An Assessment of Government Control Measures on Soil and Gully Erosion in Gombe Metropolis, Nigeria

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Abstract- ***Soil and Gully Erosion are one of the severe environmental problems in Gombe Metropolis threatening lives and properties. The study assesses Government control measures in Gombe metropolis; it also examines the causes and impact of soil and gully erosion as well as the community control measures. Five research questions were answered. A questionnaire was administered in seven political wards in Gombe town that were selected purposively. A sample of 100 respondents mainly heads of household were selected using simple random sampling technique. Structured interview schedule (SIS) was also used to collect primary data. Simple percentages, pictures, charts and frequency were used to analyze the research questions. It was found that Gombe state Government have adopted some measures to control soil and gully erosion in Gombe metropolis. These measures include: Concrete drain, Gabion (gravel Parking), Dam (dyke), Block drain and vegetation planting. Concrete drains were the most adopted measure with 52.2%, 16.7 % were other non-specified measures. 8.9% was retaining walls, 7.8% was for gravel parking, 6.7% for vegetation planting and the measure with the least percentage is Dam (dyke) with 2.2%. The study also revealed that Government has spent quite a lot of money in controlling the menace. In addition to the measures adopted by the Government, the study recommends that the Government should encourage the community to avoid artificial gully erosion causes, encourages clearing of drains, vegetation planting, avoiding building on flood plains and water ways and an Environment Impact Assessment (EIA) should be embarked upon before any project is to be carried out.***

Indexed Terms- ***Government control, Soil Erosion, Gully Erosion, Gombe Metropolis, Erosion Control***

I. INTRODUCTION

Gully Erosion is one of the devastating forms of environmental degradation that affect live, properties and Resources Gully erosion is the removal of soil by runoff water and often persists in narrow channels and over short periods removes the soil from a narrow area to considerable depth (Poesen, 2002). Gully erosion is caused when run off concentrates flows at a velocity sufficient to detach and transport soil particles. If no protective measures are taken, advanced rill erosion can develop into gully erosion. Although gully erosion is a global problem and occurs in all geographical areas (Menendez-Duarte et al. 2007), Africa is the worst-hit continent (Were et al. 2023). Gully erosion is associated with Several causes which include deforestation, soil type, surface runoff and steep slopes its effects include land degradation and lost of livestock (Churu et al 2024). The nature and type of sediments, and anthropogenic factors such as indiscriminate disposal of refuse may also contribute to the gully erosion development (Igwe et al. 2020). Studies have shown that gully erosion is one of the most soil degradation processes in most states of the southeast and south-south zones of Nigeria as it causes considerable soil loss and produces larger volume of sediment (Ocheli et al., 2021; Nwosu et al., 2022). The man-made activities that has contributed to gully erosion hazard in south-eastern in Nigeria are construction of infrastructure such as road grazing and high population density (Igwe and Orji 2019; Ebong et al., 2023). Gully erosion is caused by natural and anthropogenic factors; the natural factors include the nature of the topography, nature of the soil and rainfall pattern of an area while the human factors include continuous mining of sand and dumping of waste in the drainage system (Maina, 2022). Gully erosion has devastating effects to physical structures and socio-economic activities, it affect and destroy residential houses, bridges, road network, culverts, farmland and farm produce (Jibo, 2020).

Gully erosion menace in Gombe town is a common phenomenon, the areas where the population density is highest are where worse damage of gully erosion is found (Heiko, *et al*, 2013). Soil and gully erosion has

become one of the greatest environmental disasters facing Gombe town (Lazarus, *et al* 2012). They are serious environmental problems in City, threatening infrastructure, properties, lives and the physical growth of the town. Because of the distinctiveness of the savannah climates, the low level part of the old Gombe town suffer seasonally from the menace of flood, soil erosion and destructive force of gully erosion, destroying houses and urban infrastructures (Heiko, *et al* 2010).

