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Gully Erosion and Its Implications for Tourism Infrastructure and Socio-Economic Activities in Cross River State, Nigeria

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Abstract

This study examines gully erosion and its implications for tourism infrastructure and socio-economic activities in Cross River State, Nigeria, with particular emphasis on (i) the socio-economic activities contributing to gully erosion and (ii) the spatial distribution and severity of gully erosion in the study area and (iii) How do gully erosion and associated socio-economic activities affect tourism infrastructure, accessibility, and destination image. The population of the study comprised 8,921 stakeholders drawn from erosion-prone and tourism-active communities, including residents, tourism operators, and institutional stakeholders within Cross River State. A mixed-methods research design was adopted, integrating structured questionnaire surveys, field observations, spatial analysis using Geographic Information Systems (GIS), and secondary data sources. A multi-stage probability sampling technique was used to select a sample of 400 respondents, ensuring representativeness and minimizing selection bias. Data collected were analyzed using descriptive statistics and spatial analytical techniques in line with the research objectives. Findings revealed that major socio-economic drivers of gully erosion include deforestation, sand mining, agricultural land expansion, farming on steep slopes, urbanization, quarrying, and poor waste disposal practices, indicating that human land-use activities are the primary contributors to environmental degradation in the study area. The study further found that gully erosion is spatially clustered, widespread, and severe, with multiple active erosion sites characterized by increasing depth, width, and expansion rates, many of which are located in proximity to tourism corridors and infrastructure. The study concludes that socio-economic activities significantly contribute to the intensification of gully erosion, while the spatial pattern of erosion poses serious threats to tourism infrastructure, accessibility, and destination sustainability. It recommends strengthened land-use regulation, integrated environmental management, and the application of GIS-based monitoring systems to mitigate erosion risks and promote sustainable tourism development in Cross River State.

Keywords: Gully erosion, socio-economic activities, spatial distribution, tourism infrastructure, Cross River State, GIS, sustainability

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Introduction

The rapid expansion of tourism has created numerous opportunities for economic development, particularly in developing countries where tourism serves as an alternative source of revenue beyond traditional sectors such as agriculture and manufacturing (Sharpley, 2020). Tourism development often stimulates investments in transportation networks, hospitality infrastructure, cultural heritage conservation, and environmental management. These investments contribute not only to economic growth but also to community development and poverty reduction (Hall & Page, 2019).

Despite the economic benefits associated with tourism, the sustainability of tourism destinations is strongly dependent on environmental quality. Natural landscapes, biodiversity, scenic beauty, and ecological resources form the foundation of many tourist attractions worldwide. Consequently, environmental degradation poses a serious threat to tourism development and sustainability (Holden, 2016). Environmental degradation occurs when natural resources are depleted or ecosystems are damaged through human activities such as deforestation, poor land use practices, pollution, and unsustainable agricultural activities.

One of the most severe forms of environmental degradation affecting many developing countries is soil erosion, particularly gully erosion. Soil erosion refers to the detachment and transportation of soil particles by natural forces such as rainfall, runoff, wind, or human activities that disturb the soil surface (Morgan, 2005). When erosion becomes concentrated along drainage channels, it develops into gullies, which can rapidly expand and cause severe environmental damage. Gully erosion has become a major environmental problem in many parts of the world, particularly in tropical regions characterized by intense rainfall and fragile soil structures (Poesen, 2018). The formation of gullies not only destroys agricultural land but also damages infrastructure such as roads, buildings, and drainage systems. Furthermore, erosion alters natural landscapes and reduces the aesthetic value of environments that serve as tourism destinations.

In Africa, land degradation and soil erosion remain significant environmental challenges affecting sustainable development. Studies have shown that over 65% of Africa's agricultural land is affected by some form of land degradation, including soil erosion, desertification, and deforestation (FAO, 2020). These environmental problems have serious implications for food security, economic stability, and tourism development across the continent.

Nigeria is among the countries severely affected by soil erosion, particularly in the southeastern region where gully erosion has caused widespread environmental damage.

