

The Effects of Gully Erosion on Socio-Economic Development in Kaltungo Local Government, Gombe State Nigeria

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Abstract: Erosion is one of the major environmental challenges affecting sustainable development in Kaltungo Local Government Area, Gombe State, Nigeria. This study examines the causes, effects, and implications of erosion in Kaltungo LGA. The area, with a total land area of 881 km² and a projected population of 268,600 as of 2022, experiences two distinct seasons and an estimated annual rainfall of 1000 mm, which contributes to both water and gully erosion. The study adopts both primary and secondary data. Data were collected through field observation, questionnaire administration, and review of relevant literature and government reports. Findings reveal that the major causes of erosion in Kaltungo LGA include heavy rainfall, poor drainage systems, deforestation, poor agricultural practices, and uncontrolled construction activities. The effects of erosion in the study area are both environmental and socio-economic. Environmentally, erosion leads to loss of fertile topsoil, formation of gullies, destruction of vegetation, and siltation of water bodies. Socio-economically, it results in loss of farmlands, destruction of houses and roads, displacement of communities, reduction in agricultural productivity, and increased poverty among residents. Key infrastructure such as roads linking Kaltungo town to other wards including Awak, Tula Baule, Tula Wange and others villages have also been threatened. Details field work was carried out to collect all the necessary data to be use for this study, which will involve the collection of the following primary data such as the geographic location of eroded areas within the study area. A total number of one hundred and fifty (150) questionnaires was distributed proportionally and randomly based on the population size of the various sampled communities. Landsat images was classified using the supervised image classification technique. A supervised classification method was carried out using training samples. This process enables us to assign each pixel of an image to a particular land cover group or class. Maximum Likelihood Algorithm was employed to detect the land cover types using ArcGIS 10.8 software, map analysis and production was also carried out in AcrGIS 10.8 software and statistical analysis were carried out in Microsoft 2013 version. The study concludes that if erosion is not properly managed, it will continue to undermine agriculture, infrastructure, and livelihoods in Kaltungo LGA. It recommends afforestation, construction of drainage channels, public enlightenment, terracing, and government intervention through erosion control projects as sustainable measures to mitigate the problem.

Keywords: Erosion, Gully Erosion, Environmental Degradation, Kaltungo LGA, Gombe State, Sustainable Development.

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I. INTRODUCTION

Soil erosion is a major environmental hazard affecting many parts of Nigeria, particularly in areas with undulating topography, high rainfall intensity, and poor land management practices. Kaltungo Local Government Area is located in the southern part of Gombe State, within the Guinea Savanna ecological zone. The LGA is characterized by hilly terrain, seasonal rainfall, and soils that are highly susceptible to erosion.

Soil erosion is a serious environmental problem in Kaltungo Local Government Area of Gombe State. The area experiences significant rainfall, and its hilly and sloping terrain can increase surface runoff. Erosion is also worsened by human activities such as deforestation, overgrazing, and poor land-use practices. Research specifically on Kaltungo identifies several major effects of erosion in the area.

The major effects of erosion in Kaltungo Local Government Area (LGA), Gombe State, Nigeria are environmental, economic, and social. Due to seasonal heavy rainfall, sloping terrain, sparse vegetation, and poor land management, both sheet and gully erosion are common in the area.

The human activities are seriously disturbing the land surface of the earth and thereby induce the significant alteration of natural erosion rates. Soil erosion by water has been recognized as the most severe hazard threatening the protection of soil as it reduces soil productivity by removing the most fertile top soil (Vrieling, 2008).

Over the years, Kaltungo has experienced increasing cases of gully, rill, and sheet erosion. Human activities such as deforestation, bush burning, overgrazing, poor farming techniques, and uncontrolled construction have accelerated the process. During the rainy season, heavy runoff cuts deep gullies through farmlands, roads, and residential areas, destroying livelihoods and infrastructure.

Despite government and community efforts, erosion continues to expand in towns like Kaltungo, Tula Wange, and Awak. This has raised concerns about food security, environmental sustainability, and the well-being of residents who depend largely on agriculture.

Soil erosion is one of the most pressing environmental challenges facing Kaltungo Local Government Area in southern Gombe State, Nigeria. Located in the Guinea Savanna zone and bordered by hills and seasonal streams, Kaltungo experiences both sheet, rill, and gully erosion, especially during the rainy season from May to October. The combination of intense rainfall, fragile soil types, deforestation, and poor land-use practices has made erosion a recurring problem across many communities in the LGA,

including Kaltungo town, Tula, Lakweme, Popandi, and Awak axis.

The effects of erosion in Kaltungo LGA are both environmental and socio-economic. Environmentally, gully erosion has led to massive loss of fertile topsoil, reduced agricultural productivity, and degradation of farmlands that many households depend on for millet, maize, groundnuts, and beans. It has also resulted in the destruction of natural vegetation, increased siltation of streams and rivers, and loss of biodiversity.

On the human side, erosion has damaged roads, bridges, houses, and public infrastructure, cutting off villages and limiting access to markets, schools, and health facilities. Many families have been displaced as gullies expand into residential areas, leading to loss of property and increased vulnerability. Economically, the cost of rehabilitation and the decline in farm yields have worsened poverty levels and food insecurity in the area.

Beyond physical damage, erosion in Kaltungo also contributes to social problems such as communal disputes over land, migration of youths to urban centers, and increased burden on women who must walk longer distances to fetch water and firewood as nearby sources are degraded.

Addressing erosion in Kaltungo LGA therefore requires urgent attention through soil conservation measures, afforestation, proper drainage, and community sensitization. Understanding the specific effects in the area is the first step toward designing sustainable solutions that will protect livelihoods, infrastructure, and the environment.

➤ Statement of the Problem

Erosion in Kaltungo LGA has become more severe in the last decade. Gully sites have cut off access roads, washed away hectares of farmland, and forced the relocation of households. The loss of fertile topsoil has led to declining crop yields, while siltation of streams and rivers has affected water quality and availability.

In addition, the destruction of roads and bridges increases transportation costs and isolates rural communities from markets and social services. Many youths are also migrating out of affected villages due to loss of farmland and economic opportunities.

Although studies have been done on erosion in Gombe State generally, there is limited documentation focusing specifically on the extent and effects of erosion in Kaltungo LGA. This gap makes it difficult to plan targeted interventions. It is against this background that this study seeks to assess the effects of erosion in Kaltungo LGA.

➤ *Aim of the Study*

To examine the effects of erosion on the environment and socio-economic activities in Kaltungo Local Government Area of Gombe State.