The situation is increasing due to the infrastructural development coupled with demographic changes, soil erosions have now developed into big gullies and those that have their houses of reasonable distance from rills some years back are now helplessly observing their houses collapsing (Gombe SEEDS, 2006).

According to Izinyon, Ehiorobo and Adedeji 2011, "There are many physical and biological techniques which can be applied for effective gully treatment However; the application of biological and physical measures (Bio-physical approach) is the best solution for effective gully control. The choice of the measures depend on the amount of runoff and the status of the gully whether young and actively eroding or mature and establishing naturally. Gully erosion can be controlled in two major ways: the structural and non-structural measures. The structural measures include gully reshaping and filing, Gabion check dam, sandbag check dam, chutes, drop structures and geotextile. The non-structural (vegetative control measures) offers an inexpensive and permanent protection. Vegetation will protect the gully floor and banks from scouring and grasses on the erosion floor slow down the velocity of the runoff and helps in depositing the soils transported. maintenance of existing vegetation coverand planting of trees where the soil has been devegetated provide the needed panacea for erosion management (Igwe, 2017). According to Igwe et al 2017 landscape design can be used to prevent and control gully erosion giving special attention to the use of vegetation as this not only helps to control gullies but also has other environmental benefits.

Solving the menace of erosion in Gombe town requires government Intervention (Mbaya, 2012). Federal and state governments have attempted to arrest the problem through numerous contracts awarded for soil and gully erosions projects at some key sites in Gombe. However, the economic and engineering control measures has not met people expectation, owing to lack of adequate information on the topography, soil and geology, rainfall, catchment area and land use pattern of Gombe town (Mbaya, 2012)
Although several researches such as Mbaya (2012), Mbaya, Ayuba and Abdullahi (2012), Mbaya (2017), Jibo et al (2020) have been carried out on both soil and gully erosion in Gombe, assessing the Control measures put in place by the state Government to control soil and gully erosion in Gombe Metropolis is of paramount importance.

II. STUDY AREA

Gombe town is located between latitude 10^0 to $15^{'}$ 02¨N and $10^0$20'00''and longitude 11^0 05'00'' and 11^0 $15^{'}$ 05''E (Figure 2). The city shares common border with Kwami from the north, Yamaltu-Deba Local Government Area to the East and Akko LGA in the south and West. Being the capital of Gombe state, the city occupies an area of about 52km^2 (Ministry of Lands and Survey Gombe, 2009). Centrifugal expansion, building densification, and changes to the urban design were shown by the geographical and chronological examination of Gombe city's Layout (Balzerek, et al., 2003).

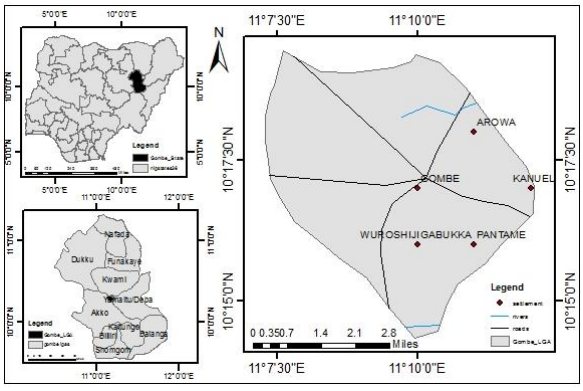


Figure 1: Study Aea

Source: Modified from administrative Map of Gombe State (2020)