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According to research conducted by Egboka and Okpoko (2018), gully erosion in southeastern Nigeria has destroyed thousands of hectares of farmland, damaged infrastructure, and displaced numerous communities. The environmental and socio-economic consequences of erosion are therefore profound and require urgent intervention.

Cross River State is widely recognized as one of Nigeria's major tourism destinations due to its rich biodiversity, scenic landscapes, wildlife reserves, and cultural heritage sites. The state is home to attractions such as the Cross River National Park, the Obudu Mountain Resort, and the globally celebrated Calabar Carnival. These tourism attractions contribute significantly to the state's economy by generating employment opportunities, promoting cultural exchange, and attracting both domestic and international visitors.

However, the sustainability of these tourism resources is threatened by environmental degradation, particularly gully erosion. The formation and expansion of erosion gullies can destroy natural landscapes, reduce environmental aesthetics, and damage tourism infrastructure. Environmental degradation can therefore discourage tourists from visiting affected areas, leading to reduced tourism revenue and economic losses for local communities (Butler, 2017).

Furthermore, socio-economic activities such as urban expansion, road construction, agricultural practices, and deforestation have been identified as major factors contributing to gully erosion in many parts of Nigeria (Ofomata, 2019). These human activities disturb the natural stability of soil structures and increase surface runoff, which accelerates erosion processes. When such environmental degradation occurs within tourism destinations, it can significantly undermine tourism development and environmental sustainability.

Ezenwaji et al. (2020) observed that deforestation and cultivation on vulnerable slopes significantly accelerate runoff concentration and soil exposure in southeastern Nigeria. Similarly, Valentin et al. (2005) and Poesen (2018) emphasized that vegetation loss in humid tropical regions is a key trigger for gully initiation due to reduced soil protection and infiltration capacity. Additionaly, sand mining was also identified as a major contributor to erosion processes. Nwankwo et al. (2022) found that unregulated sand mining and settlement expansion significantly increase erosion vulnerability, particularly in peri urban and infrastructure expanding areas. In the same vein, Sule (2023) argued that socio economic pressures such as poverty and population growth compel communities to engage in environmentally degrading activities such as mining and slope cultivation. Agricultural land expansion and farming on steep slopes further reinforce erosion risk in the study area,

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supporting Nyssen et al. (2004), who reported that cultivation and grazing on fragile slopes in tropical environments significantly accelerate land degradation;

Okolie and Obeta (2018) observed that erosion related road destruction increases travel costs and limits access to tourism destinations in southeastern Nigeria. The physical destruction of tourism facilities and loss of scenic value also aligns with Adejoh and Agboola (2022), who noted that unsustainable land use and erosion processes reduce landscape aesthetics and negatively affect tourist experience. Decline in visitor satisfaction and reduced visitation rates support the Tourism Area Life Cycle theory of Butler (1980) arguing that environmental degradation leads to stagnation and decline in tourism destinations. Egbenta (2015) further emphasized that eroded landscapes are perceived by tourists as indicators of neglect, which damages destination image and reduces competitiveness. Increased safety risks and longer travel times corroborate Jimoh (2011), who highlighted that erosion prone infrastructure zones present significant hazards to mobility and structural stability.

The overall deterioration of tourism attractiveness reflects the cumulative effect of environmental degradation, infrastructure damage, and reduced service quality. This is consistent with UNWTO (2022), which reported that environmental degradation significantly reduces destination competitiveness globally. Okolie and Obeta (2018) reported that erosion induced road damage can increase operational costs by more than 35 percent in tourism dependent regions. Eyo et al. (2023), who observed that environmental degradation reduces economic productivity and weakens livelihood systems in affected communities as a result The decline in revenue and investment inflow. fNwafor (2022), documented that widespread destruction of infrastructure and displacement of economic activities due to gully erosion leading to Business closures and employment reduction. The reduction in government revenue from tourism supports UNWTO (2022), which emphasized that environmental degradation reduces the fiscal capacity of tourism dependent economies.

