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# Assessing the Impact of Soil Erosion on Rural Livelihoods and Food Security in Support of the Sustainable Development Goals (SDGs)

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## ABSTRACT

Soil erosion represents a major challenge to agricultural sustainability, rural livelihoods, and food security in many developing regions, particularly in climate-fragile areas of Nigeria. This study assesses the impact of soil erosion on rural livelihoods and food security in Nigeria's North-East region in the context of supporting the Sustainable Development Goals (SDGs). A mixed-methods approach was employed, integrating household surveys, key informant interviews, and geospatial analysis using remote sensing and GIS techniques. The results indicate widespread soil degradation across agricultural landscapes, leading to declining soil fertility, reduced crop yields, income losses, and increased household food insecurity. Communities lacking effective erosion control measures were found to be more vulnerable to livelihood shocks and food access constraints. The findings highlight soil erosion as a critical driver of rural vulnerability and a significant barrier to achieving SDG targets related to zero hunger, climate action, and sustainable land management. The study underscores the importance of integrated soil conservation strategies, sustainable land management practices, and policy support to enhance agricultural resilience and food security.



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## 1. INTRODUCTION

Soil erosion remains one of the most severe forms of land degradation affecting agricultural productivity, rural livelihoods, and food security across many developing regions of the world. It involves the detachment and transportation of topsoil by water, wind, and human activities, resulting in the loss of fertile soil layers that are essential for sustainable crop production. In agrarian economies where livelihoods depend heavily on land-based activities, soil erosion poses a direct threat to income generation, food availability, and long-term rural development (Lal, 2003; Adger, 2006).

In Nigeria, soil erosion has emerged as a persistent environmental and socio-economic challenge, particularly in rural areas where rain-fed agriculture dominates. The impacts of erosion are especially pronounced in the North-East region, which is characterized by fragile soils, climatic variability, and increasing pressure on land resources. Intense seasonal rainfall, undulating terrain, deforestation, overgrazing, and unsustainable farming practices have accelerated erosion processes, including sheet, rill, and gully erosion, leading to widespread land degradation and declining agricultural productivity (Igwe, 2013; Adeoye *et al*., 2016). As fertile topsoil is removed, the soil's capacity to retain moisture and nutrients is reduced, resulting in lower crop yields and increased vulnerability of farming systems to climatic shocks.

The relationship between soil erosion and rural livelihoods is complex and multifaceted. Rural households in North-East Nigeria depend largely on smallholder agriculture, livestock rearing, and natural resource-based activities for food and income. Soil erosion reduces the availability of cultivable land, increases production costs, and often forces farmers to cultivate marginal or erosion-prone areas, thereby reinforcing cycles of land degradation and poverty (Nwajiuba & Onyeneke, 2015; Ayuba *et al*., 2007). In many communities, erosion-induced farmland loss has also contributed to migration, livelihood diversification, and social vulnerability, particularly among women and youth who rely heavily on land-based livelihood strategies.

Food security is closely linked to soil quality and land productivity, especially in rural regions where agriculture serves as the primary source of food and income. Soil erosion undermines food security by reducing food availability, limiting household access to income, and destabilizing local food systems. In erosion-prone areas, households often experience seasonal food shortages, reduced dietary diversity, and increased dependence on external food sources (Yahaya *et al*., 2018). These challenges are further intensified in conflict-affected parts of North-East Nigeria, where displacement and insecurity compound the effects of land degradation on agricultural livelihoods and food access.

Despite growing recognition of soil erosion as a critical environmental problem in Nigeria, many existing studies have focused primarily on its physical dimensions, such as erosion rates, spatial distribution, and geomorphological impacts. Fewer studies have examined the direct socio-economic implications of soil erosion for rural livelihoods and food security at the local level, particularly within the context of climate variability and development challenges in the North-East region (Nnaji *et al*., 2011; Olorunfemi & Raheem, 2015). As a result, there remains a need for empirical, region-specific assessments that integrate biophysical analysis with socio-economic perspectives.