The Movement of the Inter-Tropical Convergence Zone mostly determines the dry and wet seasons of Gombe's climate (ITCZ). It receives 835mm of

precipitation on average annually (between May and September), with its peak occurring in August (Amos *et al.,* 2015). A heavy rainfall in the months of July and August is associated with storms of high intensity accelerating gully erosion (Balzerek et al, 2003). The city is situated on a low-lying and undulating terrain that slopes from the Liji hill in the east to the Akko escarpment in the west (Amos *et al. 2015).* Areas on Mountainous terrain have the elevation of about 622m. The stratigraphy consists of the alluvium, the cretaceous sedimentary formation of Keri-Keri formation, the siltstone, sandstone, iron stone of the Gombe formation, the shale and limestone of the Pindiga and Yolde formation, Bima formation and the basement rock (Obaje, 1999). Regarding the drainage, rivers like the river Magariya and the Kware run from west to east. These streams eventually turned into gullies, because of the increase in population gravity on the land (Pentagon Design Consultanat, 2003). River Dadin Kowa (a tributary of the Gongola River) drains the entire area (Balzerez, 2003). Gombe Metropolis has the population of 312,467 in the census 2006 which is projected to about 400,000 in 2010 (NPC, 2007). Soil and Gully Erosion has been one of the Environmental problems Gombe metropolis is being faced with, going by the numerous effects of soil and gully erosion, there is always the need to adopt ways of preventing and controlling these environmental disasters. There is therefore the need to assess the government control measures to prevent and mitigate soil and gully erosion for better soil conservation and suitable lands for human settlements.

III. METHODS

This section primarily describes the research methods used; data gathering, processing and analysis.

3.1 Types and Sources of Data

The Quasi-Experimental Research design Survey was adopted for this study. In addition, the Survey designs. Both Quantitative and Qualitative data were collected; These Data were drawn from the primary and secondary sources. The primary sources of data were derived from questionnaires and personal interviews, while secondary data were drawn from magazines, journals, news, textbooks, government agencies and parastatals documents, internet and Encarta. The secondary data has helped to strengthen and validate the primary data collected.

Gombe metropolis has many wards that are affected by soil and gully erosion out of which seven of the eleven wards; Bajoga, Pantami, Bolari East, Jekadafari, Herwagana,Tudun-wada (Shamaki) and Dawaki which are seriously affected were selected purposively, Reconnaissance survey was first conducted in the study area to arrive at that selection, A simple random sampling technique was used in administering the questionnaires.

A Questionnaire was designed related to the purpose of the study to which the respondents responded. The questionnaire consist of sections A, B, C and D. Section A consists of the demographic profiles of the respondents which include sex, age, locality, marital status, level of education and occupation. Section B, were questions on soil and gully erosion risk and damage in the area. Section C is on government control measures. Section D was possible solutions to the problems. The questions in the questionnaire were both open and closed ended.

In the study area, a total number of one hundred (100) heads of household were selected from the seven (7) wards purposively selected for the administration of questionnaires based on their sizes and the magnitude of the disaster. The number was shared as follows; fifteen each in Tudun-wada (Shamaki) and Pantami, and fourteen each in Bajoga, Bolari East, Jekadafari, Dawaki and Herwagana.

An interview was conducted with Engineer in charge of the gully control unit of the Ministry of Environment Gombe State and Gombe State Environmental Protection Agency (GOSEPA). The interview was conducted in the gully control unit in GOSEPA

3.2 Data Analysis

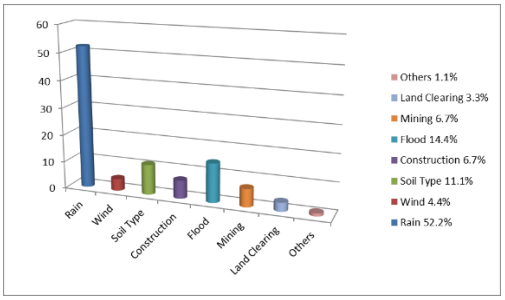
The data collected were presented using descriptive statistics. The data collected were presented in tables and simple percentages are used to determine the strength of responses. Pictures, charts and frequency distribution were used to further strengthen the findings.