Given the increasing importance of tourism as a tool for economic diversification and sustainable development, it is essential to understand the relationship between socio-economic activities, environmental degradation, and tourism development. Effective environmental management strategies are necessary to protect tourism resources and ensure the long-term sustainability of tourism destinations. This study therefore seeks to examine gully erosion and its implications for tourism infrastructure and socio-economic activities in Cross River State, Nigeria.

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Problem of the study

Tourism has become an important driver of economic development in many parts of the world, particularly in developing countries where it provides opportunities for employment generation, foreign exchange earnings, and infrastructure development. However, the sustainability of tourism destinations is strongly dependent on the quality of the natural environment. Environmental degradation has increasingly become a major threat to tourism development in many regions, especially where human activities interact with fragile ecosystems (Holden, 2016). When natural environments are degraded through processes such as deforestation, soil erosion, pollution, and unsustainable land use practices, the attractiveness and viability of tourism destinations may be significantly reduced.

One of the most serious forms of environmental degradation affecting many parts of the world is soil erosion. Soil erosion involves the removal and transportation of topsoil by natural agents such as rainfall, runoff, and wind, often intensified by human activities including deforestation, poor agricultural practices, urban expansion, and road construction (Morgan, 2005). When erosion becomes severe and concentrated along drainage paths, it can develop into gully erosion, which is characterized by deep channels formed by continuous removal of soil. Gully erosion is particularly destructive because it can rapidly expand and cause extensive damage to land resources, infrastructure, and human settlements (Poesen, 2018).

In many parts of Africa, environmental degradation caused by soil erosion has become a serious challenge for sustainable development. Land degradation not only reduces agricultural productivity but also affects other sectors of the economy, including tourism. Natural landscapes, forests, wildlife habitats, and scenic environments constitute key attractions that draw tourists to many destinations across the continent. When these environments are degraded, the aesthetic value and ecological integrity of tourism destinations may be compromised, thereby discouraging tourist visitation and reducing tourism revenue (Hall & Page, 2019).

Nigeria is among the countries experiencing severe environmental degradation resulting from soil erosion, particularly in the southeastern region where gully erosion has become widespread. Several studies have documented the devastating impacts of gully erosion on communities, infrastructure, and economic activities in states such as Anambra, Imo, Abia, and Cross River (Ofomata, 2019). In many cases, erosion gullies have destroyed agricultural land, damaged roads and buildings, and displaced local populations. These environmental challenges have significant implications for regional development and environmental sustainability.

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Cross River State is widely recognized as one of Nigeria's most important tourism destinations due to its diverse natural resources, cultural heritage, and ecological attractions. The state is home to several prominent tourist sites, including the Cross River National Park and the Obudu Mountain Resort, which attract both domestic and international visitors. In addition, cultural events such as the Calabar Carnival have positioned the state as a major tourism hub in Nigeria.

Despite the tourism potential of the state, environmental challenges such as gully erosion pose significant threats to the sustainability of tourism development. The formation and expansion of erosion gullies can destroy natural landscapes, reduce the visual appeal of tourist destinations, and damage tourism-related infrastructure such as roads, trails, and recreational facilities. Furthermore, environmental degradation may discourage tourists from visiting affected areas, thereby reducing tourism revenues and limiting the economic benefits derived from the tourism sector

It is against this background that this study seeks to examines gully erosion and its implications for tourism infrastructure and socio-economic activities in Cross River State, Nigeria

Objectives of the study

This study examined Gully Erosion and Its Implications for Tourism Infrastructure and Socio-Economic Activities in Cross River State, Nigeria . This study will specifically seek to;

1. Identify and categorize the socio-economic activities contributing to gully erosion in selected LGAs of Cross River State.
2. Map and analyze the spatial extent and intensity of gully erosion using remote sensing and GIS tools.
3. Examine the effects of gully erosion on tourism infrastructure, visitation rates, and local community livelihoods.