➤ *Objectives of the Study*

The specific objectives are to:

- Identify the major types and causes of erosion in Kaltungo LGA
- Assess the environmental effects of erosion on soil, vegetation, and water bodies
- Examine the socio-economic effects of erosion on agriculture, infrastructure, and livelihoods
- Evaluate existing control measures and suggest sustainable strategies for erosion management in the area

➤ *Significance of the Study*

This study will be useful to government and policymakers for planning erosion control projects and disaster risk management in Kaltungo, the farmers and communities to adopt better land-use and soil conservation practices, also the researchers and students as reference material for further studies on erosion in Gombe State and NGOs and development agencies working on environmental sustainability in northern Nigeria.

➤ *Scope of the Study*

This study focuses specifically on the effects of erosion in Kaltungo Local Government Area of Gombe State, Nigeria. The study covers selected communities that are most affected by erosion such as Kaltungo town, Tula, Ture, and Awak.

It examines the environmental impacts on soil, vegetation and water resources, as well as the socio-economic impacts on agriculture, infrastructure, housing and livelihoods. The study also reviews existing erosion control measures within the LGA. Data for the study will be obtained through field observation, questionnaires, interviews, and review of relevant literature.

II. LITERATURE REVIEW

➤ *Conceptual Framework*

Erosion is the process of detachment, transportation, and deposition of soil particles by agents such as water, wind, and gravity. Water erosion is the dominant type in Nigeria, especially in areas with high rainfall intensity and sloping terrain like Kaltungo LGA.

This includes sheet erosion, rill erosion, and gully erosion. Gully erosion is the most destructive in Kaltungo because it destroys farmlands, roads, and houses and is difficult to reclaim.

➤ *Causes of Erosion*

Several studies have identified both natural and anthropogenic causes of erosion:

- **Natural Factors:** High rainfall intensity, fragile soil structure, steep slopes, and poor vegetation cover in the Guinea Savanna zone.
- **Human Factors:** Deforestation for fuel wood, bush burning, overgrazing, poor farming practices, improper drainage construction, and unplanned settlement expansion.

In Kaltungo, the combination of hilly topography and seasonal heavy rains makes the area highly vulnerable once vegetation is removed.

➤ *Effects of Erosion*

Literature shows that erosion has multi-dimensional effects:

• *Environmental Effects*

- ✓ **Loss of Topsoil and Soil Fertility:** Removal of the nutrient-rich topsoil reduces agricultural productivity. When the topsoil is washed away, important nutrients and organic matter are lost. This leads to poor soil fertility and reduced crop yields.
- ✓ **Land Degradation:** Formation of gullies renders large areas of land unusable, continuous removal of soil causes the land to lose its productive capacity. Over time, vegetation may decline and the land may become increasingly degraded and vulnerable to desertification.
- ✓ **Siltation of Water Bodies:** Sediments wash into streams and rivers, reducing water quality and causing flooding downstream. Erosion creates channels and gullies that can increase the speed and concentration of runoff during heavy rainfall. This can worsen flooding and cause additional damage to farmland, homes, and roads.

• *Socio-Economic Effects*

The destruction of farmland, houses, roads, and properties can increase household expenses, reduce farmers' income, and negatively affect food security and livelihoods. The wider Gombe State evidence also links severe erosion, particularly around Kaltungo and other southern areas, with reduced agricultural productivity and food-security challenges.

- ✓ **Agricultural Losses:** When the topsoil is washed away, important nutrients and organic matter are lost. This leads to poor soil fertility and reduced crop yields. Decline in crop yield for millet, maize, groundnut, and beans which are staple crops in Kaltungo. Erosion can wash away crops, expose their roots, bury farmland with sediment, and reduce the amount of land available for agricultural production.
- ✓ **Damage to Infrastructure:** Erosion can cut across roads, weaken road foundations, and create gullies that make transportation difficult. It can also threaten other public infrastructure. Roads, culverts, and buildings are destroyed, increasing cost of maintenance and isolating communities.
- ✓ **Displacement and Poverty:** Households lose homes and farmland, leading to migration and increased poverty.

- ✓ Health and Safety Risks: Open gullies become breeding grounds for mosquitoes and pose danger to children and livestock. Soil and other materials carried by runoff can enter streams and other water sources. This increases sedimentation and may reduce the quality of water available to communities and causes harm to the environment.

➤ *Erosion in Gombe State and Kaltungo LGA*

Studies on erosion in northeastern Nigeria indicate that Gombe State is one of the moderately affected states. Southern Gombe, including Kaltungo and Billiri LGAs, experiences more severe gully erosion due to higher rainfall and undulating terrain compared to northern Gombe.

In Kaltungo, reports from community members and field observations show that gullies have expanded in the last 10 years, affecting access roads to Tula and Awak, and reducing farm sizes. However, there is limited published academic data specifically quantifying the impact in Kaltungo LGA, which creates a gap this study intends to fill.

➤ *Erosion Control Measures*

Scholars and agencies recommend both structural and non-structural measures:

- Structural: Construction of drainage channels, check dams, terracing, and stone pitching in gully heads.
- Vegetative: Afforestation, agroforestry, grass planting, and cover cropping to bind the soil.
- Agronomic: Contour plowing, crop rotation, and reduced tillage.
- Policy and Education: Community sensitization, enforcement of environmental laws, and proper town planning.

The effectiveness of these measures depends on community participation and government support.

➤ *Gap in Literature*

While general studies exist on erosion in Nigeria and Gombe State, there is a paucity of localized data on the specific extent, causes, and socio-economic effects of erosion in Kaltungo LGA. This study therefore seeks to bridge that gap by providing current field-based information.

III. METHODOLOGY

➤ *Research Design*

This study adopted a descriptive survey research design. The design is considered appropriate because it allows the researcher to collect both quantitative and qualitative data on the effects of erosion as perceived by residents, farmers, and relevant stakeholders in Kaltungo LGA. Both primary and secondary data sources were used. Details field work was carried out to collect all the necessary data to be use for this study, which will involve the collection of the following primary data such as the geographic location of eroded areas within the study area. A total number of one hundred and fifty (150) questionnaires was distributed proportionally and randomly based on the population size of the various sampled communities. Landsat images was classified using the supervised image classification technique. A supervised classification method was carried out using training samples. This process enables us to assign each pixel of an image to a particular land cover group or class. Maximum Likelihood Algorithm was employed to detect the land cover types using ArcGIS 10.8 software, map analysis and production was also carried out in AcrGIS 10.8 software and statistical analysis were carried out in Microsoft 2013 version.