In this context, assessing the impact of soil erosion on rural livelihoods and food security is essential for informing sustainable land management and development planning. Such assessments are particularly relevant to Nigeria's efforts to achieve the Sustainable Development Goals (SDGs), including SDG 2 (Zero Hunger), SDG 13 (Climate Action), and SDG

15 (Life on Land). Therefore, this study aims to assess the impact of soil erosion on rural livelihoods and food security in Nigeria's North-East region, with emphasis on understanding erosion-driven land degradation, household vulnerability, and implications for sustainable agricultural development and SDGs implementation.

## 2. LITERATURE REVIEW

Soil erosion has long been recognized as a major driver of land degradation and a critical constraint to sustainable agricultural development, particularly in sub-Saharan Africa. The removal of fertile topsoil through water and wind erosion leads to declining soil quality, reduced crop productivity, and loss of ecosystem services essential for rural livelihoods. In agrarian economies where agriculture constitutes the backbone of household income and food supply, soil erosion represents both an environmental and a socio-economic challenge (Lal, 2003; Adger, 2006).

In Nigeria, soil erosion manifests in various forms, including sheet, rill, and gully erosion, with gully erosion being especially destructive in several regions. Previous studies have documented extensive land degradation resulting from erosion processes in both northern and southern parts of the country. Some reports (Igwe, 2013) highlighted the role of soil properties, rainfall intensity, and land misuse in accelerating gully erosion, while other papers (Adeoye *et al*., 2016) emphasized the combined influence of slope gradient, vegetation loss, and human activities in shaping erosion dynamics in North-East Nigeria. These findings underscore the vulnerability of fragile landscapes subjected to increasing anthropogenic pressure.

The relationship between soil erosion and agricultural productivity is well established in the literature. Soil erosion reduces soil organic matter, depletes essential nutrients, and alters soil structure, thereby limiting the land's capacity to support crop growth. Even small losses of topsoil can result in significant yield reductions under tropical conditions (Lal, 2003). In Nigeria, erosion-induced land degradation has contributed to declining crop yields and increased production costs, particularly among smallholder farmers who lack access to soil restoration inputs (Nwajiuba & Onyeneke, 2015).

Beyond its biophysical impacts, soil erosion has profound implications for rural livelihoods. Rural households depend heavily on land-based activities such as farming, livestock rearing, and agroforestry. When erosion reduces the availability and productivity of arable land, households experience income losses, food shortages, and heightened vulnerability to economic shocks. Erosion and climate variability in the Lake Chad region have disrupted traditional livelihood systems, forcing households to diversify income sources or migrate in search of alternative opportunities (Ayuba *et al*., 2007). Similarly, there are documented cases of farmland abandonment and displacement linked to severe erosion in parts of northeastern Nigeria (Nnaji *et al*., 2011).

Soil erosion also poses a significant threat to food security by undermining food availability, access, and stability. In rural areas, where food production and consumption are closely intertwined, declines in agricultural output directly translate into reduced household food access. Communities located in erosion-prone areas of Gombe State experienced higher levels of food insecurity due to reduced farm productivity and limited coping capacity (Yahaya *et al*., 2018). At the national and regional levels, food security assessments have increasingly recognized land degradation as a key factor constraining progress toward food security goals.

Despite extensive research on soil erosion in Nigeria, several knowledge gaps remain. Many studies have focused on mapping erosion-prone areas or estimating soil loss rates, with

limited attention to the socio-economic consequences for rural livelihoods and food security at the community level. Moreover, few studies explicitly link soil erosion impacts to broader development frameworks such as the Sustainable Development Goals (SDGs). Weak institutional frameworks and inadequate land management policies continue to hinder effective erosion control in Nigeria, highlighting the need for integrated approaches that connect environmental management with rural development objectives (Olorunfemi & Raheem, 2015).

In the context of the Sustainable Development Goals, soil erosion presents a major obstacle to achieving targets related to zero hunger, poverty reduction, climate resilience, and sustainable land use. Addressing soil erosion is therefore not only an environmental necessity but also a development imperative. There is a growing need for empirical, region-specific studies that integrate geospatial analysis with socio-economic assessment to better understand how soil erosion affects rural livelihoods and food security, particularly in climate-fragile regions such as Nigeria's North-East. This study responds to this gap by examining the spatial extent and livelihood impacts of soil erosion and situating its findings within the framework of sustainable agricultural development and SDGs implementation.