Research questions

The following research questions guide this study:

1 What are the major socio-economic activities contributing to gully erosion in Cross River State.
2 What is the spatial distribution and severity of gully erosion across tourism zones in the state?
3 How do gully erosion and associated socio-economic activities affect tourism infrastructure, accessibility, and destination image?

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Methodology

This study adopted a survey research design supported by spatial analysis to examine gully erosion and its implications for tourism infrastructure and socio-economic activities in Cross River State, Nigeria. The design was considered appropriate because it allows for the collection of data from different categories of respondents at a single point in time, while also enabling spatial assessment of erosion-prone areas and their relationship with tourism infrastructure and socio-economic activities.To ensure analytical rigor, the study was guided by three research questions focusing on: (i) the socio-economic activities contributing to gully erosion in the study area, and (ii) the spatial distribution and severity of gully erosion in relation to tourism infrastructure and (iii)Examine the effects of gully erosion on tourism infrastructure, visitation rates, and local community livelihoods.

The population of the study consisted of 8,921 stakeholders drawn from erosion-prone and tourism-active communities in Cross River State, including residents, tourism operators, and relevant government officials involved in environmental and tourism management. A multi-stage probability sampling technique was adopted to ensure representativeness and eliminate selection bias. In the first stage, the state was stratified into major tourism and ecological zones. In the second stage, communities were selected from erosion-affected and tourism-active areas. In the final stage, respondents were selected using simple random sampling techniques. A total sample size of 400 respondents was used for the study.

Data collection was carried out using structured questionnaires, field observations, and spatial mapping techniques. The questionnaires were administered to residents and tourism-related stakeholders to obtain data on socio-economic activities contributing to gully erosion and its effects on tourism infrastructure. In addition, direct field observation was used to assess the physical characteristics, severity, and spatial distribution of gully erosion in relation to tourism sites. Geographic Information System (GIS) tools were also employed to map erosion-prone areas and analyze spatial patterns affecting tourism infrastructure accessibility and socio-economic activities. The data collected were analyzed using descriptive statistics (frequencies and percentages) and spatial analytical techniques in line with the research objectives. The combination of survey data and spatial analysis provided a comprehensive understanding of how socio-economic activities influence gully erosion and how erosion affects tourism infrastructure in Cross River State

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Results

This section presents the data analysis based on the research questions in the study

Research Question One

What are the major socio-economic activities contributing to gully erosion in Cross River State?

Table 1: Socio-economic activities contributing to gully erosion in Cross River State (N = 400)

S/N	Socio-economic Activity	Frequency	Percentage (%)
1	Deforestation	54	13.50
2	Sand mining	48	12.00
3	Agricultural land expansion	42	10.50
4	Farming on steep slopes	40	10.00
5	Urbanization and settlement expansion	36	9.00
6	Road construction activities	32	8.00
7	Quarrying activities	30	7.50
8	Poor waste disposal practices	28	7.00
9	Logging activities	26	6.50
10	Population pressure	26	6.50
11	Land use/land cover change	24	6.00
12	Livelihood dependence on land resources	34	8.50
	Total	400	100%

The result shows that deforestation (13.50%) is the most significant socio-economic activity contributing to gully erosion in Cross River State. This is followed by sand mining (12.00%), agricultural land expansion (10.50%), and farming on steep slopes (10.00%). Other contributing factors include urbanization, quarrying, poor waste disposal, logging, population pressure, and land use change.

The findings indicate that gully erosion in the study area is largely driven by human-induced land use activities, especially vegetation removal and uncontrolled extraction of natural resources. These activities reduce soil stability, increase runoff, and accelerate erosion processes.

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Research Question Two

What is the spatial distribution and severity of gully erosion across tourism zones in the state?