➤ *Study Area*

The study was carried out in Kaltungo Local Government Area of Gombe State, Nigeria. Kaltungo LGA is located in the southern part of Gombe State within the Guinea Savanna ecological zone. It lies between latitude 9° 48' N to 10° 5' N and longitude 11° 15' E to 11° 35' E. The LGA has an estimated population of about 268,600 people in 2022 Projection with 3.3% annual growth rate from 2006 – 2022 with the total area of 881 km² and is characterized by hilly terrain, seasonal rainfall, and soils prone to erosion. Major towns include Kaltungo, Tula, and Awak. Agriculture is the dominant occupation.

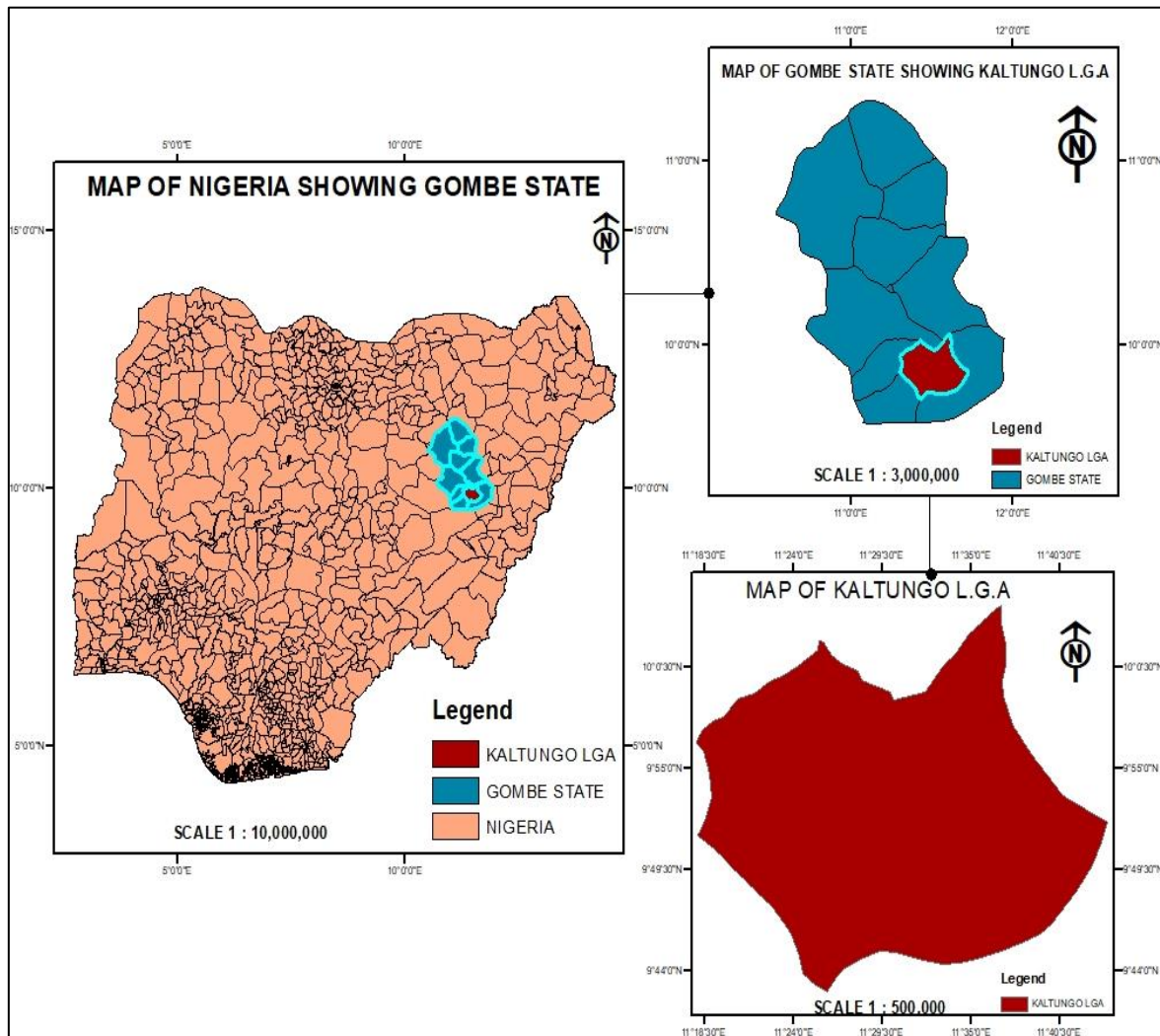


Fig 1 The Map of Nigeria Showing Gombe State, Showing the Study Area sKaltungo L.G.A
Source: NASRDA

➤ Population of the Study

The population of the study comprised residents of selected erosion-affected communities in Kaltungo LGA. This includes farmers, household heads, community leaders, and officials of relevant government agencies such as the Ministry of Environment and LGA Works Department.

➤ Sample Size and Sampling Technique

A sample size of 150 respondents was used for the study.

- Sampling Technique: A combination of purposive sampling and simple random sampling was used.
- Purposive sampling was used to select communities most affected by erosion: Kaltungo town, Tula, and Awak.

Simple random sampling was then used to select respondents within each community to ensure equal representation.

➤ Sources of Data

Two sources of data were used:

- Primary Data: Obtained through administration of questionnaires, oral interviews, and field observation of gully sites and damaged infrastructure.
- Secondary Data: Obtained from textbooks, journals, government reports, Gombe State Ministry of Environment records, and internet sources.

Table 1 Data Description

Data	Source	Resolution	Date
LandSat 8 imagery	https://earthexplorer.usgs.gov/	30 m	2026
Landcover reference data	Field work	-	June 2026
Questionnaires	Kaltungo LGA Occupants which comprised of farmers, Civil servants, Traders and others	-	June 2026
Population	National Population Commission Gombe branch, Gombe state Nigeria	-	2006

➤ Research Instrument

The main instrument for data collection was a structured questionnaire titled "Effects of Erosion Questionnaire - EEQ".

The questionnaire was divided into 3 sections:

- Section A: Demographic information
- Section B: Causes and types of erosion
- Section C: Environmental and socio-economic effects of erosion

The instrument was validated by the project supervisor and tested for reliability.

➤ Method of Data Collection

Copies of the questionnaire were administered directly to respondents in the selected communities with the help of

research assistants. Interviews were also conducted with community leaders and environmental officers. Field observation was carried out to take photographs and measure the extent of gully sites. The GPS was used to obtain the coordinates of the degraded areas.

➤ Method of Data Analysis

Data collected were analyzed using descriptive statistics such as frequency tables, percentages, and charts. Responses on causes and effects were analyzed using mean and standard deviation on a 4-point Likert scale.