IV. RESULTS AND DISCUSSION

The findings from the analysis of the Data gathered during the field survey are presented under the following sub-headings;

4.1 Response Soil and Gully Erosion Risk and Damage

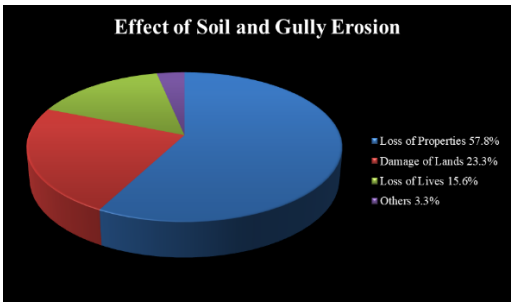
Figure 2 is a chart that presents the causes of soil and gully erosion in the study area the largest proportion of the respondents answered that rain is the cause of soil and gully erosion. Others responded that either soil type or flood is the cause and the cause with least percentage being responded are land clearing, wind, mining and others. The result therefore shows that rain is the main cause of soil and gully erosion in Gombe metropolis followed by flood and soil type.



Source: Field Survey, 2021

Fig. 2: Causes of Soil and Gully Erosion

The pie chart below shows that more than half of the respondents answered that loss of properties is the effect posed by soil and gully erosion in the study area, one –fifth responded that it causes damage to Agricultural land, 15% is for loss of lives and only three respondents specify other effects. The result shows that soil and gully erosion in Gombe metropolis causes mainly loss of properties and agricultural land and less frequently loss of lives.

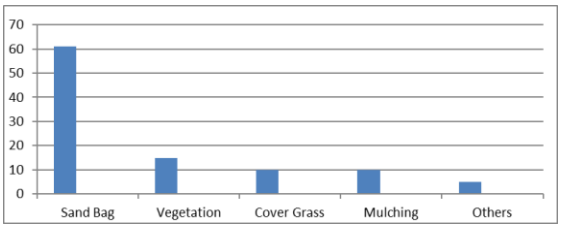


Source: Field Survey, 2021

Fig. 3: Effect of Soil and Erosion

4.2 Response on Soil and Gully Erosion Control Measures

The bar chart below the control measures adopted by the affected communities in the study area as half of the respondents adopted sand bag as the control measure, a larger number adopted vegetation planting while least numbers adopted either cover grass or mulching, and only 3% specified other measures. The result shows that sandbag is the most widely used measure to control soil and gully erosion at the community level, followed by vegetation planting and other least used measures are cover grass and mulching. Hence soil and gully erosion at the community level used cheap measures in their control.

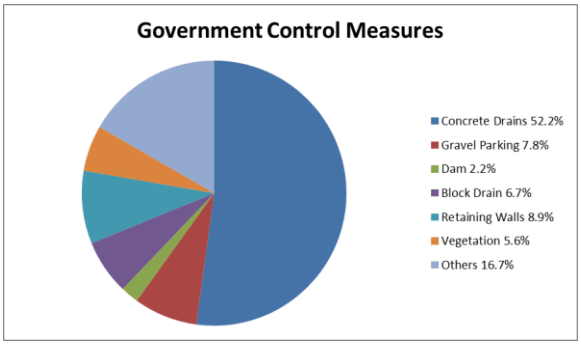


Source: Field Survey, 2021

Fig. 4: Community Control Measures

Figure 5 is a pie chart showing the control measures adopted by government as responded by the respondents. The most adopted measure is the construction of concrete drains which constitute about half of the control measure, gravel parking, dam, clock drain, retaining walls and vegetation are adopted to some extent and about one-seventh of the respondents specified other measures adopted by the Government. The result shows that the Gombe State Government takes part in controlling soil and gully erosion within the state capital mainly through the construction of concrete drains. It also reveals that the types of control measures used by the Government are structured measures which require huge amount of money. The state Government has spent over Four billion Naira in controlling soil and gully erosion from 2012-2021 (Ministry of Environment 2021) The project include Gully erosion from Pantami Market to Pantami Doma 100% completed, Tudun wada to shamaki to GCDSS to Rail line gully erosion control 100% completed, Shongo estate to CBN gully erosion control project 100% completed, Herwagana/Gidan Modibbo to Rail line gully erosion control 89% completed and LL saint

college to Ilimi college gully control 80% completed (Gombe state Government; The chronicle, 2014).