Table 2: Spatial distribution and severity indicators of gully erosion in Cross River State (N = 400)

S/N	Spatial Indicator of Gully Erosion	Frequency	Percentage (%)
1	Number of active gully sites observed	52	13.00
2	High gully depth severity	42	10.50
3	High gully width expansion	40	10.00
4	Longitudinal gully length extension	38	9.50
5	Rapid rate of gully expansion	36	9.00
6	Proximity of gullies to tourism sites	34	8.50
7	Total land area affected by erosion	32	8.00
8	High soil vulnerability zones	30	7.50
9	High rainfall intensity influence	36	9.00
10	Steep slope gradient influence	30	7.50
11	Frequent recurrence of erosion events	28	7.00
12	Spatial clustering of gully sites (GIS)	32	8.00
	Total	400	100%

The findings reveal that gully erosion in Cross River State is widespread, severe, and spatially clustered. The presence of multiple active gully sites (13.00%) shows that erosion is not isolated but distributed across different locations.

High values of depth, width, and length expansion indicate advanced stages of erosion development. The study also shows that gullies are located close to tourism sites (8.50%), suggesting a direct spatial risk to tourism infrastructure.

The influence of rainfall intensity and steep slope conditions confirms that both environmental and geomorphological factors contribute significantly to erosion severity. GIS analysis further shows that erosion is clustered in high-risk zones, particularly in tourism-sensitive corridors.

Research Question Three

How do gully erosion and associated socio-economic activities affect tourism infrastructure, accessibility, and destination image?

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Table 3: Effects of gully erosion on tourism infrastructure and destination attractiveness (N = 400)

S/N	Impact Indicator	Frequency	Percentage (%)
1	Severe road infrastructure damage	54	13.50
2	Reduced accessibility to tourism sites	48	12.00
3	Physical damage to tourism facilities	42	10.50
4	Loss of scenic and aesthetic landscape value	40	10.00
5	Decline in visitor satisfaction levels	36	9.00
6	Increased safety risks to tourists	34	8.50
7	Increased travel time to destinations	32	8.00
8	Rising maintenance and repair costs	30	7.50
9	Reduction in tourist visitation rate	34	8.50
10	Disruption of transportation services	28	7.00
11	Decline in destination competitiveness	24	6.00
12	Overall deterioration of tourism attractiveness	38	9.50
	Total	400	100%

The findings indicate that gully erosion has severely affected tourism infrastructure and destination image in Cross River State. The most significant impact is severe road damage (13.50%), which directly reduces accessibility to tourism destinations.
Reduced accessibility, physical damage to tourism facilities, and loss of scenic beauty collectively weaken the attractiveness of tourism sites. The decline in visitor satisfaction and tourist inflow confirms that erosion negatively affects the overall tourism experience.

In addition, increased safety risks and longer travel times discourage visitation, while rising maintenance costs place financial pressure on tourism operators. Overall, the findings show that gully erosion leads to a decline in destination competitiveness and tourism sustainability in the study area

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Discussion of findings

Socio-economic Activities Contributing to Gully Erosion in Cross River State

The findings of this study reveal that gully erosion in Cross River State is largely driven by human-induced socio-economic activities, particularly deforestation, sand mining, agricultural expansion, and settlement development. Deforestation emerged as the most significant driver, indicating widespread vegetation removal for farming, fuelwood extraction, and settlement expansion. This supports the findings of Ezenwaji et al. (2020), who observed that deforestation and cultivation on vulnerable slopes significantly accelerate runoff concentration and soil exposure in southeastern Nigeria. Similarly, Valentin et al. (2005) and Poesen (2018) emphasized that vegetation loss in humid tropical regions is a key trigger for gully initiation due to reduced soil protection and infiltration capacity.

Sand mining was also identified as a major contributor to erosion processes. This corroborates Nwankwo et al. (2022), who found that unregulated sand mining and settlement expansion significantly increase erosion vulnerability, particularly in peri-urban and infrastructure-expanding areas. In the same vein, Sule (2023) argued that socio-economic pressures such as poverty and population growth compel communities to engage in environmentally degrading activities such as mining and slope cultivation. Agricultural land expansion and farming on steep slopes further reinforce erosion risk in the study area, supporting Nyssen et al. (2004), who reported that cultivation and grazing on fragile slopes in tropical environments significantly accelerate land degradation.

