaged themselves in planting (*Datura Stramonium Plant*). The Datura plant significantly reduces the effects of gully erosion because it enhances infiltration through the roots thereby reducing the runoff (Maina et al., 2020). However, the community failed to plant the mentioned plant because it requires more attention. It is also used to attract harmful insects like scorpions and animal-like snakes that terrorized people in the Study Area. While **(E)** shows local control measures by the community members, people in the study Area are putting scrap tires and sandbags in the gully affected Areas to reduce the Runoff, but lately, due to negligence and lack of environmental awareness, also because it requires money they have stopped applying this method in the Study Area. Lastly **(F)** is Stones wall Engineering control measures. The method is very effective in controlling erosion, but the method failed due to uncodified engineers and substandard construction materials. Moreover, this work agrees with the work of (Oldimeji et al., 2017) and (Maina et al., 2020).

However **(A)** Figure 4 shows the goggle image of the study area captured on 10/04/2022. The google image shows the mapping starting point **A** and the ending point **B.** Hence, the gully measurements were done within the distance. While **(B)** in figure 4 shows the area affected by the gully erosion, the affected area is represented in white, the buildup area in red, farmland in light green, vegetation dark green and the river in blue colors, respectively

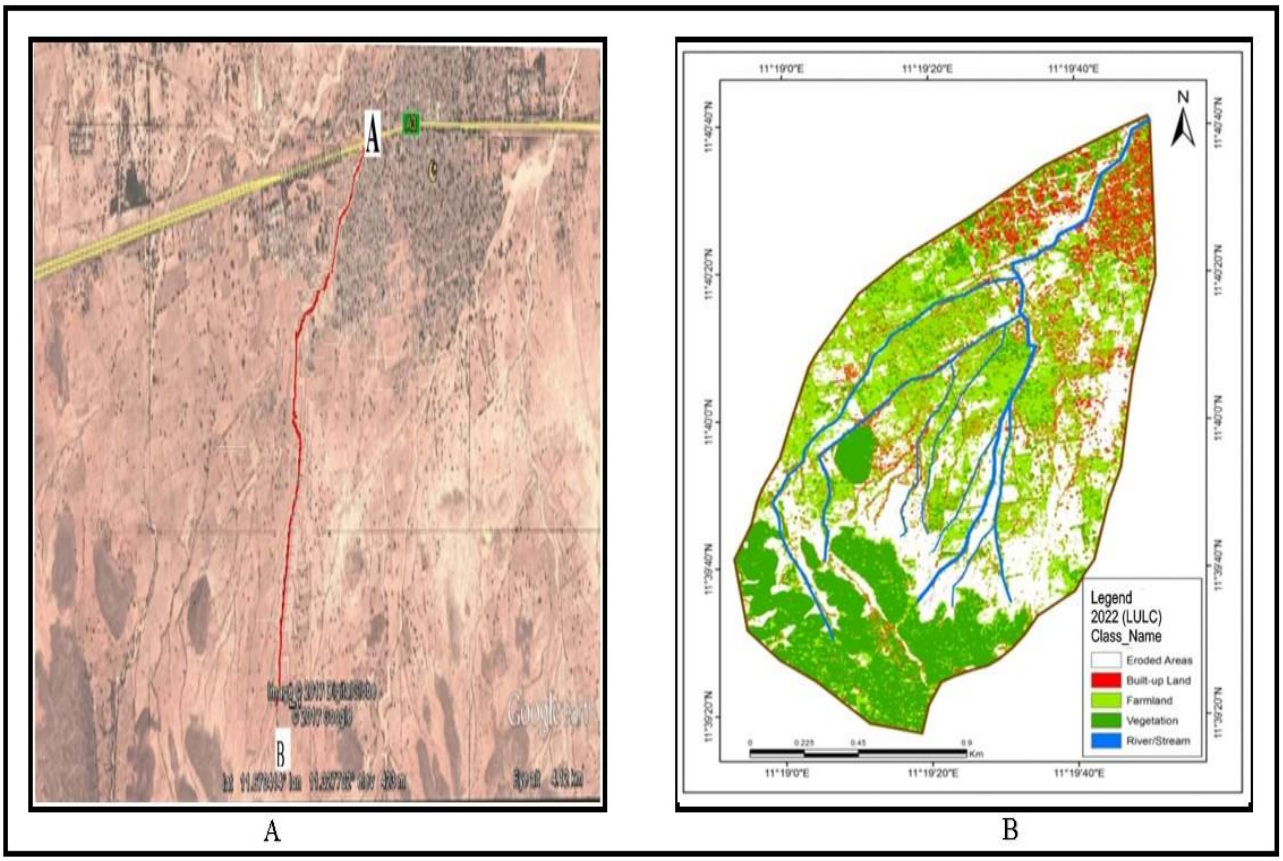

Figure 4:-Mapping Area & Areas Affected By Gully Erosion

Table 1:- the depth, width and volume of gully erosion

Gully Attributes	Length	Average width	Average Depth	Volume
First Part	560m	3m	15.3m	25604m^3
Second Part	560m	3.3m	9m	16632m^3
Third Part	560m	2.4m	2.4m	5644.8m^3

Table 1 presents the depth width and volume of all three parts of the gully erosion that were mapped out during the field survey. Four points were mapped in each segment and the distance between each point is 140m while the width of the gully in the first phase has the value of 15.3m while the middle or the second phase width was 9m and the last phase of the width was found to be 4.2m. With regards to the depth of the gully, the first phase was found to be 3.3m which is the deepest followed by second/middle phase which was 3.0m while the last phase was just 2.4m. The volume of the gully on the other hand based on the three phases was found to be the highest with 25604m^3 for the first phase, followed by the middle/ second phase with 16632m^3 and the last phase was found to have 5644.8m^3.Moreover, the total volume of the gully erosion and total distance covered were 47880.8m^3 and 1680m respectively. The results further confirm that the amount of soil lost by the effects of gully

erosion was higher in the first then second and finally the last phase because the last phase is in higher elevation and there's little vegetation that will limit the destruction of the gully than in the middle and the first phase.