Qualitative data from interviews and observations were analyzed thematically.

➤ Ethical Consideration

Respondents' participation was voluntary. Their identities were kept confidential and data collected were used strictly for academic purposes.



Plate 1 Researchers on Field Work at Kaltungo Eroded Site



Plate 2 Photos of Eroded Areas

IV. DATA PRESENTATION, ANALYSIS AND DISCUSSIONS

➤ Introduction

This chapter presents the data collected from the field through questionnaires, interviews, and observations in Kaltungo, Tula, and Awak communities. A total of 150 questionnaires were distributed and were retrieved. The data

were analyzed using frequency, percentages, mean, and standard deviation.

➤ Demographic Characteristics of Respondents

• Demographic Characteristics by Sex

Table 2 Demographic Characteristics by Sex

Variable	Frequency	Percentage %
Sex		
Male	88	62.0
Female	54	38.0

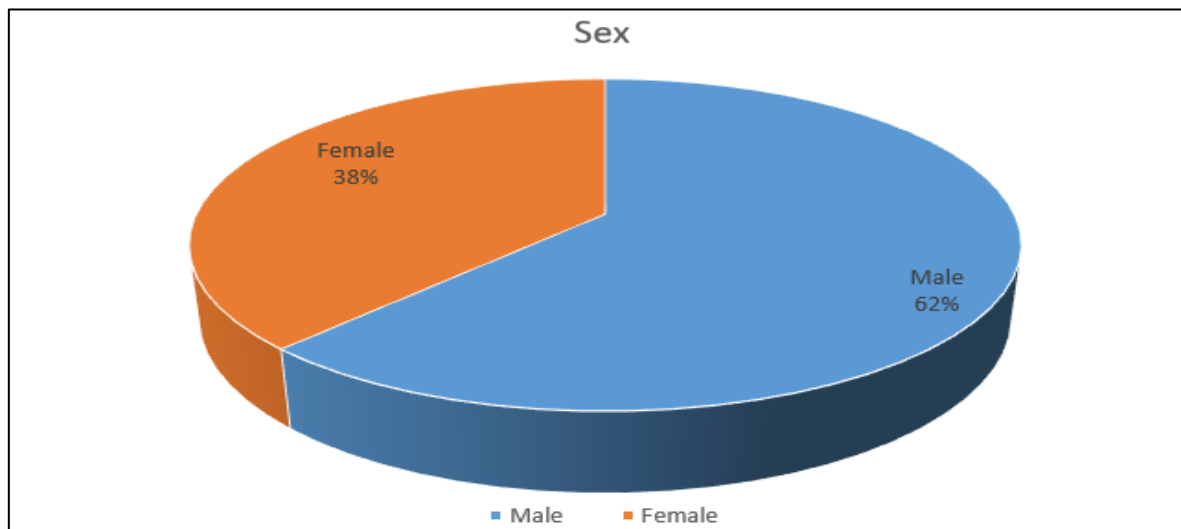


Fig 2 The Pie Chart Showing Demographic Characteristics by Sex

• Demographic Characteristics by Age

Table 3 Demographic Characteristics by Age

Variable	Frequency	Percentage %
Age		
18-30 years	40	28.2
31-45 years	62	43.7
46 years & above	40	28.2

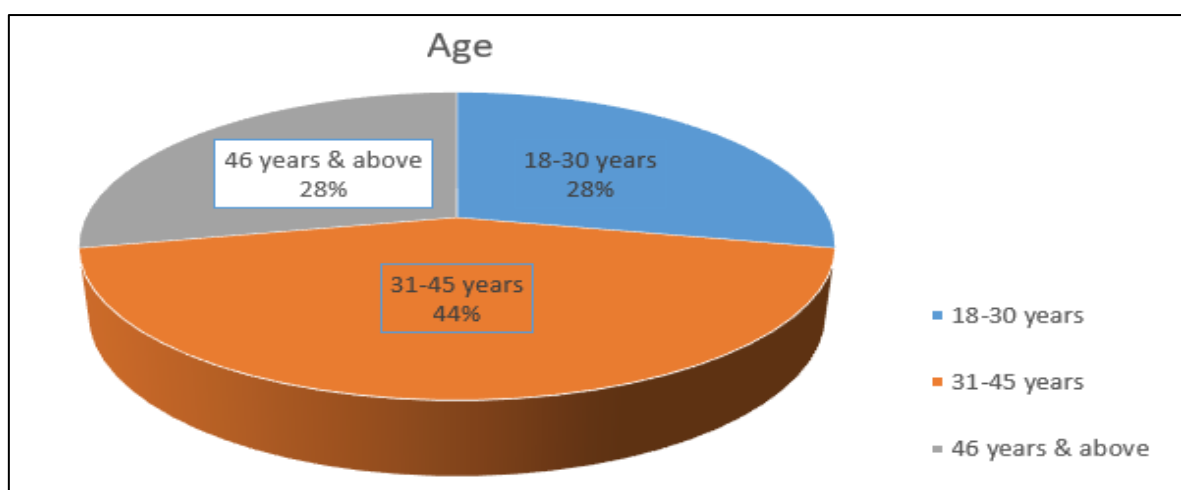


Fig 3 The Pie Chart Showing Demographic Characteristics by Age

- Demographic Characteristics by Occupation

Table 4 Demographic Characteristics by Occupation

Variable	Frequency	Percentage %
Occupation		
Farmers	79	55.6
Traders	28	19.7
Civil Servants	18	12.7
Others	17	12.0

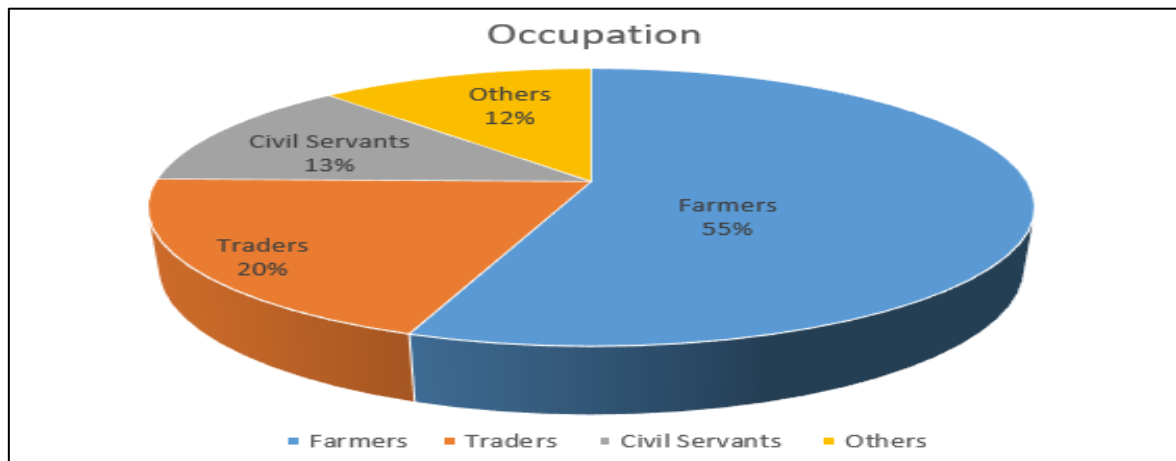


Fig 4 The Pie Chart showing Demographic Characteristics by Occupation

✓ Interpretation: Majority of respondents were male farmers aged 31-45 years. This shows that those most affected by erosion are active farmers who depend on the land.

