# Assessment Of the Environmental and Socio-Economic Implications of Sand Mining on Host Communities Along the River Kaduna Corridor in Kaduna Metropolis, Kaduna State, Nigeria

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***Abstract*—River sand mining supports construction, employment and income generation, but poorly controlled extraction can undermine river stability and the livelihoods of communities dependent on riverine environments. This study examined the environmental and socio-economic implications of sand mining on host communities along the river Kaduna corridor in Kaduna Metropolis, Kaduna State, Nigeria, through a structured synthesis of published research. The assessment draws on studies of sand mining in Kaduna Metropolis, research on encroachment along the Kaduna River, comparative evidence from the Odene–Aguleri River in Anambra State, and recent international reviews of river sand and gravel mining. The evidence shows that sand mining can provide income and support household asset acquisition.**

***A survey of 60 miners in five riverine communities in Kaduna Metropolis reported daily earnings of ₦3,000–₦5,000 among many participants and weekly earnings of ₦20,000–₦40,000. At the same time, research from other Nigerian river systems identifies concerns involving riverbank erosion, turbidity, water quality, aquatic habitats and community conflict. A 2026 global review of 411 peer-reviewed studies further identifies channel incision, bank instability, groundwater decline, infrastructure damage and livelihood insecurity as potential consequences of extraction that exceeds sediment replenishment. The synthesis suggests that the sustainability of sand mining depends on balancing construction-material demand and local employment with the ecological capacity of the river system.**

***It recommends corridor-specific environmental monitoring, extraction limits informed by sediment conditions, protection of sensitive river reaches, stronger regulatory enforcement and community-based livelihood planning. As this paper is based on secondary evidence, its conclusions identify documented patterns and research priorities rather than claiming new field measurements from the river Kaduna corridor.***

***Index Terms*—River sand mining; River Kaduna; environmental impacts; socio-economic implications; host communities; livelihood sustainability; Kaduna Metropolis.**

## I. INTRODUCTION

Sand is an essential raw material for the construction industry. It is used in concrete, mortar, road construction, land reclamation and a wide range of infrastructure projects. Growing demand for housing and infrastructure has made sand extraction an economically important activity in many developing regions. Riverbeds and floodplains are frequently exploited because they contain accessible deposits of sand and gravel. However, the environmental sustainability of this activity depends on the quantity extracted, the natural rate of sediment replenishment, the methods employed and the sensitivity of the river system.

River sand mining has attracted increasing environmental concern because the removal of sediment can alter channel morphology, sediment transport, groundwater conditions, water quality and aquatic habitats. Tripathi et al. (2025) identify geomorphological, hydrological, ecological and socio-economic consequences among the major concerns associated with river sand mining. Their review also highlights the importance of assessment techniques capable of connecting extraction activities with changes in river conditions.

The scale of the problem is further demonstrated by Park et al. (2026), whose review synthesised 411 peer-reviewed studies on river sand and gravel mining. The authors found that extraction can exceed natural

sediment replenishment, contributing to channel incision, bank collapse, declining groundwater levels, water-quality deterioration, habitat loss, infrastructure damage and livelihood insecurity. They also identified major evidence gaps: only 27% of the reviewed studies quantified the extent of extraction, while 24% analysed the socio-economic drivers of demand. These findings suggest that effective management requires better information about not only environmental damage, but also the economic and social processes that sustain mining.

In Nigeria, sand mining provides income to miners, loaders, transport operators and traders while supplying construction materials for urban development. Nevertheless, the distribution of benefits and costs may be uneven. Those directly involved in mining may receive immediate income, while other residents may be exposed to erosion, disturbed water resources, damaged access routes or changes in river-dependent livelihoods. An assessment that considers only income or employment may therefore overlook important environmental and social costs.

Kaduna Metropolis provides a relevant setting for examining this relationship. The River Kaduna and its surrounding corridor are exposed to urban development and other human activities. Wuyep et al. (2024) investigated encroachment along the Kaduna River using remote sensing, GIS and field surveys covering changes between 2000 and 2022. The study reported substantial encroachment in several river reaches and identified associated concerns involving flood risk, habitat fragmentation and biodiversity loss. Its findings establish the importance of managing the river corridor, although encroachment should not be interpreted as a direct measure of the impacts of sand mining alone.