Source: Field Survey, 2021

Fig. 5: Government Control Measures

The table below indicates that most of the respondents affirmed that the control measures adopted by the Gombe state government are effective while about half tagged them to be ineffective. The result shows that the control measures are effective because the highest number responded in the affirmative. The result coincide with the findings of Mbaya, 2017 ' Engineering method is the most effective and costly control method of gully erosion in Gombe State'. The findings also coincided with Osayande (2019) Both Mechanical and Biological Control Method are effective Gully control measures.

Table 4: Effectiveness of Government Control Measures

EFFECTIVE	FREQUENCY	PERCENTAGE
YES	48	53.3
NO	42	46.7
TOTAL	90	100

Source: Field Survey, 2021

4.5 Interview schedule findings

Findings from the interview schedule with engineer Muh'd Garba of the erosion control unit, GOSEPA revealed that the Gombe State Government from have adopted both the structural and non-structural erosion control measures. The structured measures include concrete reinforced drains, dam, gravel parking, retaining walls and block drain. While the unstructured measures include tree planting to manage the water shed.

The interview also revealed that soil and gully erosion are more pronounced in the mid-stream part of the Gombe metropolis which is characterized with clay soil (the selected wards within the study area). The interview also shows that the main cause of soil and gully erosion in Gombe metropolis is the soil type (weakness of the soil binding agents) others include building on water ways and gully banks.

The Gombe state government has spent over 2.9 billion Naira in controlling soil and gully erosion in the study area The state government's achievements include gully erosion control projects at Herwagana/Gadan Modibbo to rail line, Kasuwan Shanu to Tudun Wada primary school, Nasarawo phase A & B, Pantami-Doma to Madaki/Borunde, all Saint college to Ilimi International college, Wuro Bandu and behind International Hotel and the construction of three gully erosion projects covering 4km: Pantami market to Pantami Doma, Tudun Wada shamaki to Government Comprehensive Day Secondary school to rail line other Government effort is the creation of refuse collection centers and distribution of plastic waste bins to different locations to avoid dumping of refuse in constructed control measures. (Ministry of Information and orientation Gombe, 2021). Other findings on the success recorded are that the state government has succeeded in controlling about 45% in the mid-stream (erosion prone areas.). Suggestions were also offered during the interview.

Source: Field Survey, 2021

Table 1: Structural Gully Control at Tudun Wada Shamaki

CONCLUSION

Gombe Metropolis suffers from the problems of soil and gully erosion. Findings from the study show that the causes of soil and gully erosion in Gombe include both the natural and anthropogenic source: rain, wind, soil type, construction, flood, mining and land

clearing. The impacts include loss lives, properties and soil resources. The study also reveals that soil and gully erosion in Gombe metropolis are controlled by both the community and Government. The government adopted the structural (Engineering) methods of erosion control which were found to be effective to control the menace. However the problem is still evident despite the huge amount of money spent in controlling it, mainly due to lack of implementation of research findings and recommendations which hinder the evaluation of proposed solution.

Therefore, the individual, communities as well as the government should join hands to see that these problems are mitigated by discouraging all practices that are capable of initiating or spreading soil and gully erosion in Gombe metropolis since we have little or no control on the natural causes.

REFERENCES

[1] Balzerek,H., Werner,F., Jurgen, H., Klaus-Martin, M. and Markus, R. (2013). Man-made flood disaster in the Savannah town of Gombe, north-east Nigeria. In Erdkunde 94-109.