➤ Analysis of Research Questions

- The Major Causes of Erosion in Kaltungo LGAS
Respondents rated causes on a 4-point scale: SA=4, A=3, D=2, SD=1. Decision mean = 2.50

Table 5 Causes of Erosion

S/N	Causes	Mean	Decision
1	Heavy rainfall	3.42	Agreed
2	Deforestation	3.28	Agreed
3	Poor drainage system	3.15	Agreed
4	Bush burning and overgrazing	2.98	Agreed
5	Poor farming practices	2.87	Agreed

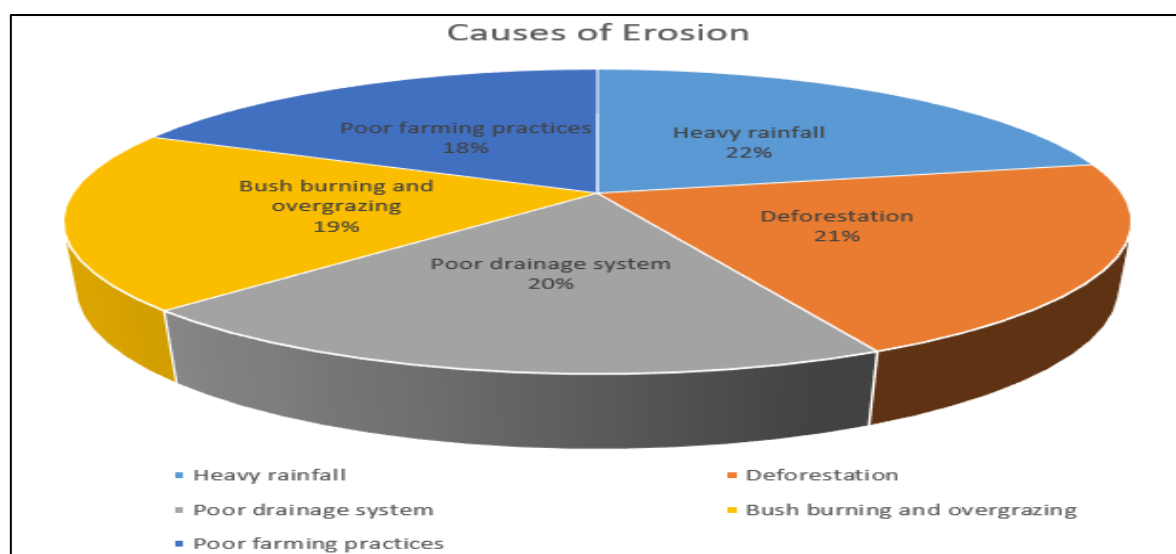


Fig 5 The Pie Chart showing the Causes of Erosion in Kaltungo L.G.A

All items had mean above 2.50. This agrees with Igwe (2012) that both natural and human activities contribute to erosion in Guinea Savanna areas.

➤ *What are the Environmental Effects of Erosions*

Table 6 Environmental Effects

S/N	Effects	Mean	Decision
1	Loss of fertile topsoil	3.51	Agreed
2	Formation of gullies	3.44	Agreed
3	Destruction of vegetation	3.30	Agreed
4	Siltation of streams/rivers	3.12	Agreed

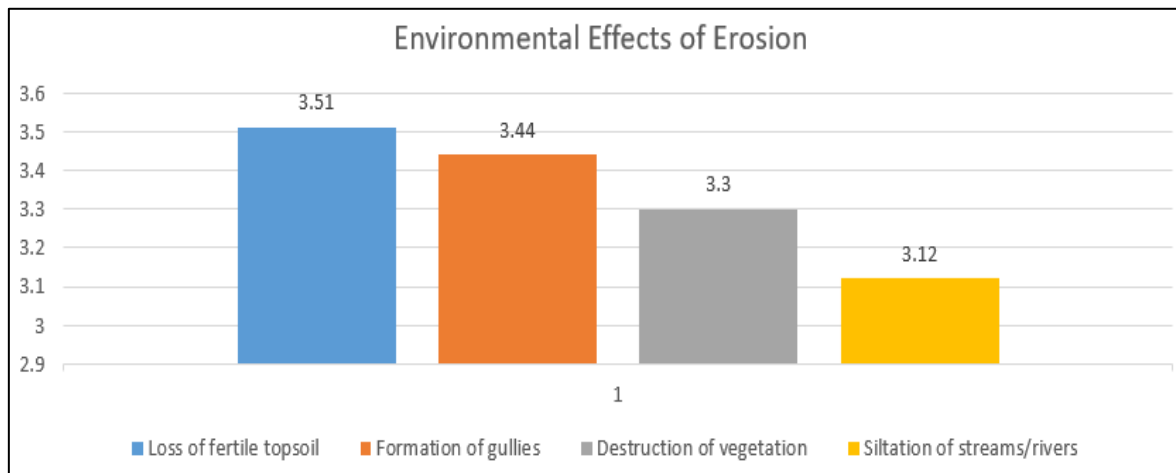


Fig 6 The Bar Chart Showing Environmental Effects of Erosion in Kaltungo L.G.A

The findings show erosion has severely degraded the environment in Kaltungo, leading to loss of soil fertility and land. This supports Akpata & Oche (2018).