## 3. METHODS

This study was conducted in Nigeria's North-East geopolitical zone, covering selected rural communities in Adamawa, Borno, Gombe, and Yobe States. The region is characterized by fragile soils, climatic variability, and a high dependence on rain-fed agriculture, which collectively increase vulnerability to soil erosion and land degradation. The geographical location of the study area and the major erosion hotspot zones in North-East Nigeria are illustrated in **Figure 1**. Areas with known erosion hotspots and strong reliance on agricultural livelihoods were purposively selected to capture the environmental and socio-economic dimensions of soil erosion.

A mixed-methods research design was adopted to assess the impact of soil erosion on rural livelihoods and food security. Quantitative data were collected through structured household questionnaires administered to farming households across selected communities, while qualitative data were obtained through key informant interviews and focus group discussions involving community leaders, extension officers, and agricultural stakeholders. This approach enabled data triangulation and provided a comprehensive understanding of erosion impacts from both household and institutional perspectives.

Geospatial analysis was employed to assess the spatial extent and severity of soil erosion. Multi-temporal satellite imagery was processed using Geographic Information System (GIS) techniques to identify erosion-prone areas and land degradation patterns. Vegetation indices, slope characteristics, land cover information, and erosion modeling outputs were analyzed to support the identification of erosion hotspots and their relationship with agricultural land use.

Quantitative survey data were coded and analyzed using statistical software to generate descriptive statistics on household characteristics, livelihood dependence, and food security conditions. Inferential analyses were conducted to examine relationships between soil erosion exposure, agricultural productivity, income levels, and food security status. Qualitative data from interviews and focus group discussions were transcribed and analyzed thematically to capture local perceptions, coping strategies, and institutional responses to soil erosion.

Ethical considerations were observed throughout the study. Participation was voluntary, informed consent was obtained from all respondents, and confidentiality of information was ensured.