Directly relevant socio-economic evidence is provided by Nuhu, Yahaya and Jamila (2026), who surveyed 60 sand miners in Kukumake, Malalin Gabas, Rafin Guza, Hayin Mallam Bello and Kabala West. The study reported that sand mining generated income and contributed to the acquisition of household assets, including housing, farmland and motorcycles. It also identified environmental degradation and the characteristics of the mining workforce as issues relevant to the long-term sustainability of the activity.

Comparative evidence from other Nigerian river systems provides additional insight into the possible consequences of extraction. Ogbo, Amaechi and Okonkwo (2024) investigated sand mining along the Odene–Aguleri River in Anambra State and reported concerns involving riverbank erosion, deteriorating water quality, turbidity, aquatic habitat loss, employment and social conflict. Their findings demonstrate that the economic benefits of mining can coexist with environmental pressures and social challenges. However, findings from Anambra State cannot be assumed to represent the magnitude of impacts along the River Kaduna without local verification.

Despite the availability of these studies, an integrated assessment must distinguish between the economic importance of sand mining, environmental risks established in the broader literature, and impacts measured directly in the selected study area. This paper therefore synthesises published evidence to assess the implications of sand mining for host communities along the River Kaduna corridor and identify priorities for more sustainable management.

### 1.1 Aim and objectives

The aim of this paper is to assess the environmental and socio-economic implications of sand mining on host communities along the River Kaduna corridor in Kaduna Metropolis, Kaduna State, Nigeria.

The specific objectives are to:

1. Examine the environmental implications associated with river sand mining.
2. Assess the reported socio-economic benefits of sand mining for host communities.
3. Analyse the potential relationships between mining-related environmental changes and community livelihoods.
4. Identify management strategies that can reduce environmental harm while recognising the economic needs of host communities.

## II. LITERATURE REVIEW

### 2.1 Concept and methods of river sand mining

River sand mining is the extraction of sand from riverbeds, riverbanks, channels and associated deposits for construction or other uses. Extraction may be undertaken manually using shovels, baskets and head pans or mechanically using excavators, dredgers and related equipment. The methods employed, the

quantity removed and the location of extraction influence the potential effects on the river environment.

Sand is part of a naturally moving sediment system. Weathering, erosion, transport and deposition determine the quantity and distribution of sediment within a river basin. The presence of sand in a channel does not mean that all available material can be removed without consequences. When extraction exceeds the rate of replenishment, the river may experience sediment deficits and changes in channel form.

Tripathi et al. (2025) review the methods used to investigate river sand mining, including satellite mapping, field measurements, analytical approaches, numerical modelling and experimental studies. Their work highlights the importance of combining spatial information with measurements of river conditions to evaluate impacts and develop sustainable extraction practices.

2.2 Environmental implications of sand mining

2.2.1 Riverbed alteration and bank erosion

Sand extraction may alter the depth, shape and stability of river channels. Removing sediment from the bed can create depressions and change the balance between erosion and deposition. Depending on local hydrological and geological conditions, these changes may contribute to channel incision, bank instability and erosion.

Park et al. (2026) identifies channel incision and bank collapse among the consequences documented in river systems where extraction exceeds natural sediment supply. They also explain that the effects can propagate beyond individual mining locations, making basin-scale assessment important.

In host communities, bank erosion may threaten land, paths, agricultural plots and structures close to the river. However, erosion can also be caused by flooding, vegetation removal, channel modification and urban encroachment. Consequently, an assessment of the River Kaduna corridor must establish whether observed erosion is spatially and temporally associated with mining and consider other possible causes.

2.2.2 Water quality and aquatic habitats

Mining activities can disturb sediment and increase suspended particles in the water, potentially increasing turbidity. Water quality may also be affected by fuel handling, waste disposal and other activities associated with extraction and transportation. Changes in channel form and substrate can alter habitats used by aquatic organisms.