CONCLUSION

This study found some significant conclusions based on the findings. Firstly, the majority of the people are affected by the gully erosion; mostly, their houses and farmland are more affected. Secondly, the study found out that people are applying Biological control measures and sandbagging to minimize the impact of the gully erosion while government is using stones wall engineering control measures. Although, both the control measures have failed because the Biological control measures attract harmful insects to the environment while sandbagging demands money. In contrast, engineering control failed due to unqualified engineers and substandard construction materials. Finally, the study revealed that the amount of soil lost by the effects of gully erosion was higher in the first phase of the affected side than in the second and last phase because the first phase has a gentle slope with low vegetation cover. Based on the study's findings, the following recommendations are proffered; first, the Government needs to enlighten people about environmental education to know the dos and don'ts of the ecological management so that people will be encouraged to continue their previous adopted methods to tackle the problem. Secondly, the NGOs needs to provide pesticides to the community members to be protected from harmful insects resulting from Biological Control measures and finally, governments need to hire more qualified engineers to redo more effective Stones wall engineering control measures.

REFERENCES

Albert, A., Adeyinka, S. A., & Peter, O. (2000). An Assessment of the Socio Economic Impacts of Soil Erosion in South-Eastern Nigeria. In *shaping the change, XXIIFIG Congress Munich Germany* (p. 12). Retrieved 12/12/2021

Ati, O. F., Iguisi, E. O., & Afolayan, J. O. (2007).Are we experiencing drier conditions in the Sudano-Sahelian Zone of Nigeria.*Journal of Applied Sciences Research*, 3(12), 1746-1751.

Bart, J.M. (2005). Pre - water audit for the Komadugu - Yobe Basin project (I U C N - the world conservation union , *federal ministry of water resources and Nigerian conservation foundation Kano Nigeria* (accessed 20/01/2022).

Bwala, H. B., Oladosu, R. O., & Nghalmi, S. M. (2015). Application of Physical Planning Strategies to Flood Control in Maiduguri, Borno State, Nigeria. *Research Journal of Environmental and Earth Sciences*, *7*(1), 1-8. Retrieved 12/4/2022

Farauta, B. K., Egbule, C. L., Agwu, A. E., Idrisa, Y. L., & Onyekuru, N. A. (2012). Farmers' adaptation initiatives to the impact of climate change on agriculture in northern Nigeria. *Journal of Agricultural Extension*, 16(1), 132-144.

Heinrich, J. (1994). Landscape development and environmental change in northern parts of the Gongola basin, north-eastern Nigeria. *Bole Language Documentation Unit BOLDU, Report I. Köln*, 49-67.

Igbokwe, J. I., Akinyede, J. O., Dang, B., Alaga, T., Ono, M. N., Nnodu, V. C., & Anike, L. O. (2008). Mapping and monitoring of the impact of gully erosion in Southeastern Nigeria with satellite remote sensing and Geographic Information System. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, *37*(part B8), 865-872.

Jimoh, H. I. (2001). Erosion studies in a Nigerian city: A methodological approach. *Environmentalist*, *21*(2), 97-101.

Maina, M.B, Abdullahi & Abba, M, B.(2020).Assessment of the gully control measures and reasons for the failure in Fune Local Government Area, Yobe State, Nigeria. *Journal of Environment and Development,* Vol 6No 1, Pp131 Retrieved 12/05/2022

Mbaya, L. A. (2011). Factors and rate of gully erosion in Gombe town,Gombe state, Nigeria. *Journal of Environmental Issues and Agriculture in Developing Countries*, Vol. 3, No. 3.Retrived 11/11/2021

Mbaya, L. A. (2017). Spatial analysis of gully erosion control measures in Gombe town, GombeState Nigeria. *Adv Image Video Process*, *5*(4), 17-17.

Martınez-Casasnovas, J. A. (2003). A spatial information technology approach for the mapping and quantification of gully erosion. *Catena*, *50*(2-4), 293-308.

Obi.E.(2017).Application of Retaining Wall in the Control of Flooding & Gully Erosion. American Journal of Engineering Research (AJER).Retrieved20/1/2022

Obiadia. I.I, Nwosu.C.M.,Ajaegwu.N.E, Anakwuba.E.K, Onuigbo.N.E, Akpunonu.E.O, & Ezim.O.E.(2011).Gully Erosion in Anambra State, South East Nigeria: Issues and Solution. *International journal of environmental sciences volume 2, no 2, 2011.*Retrived 9/10/2021.

Odede,O & Adaikpoh,E.O.(2011).Sequence stratigraphic analysis of Gombe sand stone and lower kerikeri formation exposed around Fika – Potiskum, Upper Benue Trough, Nigeria: a concideration for petroleum reservoir indicators. *Indian journal of science and technology,*4(5), 492 – 4498. Retrieved 9/1/2021.

Madu, I. A. (2009). The environmental impacts of regional disparity in population and wealth distribution in Nigeria. *Environment, development and sustainability*, *11*(2), 265-276.

Oladimeji.B. Nyanganji J. K & Ikusemoran.M. (2017).Geospatial surveillance of the degraded River Komadugu-gana area, Potiskum, Yobe State, Nigeria. *Journal of Environmental Issues and Agriculture in Developing Countries, Vol. 8, No. 2 &3*.Retrieved 30/11/2020

Zheng, F.L. (2006). Effect of vegetation changes on soil erosion on the Loess Plateau. *Pedosphere*, *16*(4), 420-427.