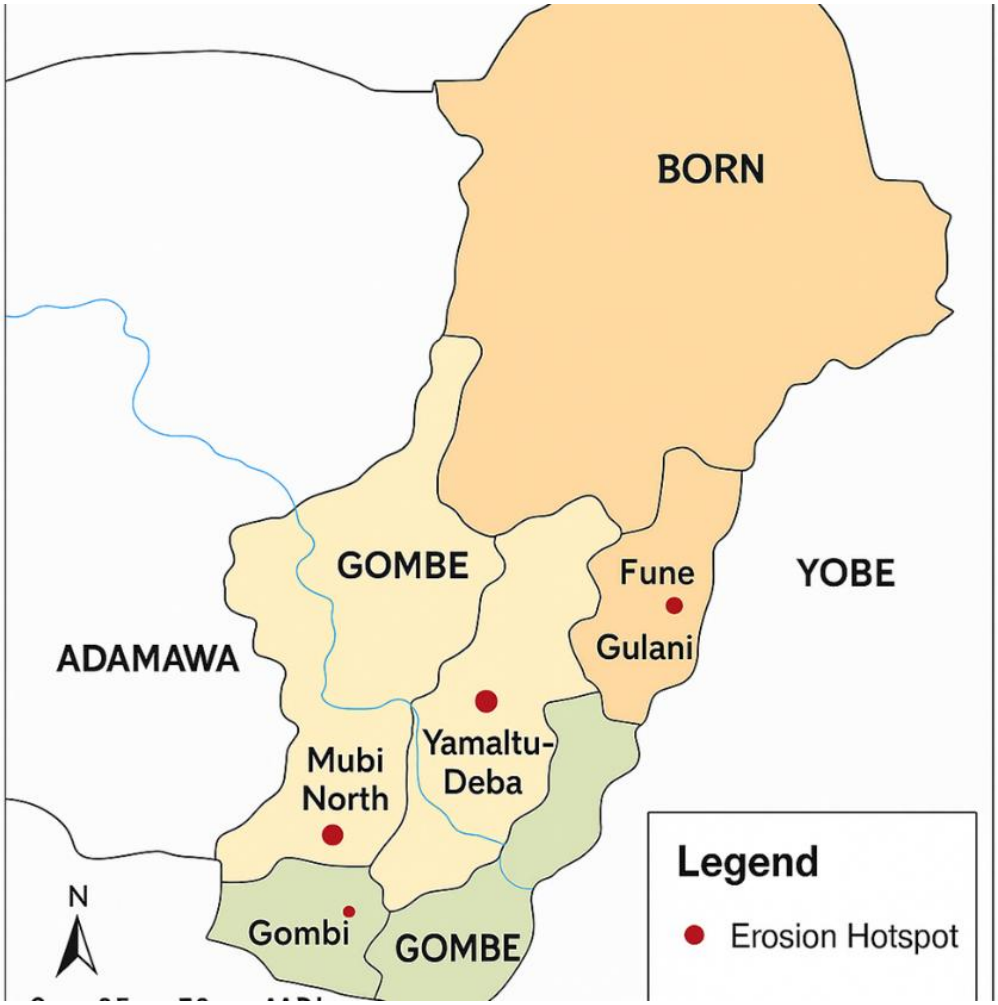


**Figure 1**. Map of North-Eastern Nigeria showing major erosion hotspot areas.

## 4. RESULTS AND DISCUSSION

The results of this study reveal that soil erosion constitutes a major environmental and socio-economic challenge for rural communities in Nigeria's North-East region. Evidence from household surveys, geospatial analysis, and qualitative field data demonstrates that soil erosion has significantly affected agricultural productivity, household income, and food security across the study area. These impacts are spatially uneven, with higher severity observed in communities located near erosion hotspots, particularly in hilly and deforested landscapes.

Analysis of erosion severity indicates that a substantial proportion of agricultural land in the study area is exposed to moderate to severe soil erosion. Field observations and GIS-based erosion modeling show that erosion is most pronounced in upland areas characterized by steep slopes, sparse vegetation cover, and intensive land use. These physical conditions, combined with unsustainable farming practices and increasing climatic variability, have accelerated topsoil loss and land degradation. As fertile topsoil is removed, the productive capacity of farmland declines, directly undermining agricultural sustainability and rural livelihoods.

Household-level data confirm that soil erosion has had a measurable impact on agricultural productivity. A majority of respondents reported declining soil fertility over recent years, manifested in reduced soil depth, increased sandiness, and the formation of rills and gullies

on farmlands. These conditions have led to notable reductions in crop yields, particularly for staple crops such as maize, sorghum, millet, and groundnut. Yield losses were more pronounced among households cultivating land within close proximity to erosion-prone zones, suggesting a strong spatial relationship between erosion exposure and agricultural performance.

Beyond crop production, soil erosion has also affected household income and livelihood stability. Many farming households rely on crop sales as their primary source of income. Declining yields, coupled with rising costs associated with land rehabilitation and soil fertility management, have reduced net farm income and increased economic vulnerability. Qualitative data from key informant interviews and focus group discussions indicate that some households have lost portions of their farmland entirely due to gully expansion, forcing them to abandon farming or shift to less secure livelihood activities such as casual labor and petty trading. These findings highlight soil erosion as a direct driver of livelihood disruption and rural impoverishment.

Food security outcomes further illustrate the severity of erosion impacts. A large proportion of surveyed households reported experiencing food insecurity, particularly during the lean agricultural season. Reduced crop production has limited household food availability, while income losses have constrained access to purchased food. Households affected by severe erosion reported greater reliance on food borrowing, meal reduction, and consumption of less diverse diets. These patterns suggest that soil erosion undermines multiple dimensions of food security, including availability, access, and stability, thereby posing a significant barrier to achieving food security targets.

Statistical analysis reveals significant relationships between soil erosion exposure and key livelihood indicators. Households located closer to erosion-prone land were more likely to report yield decline, income loss, and food insecurity than those farther away. Farm size and access to agricultural extension services also emerged as important factors influencing household resilience. Smaller farms were more vulnerable to erosion-induced shocks, while households with access to extension services demonstrated better coping capacity through the adoption of soil conservation practices. These findings underscore the importance of institutional support in mitigating the adverse effects of soil erosion on rural livelihoods.