➤ *The Socio-Economic Effects of Erosion*

Table 7 Socio-Economic Effects

S/N	Effects	Mean	Decision
1	Reduction in agricultural yield	3.48	Agreed
2	Damage to roads and bridges	3.39	Agreed
3	Displacement of households	3.21	Agreed
4	Increase in poverty level	3.18	Agreed
5	Migration of youths	2.96	Agreed

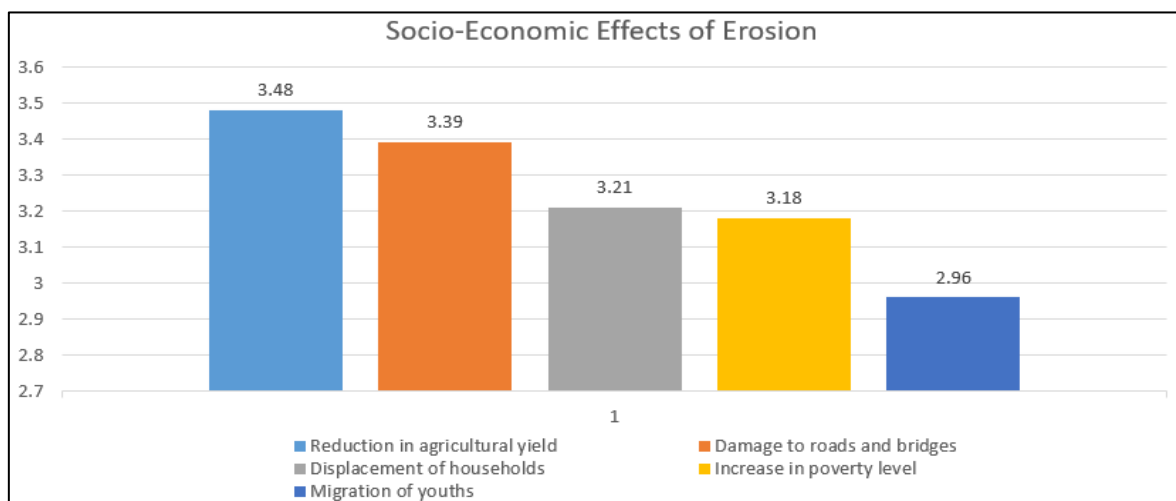


Fig 7 The Bar Chart Showing Socio-Economic Effects of Erosion in Kaltungo L.G.A

Respondents agreed that erosion has negatively affected farming, infrastructure, and livelihoods. Many farmers reported smaller farm sizes and higher transport costs due to bad roads.

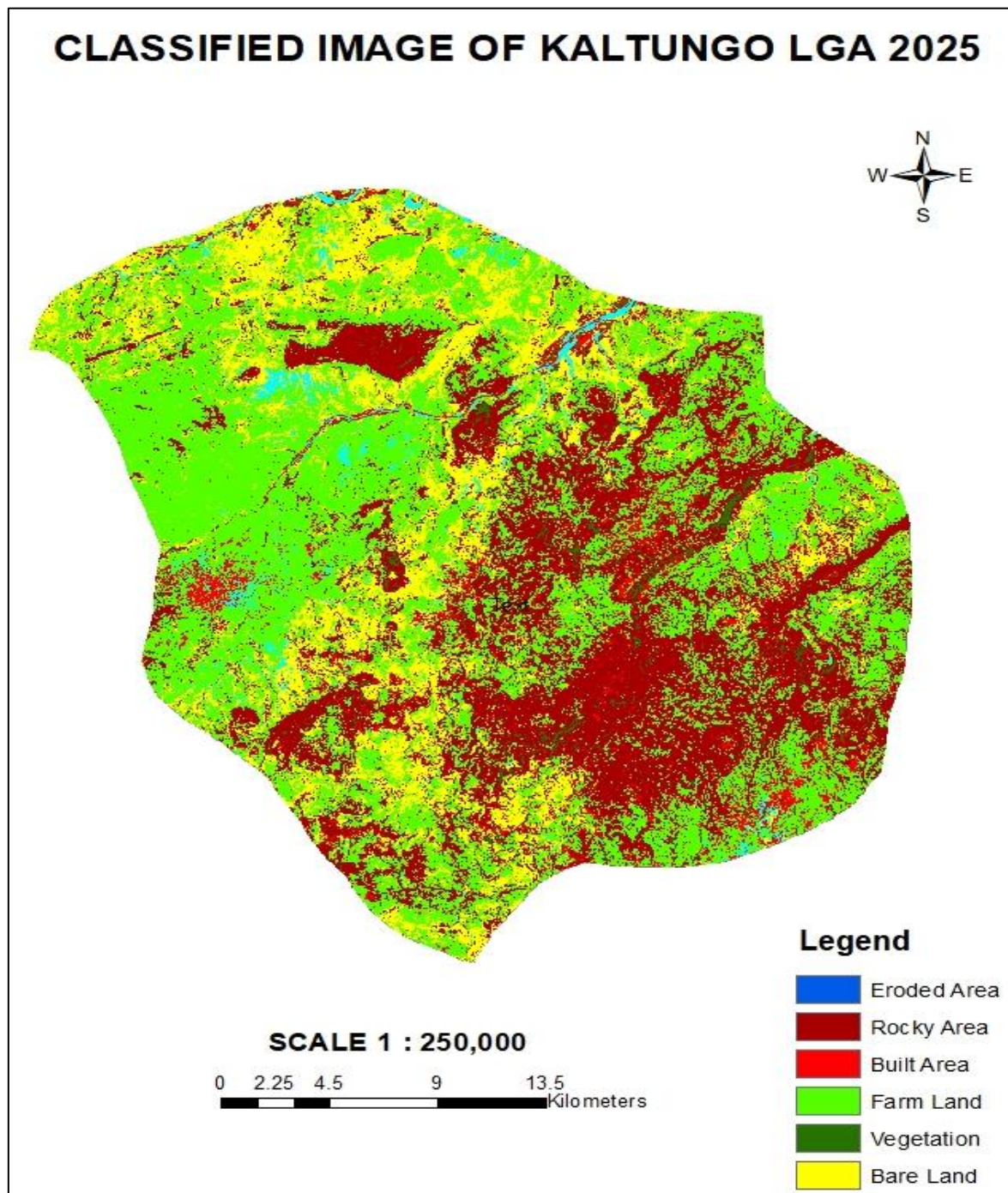


Fig 8 The Land use, Land Cover of Kaltungo L.G.A

Table 8 The Land use, Land Cover Analysis of Kaltungo L.G.A

Object ID	Class Name	Value	Count	Area M ²	Percentages
1	Eroded	1	21244	19119600	2.2
2	Rocky Area	2	274581	247122900	28.1
3	Built up Area	3	62868	56581200	6.4
4	Farm Land	4	434303	390872700	44.4
5	Vegetation	5	12028	10825200	1.2
6	Bare Land	6	173264	155937600	17.7
TOTAL AREA				880459200	100