[2] Churu, H., Kamau, S., Ng'etich, W., Magiroi, K., Alkamoi, B., Kebeney, S., Wamalwa, F.,Mumo, J. (2024). Drivers of Gully Erosion and its Socio-economic and Environmental Effects in a Tropical Semi-arid Environment Asian *Journal of Soil Science and Plant Nutrition Volume 10, Issue 2, Page 13-26, 2024; Article no. AJSSPN.114722* ISSN*: 2456-9682*

[3] Ebong, E.D., Urang, J.G., Melouah, O. et al. Near-surface geophysical characterization of gully erosion hazard-prone area in Calabar, southern Nigeria. Acta Geophys. (2023). https://doi.org/10.1007/s11600-023-01103-7

[4] Gombe State Government (2014): The chronicles "Tenure Report". Yaliam press ltd

[5] Heiko B.W, Werner F.J. (2003) Manmade flood disaster in the savannah town of Gombe north-east Nigeria. The natural Hazard of gully erosion caused by urbanization dynamics. Urban Zavqafoot prints.

[6] Izinyon O.C. Ehiorobo, J.O. (2011) "Monitoring of soil loss and erosion using Geoinformation and Geotechnical engineering methods" FIG Working week. Engineering methods".

[7] Igwe, P.U.; Ezeukwu, J.C.; Edoka, N.E.; Ejie, O.C.; Ifi, G.I. (2017) A Review of Vegetation Cover as a Natural Factor to Soil ErosionInternational journal of Rural Development, Environment and Health Research (IJREH) [Vol-1, Issue-4, Nov-Dec, 2017]

[8] Igwe, O. John, U. I., Solomon, O., & Obinna, O. (2020). GIS-based gully erosion susceptibility modeling, adapting bivariate statistical method and AHP approach in Gombe town and environs Northeast Nigeria. Geoenviron Disasters 7(1): 1–16

[9] Jibo, A. A., Laka, S. I.,Ezra, A. (2020). The Effects of Gully Erosion on Physical and Socio-Economic activities in Akko Local Government Area of Gombe State, Nigeria. *FUTY Journal of the Environment* Vol. 14 No. 2

[10] Lazarus. A. M, H. k. Ayuba, John Abdullahi (2012) *An assessment of Gully erosion in Gombe town Gombe State Nigeria.* Journal of Geography and Geology. Page 110-117.

[11] Maina, M.B (2022) Surveillance of Gully Erosion in Damagum Town and Environs, Fune Local Government Area, Yobe State of Nigeria *Dutse Journal of Pure and Applied Sciences* (DUJOPAS), Vol. 8 No. 2b June 2022

[12] Mbaya, L.A., Ayuba, H.K., Abdullahi, J. (2012). An Assessment of Gully Erosion in Gombe Town, Gombe State, Nigeria. Journal of Geography and Geology 4(3) p110

[13] National Population Commission (2007) *Census Results.* National population commission, Gombe office

[14] Nwosu, U. S., Archibong, G. A. & Nwangene, A. S. (2023). Geospatial data analysis for flood and erosion characterisation: a case study of southern Anambra Nigeria. International Journal of Advanced Academic Research. Vol. 8(8), 13-32

[15] Ocheli, A., Ogbe, O.B., & Aigbadon, G. O. (2021). Geology and geotechnical investigations of part of the Anambra Basin, southeastern Nigeria: implication for gully erosion hazards. Environ Syst Res 10(1): 1–16

[16] Osayande, A., Edobor, w.w., Kato, S. (2019) Effectiveness of Gully Erosion Control Measures in Edo State, Nigeria. *Open Access Library Journal* vol. 6 No. 3

[17] Poesen J.V, Nachtergele J.O. Van Wasemell B (2002) Gully erosion in Drynland Environments, wiley, chichester, UK

[18] Were K, Kebeney S, Churu H, Mutio JM, Njoroge R, Mugaa D, et al. Spatial Prediction and Mapping of Gully Erosion Susceptibility Using Machine Learning Techniques in a Degraded Semi-Arid Region of Kenya. Land. 2023; 12:890. https://dx.doi.org/10.22161/ijreh.1.4.4 ISSN: 2456-8678