**Table 1** summarizes the major impacts of soil erosion on livelihoods and food security across the study area. The table highlights clear gradients of vulnerability associated with erosion severity, showing higher levels of yield loss, income reduction, and food insecurity among households exposed to severe erosion. This quantitative evidence reinforces qualitative insights from field interactions, which emphasized the cumulative and reinforcing nature of erosion impacts on rural well-being.

**Table 1**. Summary of Soil Erosion Impacts on Rural Livelihoods and Food Security.

| Impact Indicator | Low Erosion Areas (%) | Moderate Erosion Areas (%) | Severe Erosion Areas (%) |
|---|---|---|---|
| Households reporting yield decline | 32.4 | 61.8 | 77.5 |
| Average crop yield reduction | <20 | 30–40 | 40–60 |
| Households reporting income loss | 28.7 | 54.6 | 69.0 |
| Households experiencing food insecurity | 21.5 | 46.3 | 58.2 |
| Adoption of soil conservation practices | 38.9 | 29.7 | 18.4 |

The results presented in **Table 1** demonstrate that soil erosion severity is closely associated with declining agricultural performance and heightened livelihood vulnerability. As erosion intensity increases, households experience greater losses in crop yield and income, alongside higher levels of food insecurity. At the same time, the adoption of soil conservation practices declines in severely affected areas, reflecting both limited capacity and inadequate institutional support. This paradox suggests that households most in need of erosion control interventions are often the least able to implement them.

Taken together, these findings indicate that soil erosion in North-East Nigeria is not merely an environmental problem but a systemic development challenge. The convergence of biophysical degradation, livelihood disruption, and food insecurity underscores the need for integrated responses that address both land management and socio-economic resilience. In the context of the Sustainable Development Goals, these results highlight critical linkages between soil erosion and progress toward SDG 2 (Zero Hunger), SDG 13 (Climate Action), and SDG 15 (Life on Land). Without effective soil conservation and livelihood support measures, erosion-driven land degradation is likely to continue undermining rural development and food security in the region.

The findings presented in the first part of this section highlight soil erosion as a critical driver of agricultural decline, livelihood disruption, and food insecurity in Nigeria's North-East region. These results are consistent with existing literature that identifies soil erosion as a major constraint to agricultural productivity and rural development in sub-Saharan Africa. The loss of fertile topsoil through erosion processes reduces soil organic matter and nutrient availability, leading to long-term declines in crop yields and land productivity (Lal, 2003). In rain-fed agricultural systems such as those predominant in North-East Nigeria, these effects are particularly severe due to limited access to soil restoration inputs and irrigation facilities.

The strong association between soil erosion severity and declining agricultural productivity observed in this study aligns with earlier research conducted in erosion-prone regions of Nigeria. Studies have shown that farmland exposed to moderate and severe erosion experiences significant yield reductions, often exceeding the capacity of smallholder farmers to recover through traditional farming practices (Igwe, 2013; Adeoye *et al*., 2016). As soil structure deteriorates and water-holding capacity declines, crops become increasingly vulnerable to dry spells and erratic rainfall, further compounding the impacts of erosion-induced land degradation.

Beyond agricultural productivity, the results demonstrate that soil erosion exerts substantial pressure on rural livelihood systems. Income losses associated with reduced crop output and farmland abandonment force households to adopt short-term coping strategies that may undermine long-term livelihood sustainability. Similar patterns have been documented in rural communities across northern Nigeria, where erosion and climate variability have contributed to livelihood diversification, labor migration, and increased dependence on non-farm income sources (Ayuba *et al*., 2007; Nwajiuba & Onyeneke, 2015). While diversification may provide temporary relief, it often reflects distress-driven adaptation rather than sustainable livelihood transformation.