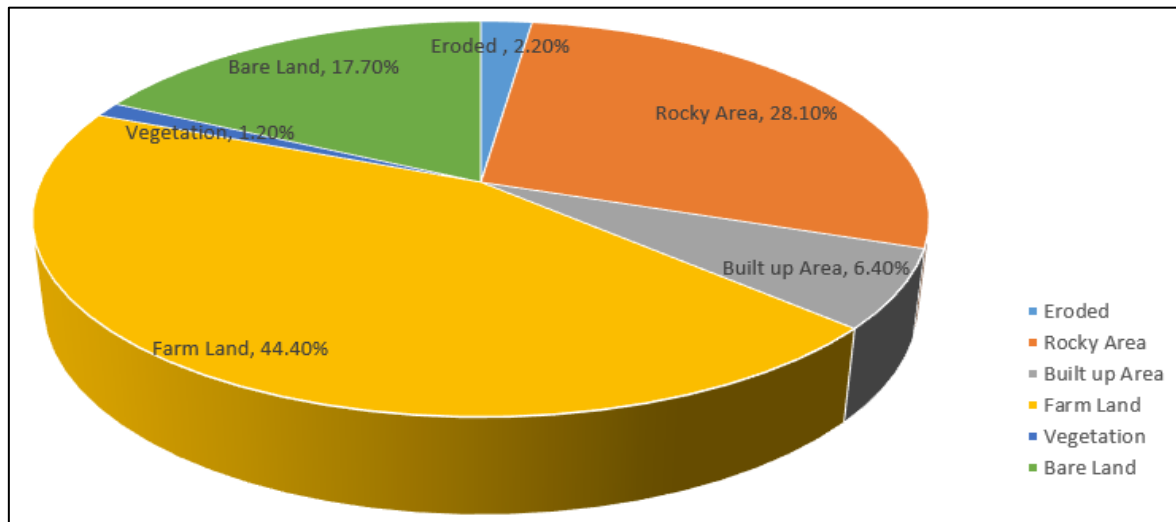


Fig 9 The Land use, Land Cover of Kaltungo L.G.A

➤ Discussion of Findings

The analysis revealed that the major causes of erosion in Kaltungo LGA are heavy rainfall, deforestation, and poor drainage system. There is massive loss of topsoil, gully formation, and degradation of vegetation and water bodies. Agriculture, roads, housing, and income have been seriously affected. Poverty and rural-urban migration are increasing.

These findings align with previous studies on erosion in northeastern Nigeria. However, the severity in Kaltungo is worsened by the hilly terrain and poor implementation of control measures.