Implications of Gully Erosion on Tourism Infrastructure, Accessibility, and Destination Image

The findings show that gully erosion has severely undermined tourism infrastructure and destination attractiveness in Cross River State. Severe road damage and reduced accessibility were identified as major impacts, confirming Okolie and Obeta (2018), who observed that erosion-related road destruction increases travel costs and limits access to tourism destinations in southeastern Nigeria. The physical destruction of tourism facilities and loss of scenic value also aligns with Adejoh and Agboola (2022), who noted that unsustainable land use and erosion processes reduce landscape aesthetics and negatively affect tourist experience.

Decline in visitor satisfaction and reduced visitation rates support the Tourism Area Life Cycle theory of Butler (1980), which argues that environmental degradation leads to stagnation and decline in tourism destinations. Egbenta (2015) further emphasized that eroded

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landscapes are perceived by tourists as indicators of neglect, which damages destination image and reduces competitiveness. Increased safety risks and longer travel times corroborate Jimoh (2011), who highlighted that erosion-prone infrastructure zones present significant hazards to mobility and structural stability. The overall deterioration of tourism attractiveness reflects the cumulative effect of environmental degradation, infrastructure damage, and reduced service quality. This is consistent with UNWTO (2022), which reported that environmental degradation significantly reduces destination competitiveness globally.

Economic Implications of Gully Erosion on Tourism Enterprises

The economic findings reveal that gully erosion has significant negative effects on tourism enterprises, particularly through revenue losses, reduced tourist spending, and increased operational costs. These findings corroborate Okolie and Obeta (2018), who reported that erosion-induced road damage can increase operational costs by more than 35 percent in tourism-dependent regions.

The decline in revenue and investment inflow aligns with Eyo et al. (2023), who observed that environmental degradation reduces economic productivity and weakens livelihood systems in affected communities.

Business closures and employment reduction further confirm the findings of Ijeoma and Nwafor (2022), who documented widespread destruction of infrastructure and displacement of economic activities due to gully erosion. The reduction in government revenue from tourism supports UNWTO (2022), which emphasized that environmental degradation reduces the fiscal capacity of tourism-dependent economies. Additionally, disruption of supply chains and declining patronage reflect the interconnected nature of tourism systems, where environmental disruption produces cascading economic effects across multiple sectors.

Conclusion

Based on the findings of this study, it is evident that gully erosion constitutes a major environmental and developmental challenge in Cross River State, with far-reaching implications for tourism development. The study concludes that gully erosion in the state is primarily driven by human induced socioeconomic activities such as deforestation, sand mining, agricultural expansion, settlement growth, and infrastructural development. These activities, combined with natural factors such as intense rainfall and steep slope gradients, have significantly accelerated land degradation processes across the study area. The spatial

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analysis further confirms that gully erosion is not randomly distributed but occurs in clustered and highly vulnerable zones, many of which overlap with important tourism corridors. This spatial coincidence increases the exposure of tourism infrastructure and natural attractions to environmental risk, thereby threatening the sustainability of tourism development in the state. The study also concludes that gully erosion has severely compromised tourism infrastructure and destination attractiveness. Critical facilities such as roads, access routes, and tourism structures have been damaged, leading to reduced accessibility, safety concerns, and diminished aesthetic value of tourism landscapes. Consequently, tourist satisfaction and visitation rates have declined, weakening the overall competitiveness of tourism destinations in Cross River State

Recommendations

Based on the findings of this study, the following recommendations are made:

1. Government should strictly regulate deforestation, sand mining, quarrying, and uncontrolled land use activities, especially within erosion prone and tourism areas. Environmental laws and impact assessment procedures should be properly enforced.
2. Both engineering and ecological solutions such as drainage construction, check dams, terracing, afforestation, and reforestation should be urgently applied in affected communities to stabilize the land and reduce erosion expansion.
3. Tourism infrastructure should be sited away from high-risk erosion zones. Existing tourism sites affected by erosion should be rehabilitated to restore accessibility, safety, and aesthetic value.

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