Food security outcomes observed in this study further emphasize the socio-economic consequences of soil erosion. Reduced agricultural output directly affects household food availability, while declining farm income constrains access to purchased food. These dynamics correspond with broader assessments of food insecurity in erosion-affected regions, where households experience seasonal food shortages, reduced dietary diversity, and heightened

vulnerability to external shocks. The findings suggest that soil erosion undermines multiple dimensions of food security simultaneously, reinforcing cycles of vulnerability among rural households.

The interaction between soil erosion and institutional factors also emerges as a key theme in this study. Access to agricultural extension services, soil conservation knowledge, and institutional support significantly influences household capacity to cope with erosion impacts. Households with access to extension services were better positioned to adopt erosion control measures such as contour farming, mulching, and agroforestry, which have been shown to reduce soil loss and improve land productivity (Olorunfemi & Raheem, 2015). However, limited coverage of extension services and weak institutional frameworks constrain the widespread adoption of such practices, particularly in remote and conflict-affected areas of North-East Nigeria.

These findings highlight important policy implications for sustainable land management and rural development. Addressing soil erosion requires integrated approaches that combine physical soil conservation measures with socio-economic support for rural households. Structural interventions such as terracing, check dams, and gully stabilization must be complemented by non-structural measures, including farmer training, land tenure security, and access to agricultural inputs. Without addressing the socio-economic constraints faced by smallholder farmers, erosion control efforts are unlikely to achieve lasting impact.

In the context of the Sustainable Development Goals, the results underscore the interconnected nature of land degradation, livelihoods, and food security. Soil erosion directly undermines progress toward SDG 2 (Zero Hunger) by reducing agricultural productivity and food availability. It also affects SDG 1 (No Poverty) by eroding income sources and increasing economic vulnerability among rural households. Furthermore, erosion-driven land degradation poses a significant challenge to SDG 15 (Life on Land), which emphasizes sustainable land management and ecosystem restoration, as well as SDG 13 (Climate Action), given the role of healthy soils in climate resilience and carbon sequestration (Lal, 2003).

The integration of geospatial analysis with household-level socio-economic data in this study provides valuable insights into the spatial distribution of erosion impacts and associated livelihood vulnerabilities. Such integrated approaches are increasingly recognized as essential for effective land use planning and environmental management, particularly in data-scarce regions (Nnaji *et al*., 2011). By identifying erosion hotspots and linking them to livelihood outcomes, policymakers and development practitioners can better target interventions to areas of greatest need.

Overall, the results and discussion presented in this study demonstrate that soil erosion in North-East Nigeria represents a multidimensional challenge with far-reaching implications for agriculture, livelihoods, and food security. The findings reinforce the need for coordinated policy responses that integrate soil conservation, agricultural development, and rural livelihood support within a broader sustainable development framework. Without such integrated interventions, ongoing soil degradation is likely to continue undermining rural resilience and delaying progress toward the Sustainable Development Goals in erosion-prone regions of Nigeria.

## 5. CONCLUSION

This study demonstrates that soil erosion constitutes a significant environmental and socio-economic challenge for rural communities in Nigeria's North-East region, with far-reaching implications for agricultural productivity, rural livelihoods, and food security. The findings reveal that increasing erosion severity is closely associated with declining crop yields,

income losses, and heightened household food insecurity, particularly among smallholder farmers located in erosion-prone areas. Soil degradation has reduced the productive capacity of agricultural land, disrupted livelihood stability, and constrained households' ability to cope with climatic and economic shocks. The results further indicate that institutional factors, including access to agricultural extension services and soil conservation knowledge, play a critical role in shaping household resilience to erosion impacts. However, limited adoption of soil conservation practices in severely affected areas highlights persistent gaps in capacity, resources, and policy support. In the context of the Sustainable Development Goals, soil erosion emerges as a major barrier to achieving targets related to zero hunger, poverty reduction, climate resilience, and sustainable land management. Overall, the study underscores the need for integrated and context-specific interventions that combine soil conservation measures with livelihood support and institutional strengthening. Addressing soil erosion is essential not only for environmental sustainability but also for enhancing agricultural resilience, food security, and sustainable rural development in erosion-prone regions of Nigeria.

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## 7. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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