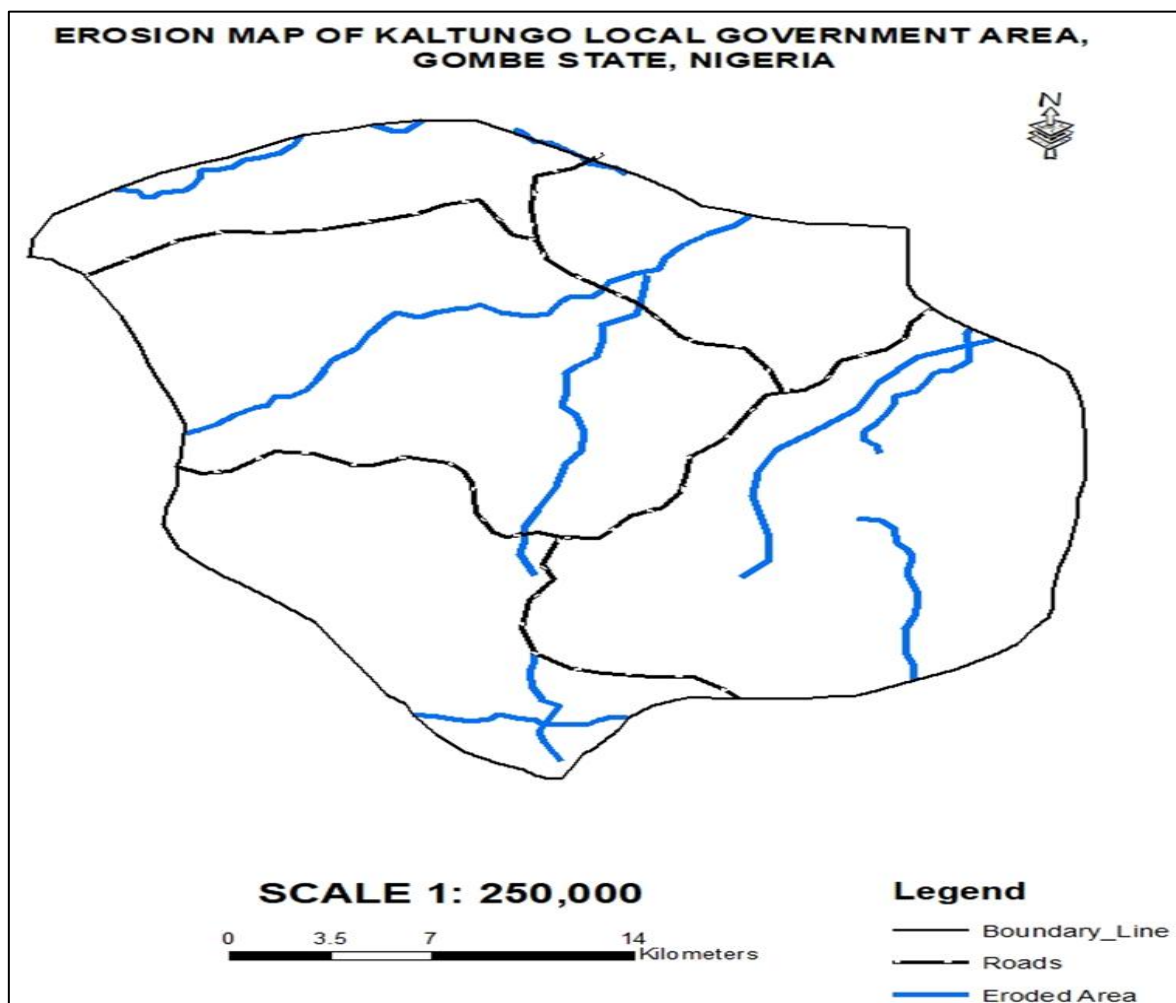


Fig 10 The Erosion Map of Kaltungo L.G.A

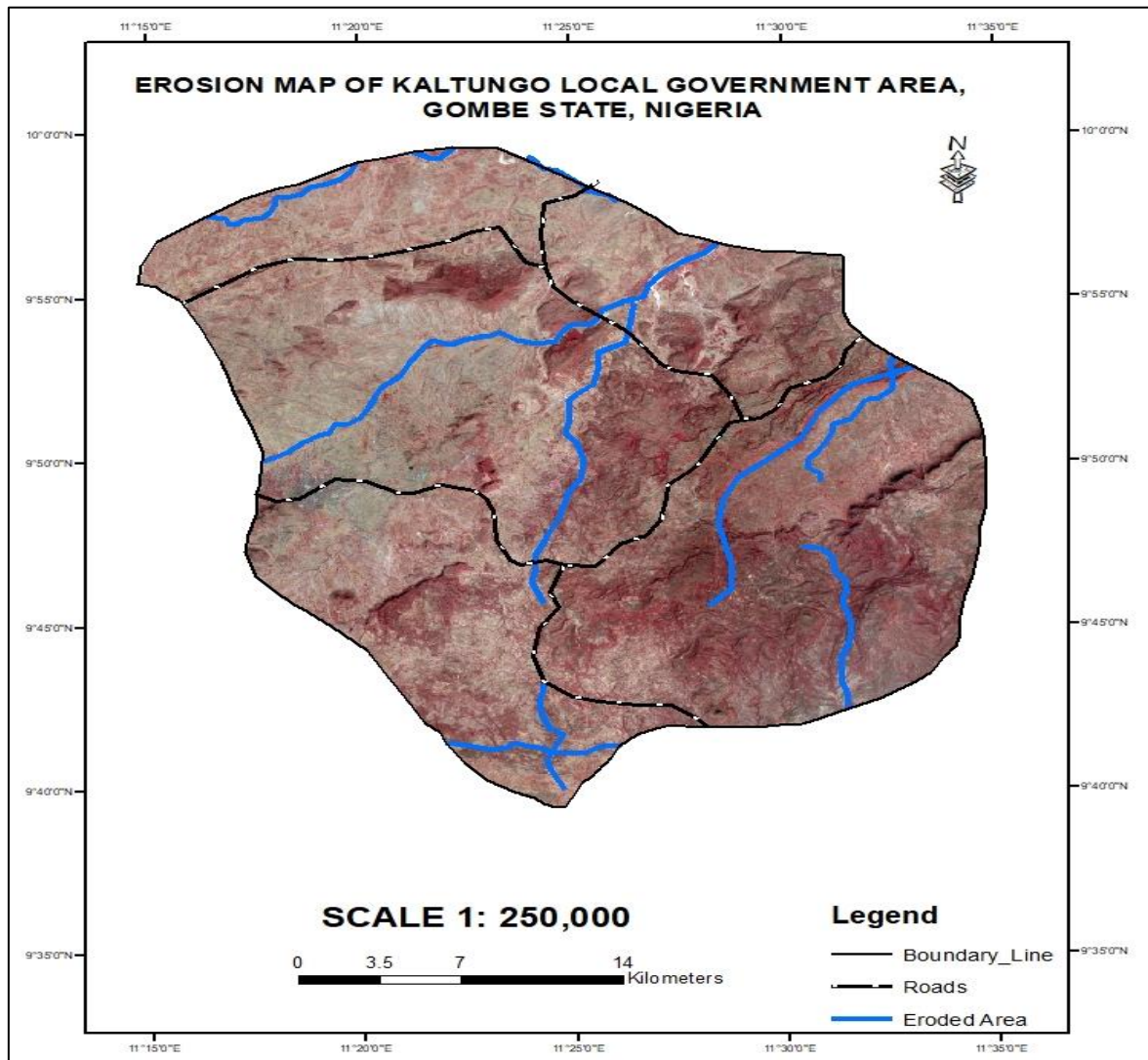


Fig 11 The Erosion Map Superimposed on the Satellite Image of Kaltungo L.G.A

V. SUMMARY OF FINDINGS

This study examined the effects of erosion in Kaltungo Local Government Area of Gombe State, Nigeria. Data were collected from 150 respondents in Kaltungo town, Tula, and Awak using questionnaires, interviews, and field observation. The major causes of erosion in Kaltungo LGA are heavy rainfall, deforestation, poor drainage systems, bush burning, overgrazing, and poor farming practices. Erosion has led to loss of fertile topsoil, formation of deep gullies, destruction of vegetation, and siltation of streams and rivers. The effects include reduction in agricultural yield, damage to roads and bridges, displacement of households, increase in poverty, and migration of youths from affected communities. Existing control measures such as tree planting and drainage construction are inadequate and poorly maintained.

VI. CONCLUSION

In conclusion, erosion in Kaltungo LGA has serious environmental, agricultural, economic, and social effects. Its major impacts include the depletion of farmland, loss of soil nutrients, destruction of houses and roads, devaluation of

properties, water pollution, flooding, and reduced agricultural productivity. Effective control measures such as afforestation, construction of proper drainage systems, controlled grazing, vegetation cover, and improved farming practices are necessary to reduce the problem.

Based on the findings, it is concluded that erosion is a serious environmental and socio-economic problem in Kaltungo LGA. It threatens food security, destroys infrastructure, displaces people, and degrades the environment. If urgent and sustainable measures are not taken, the problem will continue to worsen and affect the livelihoods of the people and future development of the area.

Erosion in Kaltungo LGA has serious consequences for agriculture, infrastructure, water resources, and livelihoods. If left uncontrolled, it will continue to reduce agricultural productivity, threaten food security, damage public infrastructure, and hinder sustainable development. Effective control measures include afforestation, proper drainage systems, contour farming, terracing, controlled grazing, and community-based soil conservation practices.

VII. RECOMMENDATIONS

➤ *Based on the Findings, the Following Recommendations are made:*

- Government Intervention: The Gombe State Government and Kaltungo LGA should construct proper drainage channels, culverts, and embankments in erosion-prone areas.
- Afforestation and Vegetative Cover: Massive tree planting and grassing of gully heads should be encouraged to bind the soil and reduce runoff.
- Public Enlightenment: Community sensitization programs should be organized to educate people on the dangers of bush burning, deforestation, and poor farming practices.
- Adoption of Soil Conservation Techniques: Farmers should be trained on contour plowing, crop rotation, cover cropping, and agroforestry.
- Collaboration with NGOs and Agencies: Government should partner with NEWMAP, NGOs, and international agencies to fund erosion control projects in Kaltungo.

VIII. SUGGESTIONS FOR FURTHER STUDY

➤ *The Following Areas are Suggested for Further Research:*

- A comparative study of erosion effects in Kaltungo LGA and neighboring Billiri LGA.
- Assessment of the effectiveness of government erosion control policies in Gombe State.
- The use of remote sensing and GIS in mapping and monitoring gully expansion in southern Gombe.

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