Ogbo et al. (2024) reported increased turbidity, deteriorating water quality and loss of aquatic habitats among the concerns associated with sand mining along the Odene–Aguleri River. These findings support the inclusion of water-quality and ecological indicators in assessments of river sand mining. They do not establish the current water-quality status of the River Kaduna.

2.2.3 Groundwater and hydrological changes

Rivers and adjacent groundwater systems may interact through the movement of water between channels, banks and underlying geological materials. Changes in channel elevation and sediment distribution can influence this interaction, although the effects depend on local conditions.

Park et al. (2026) identifies declining groundwater levels among the consequences reported in cases of excessive sand and gravel extraction. This is particularly relevant where communities depend on shallow wells or other groundwater sources. However, any claim that mining has lowered groundwater levels along the River Kaduna corridor requires local monitoring and cannot be established from the general literature alone.

2.2.4 Flooding, encroachment and infrastructure

Flooding and river-corridor degradation are influenced by multiple factors, including rainfall, floodplain development, vegetation removal, waste accumulation, channel modification and sediment dynamics. Sand mining may contribute to some changes, but it should not be treated as the sole cause of flooding without supporting evidence.

Wuyep et al. (2024) documented encroachment along the Kaduna River and discussed implications for flood risk, habitat fragmentation and biodiversity. Their study provides relevant evidence of wider environmental pressure within the river corridor. It does not, however, quantify the contribution of sand mining to the reported encroachment.

2.3 Socio-economic benefits of sand mining

Sand mining can provide direct and indirect employment. Direct employment includes extraction, loading and site operations, while indirect employment may include transportation, equipment supply and sand trading. Income from these activities can support household expenditure and asset acquisition.

Nuhu et al. (2026) found that sand mining contributed to income generation among surveyed miners in selected riverine communities of Kaduna Metropolis. Many participants reportedly earned between ₦3,000 and ₦5,000 daily and between ₦20,000 and ₦40,000 weekly. The authors also reported that income contributed to the acquisition of housing, farmland and motorcycles.

These findings demonstrate the economic importance of mining for participating households. However, the reported income ranges should not be treated as net profit or as representative of all miners. A comprehensive analysis would consider operating costs, transport expenses, equipment ownership, fees, seasonality and fluctuations in market demand.

2.4 Socio-economic costs and livelihood vulnerability

The economic benefits of sand mining may coexist with costs experienced by people who are not directly involved in extraction. Erosion can affect land near the river; changes in aquatic conditions may affect fishing; and heavy vehicles may affect roads and local safety. Competition over mining locations, access rights and revenue distribution may also create community disputes.

Ogbo et al. (2024) reported employment opportunities alongside environmental and social concerns in their study of the Odene–Aguleri River. This illustrates the importance of assessing benefits and costs together rather than treating employment as sufficient evidence that mining improves overall community welfare.

The distribution of costs and benefits is a central consideration. Miners and traders may receive immediate income, whereas other households and public institutions may bear some costs associated with environmental damage or infrastructure maintenance. The net effect of sand mining on community welfare therefore depends on the scale of environmental impacts, the distribution of income, the availability of alternative livelihoods and the effectiveness of environmental regulation.

2.5 Sustainable management and governance

Sustainable sand mining requires a management approach that accounts for environmental limits and socio-economic realities. Important measures include identifying suitable extraction areas, estimating the rate of sediment replenishment, setting extraction limits, protecting sensitive locations, monitoring environmental conditions and enforcing relevant regulations.

Park et al. (2026) emphasises the need to connect the drivers of sand demand, the extent of extraction, environmental impacts and management responses. Their review highlights the limited availability of quantitative information on extraction volumes and demand drivers, which complicates the design of effective policies. Tripathi et al. (2025) similarly identify sediment budgeting as a useful approach for balancing construction-material demand with river conservation.

For host communities, management should also include participation in decisions, transparent procedures for resolving grievances and support for alternative income opportunities where restrictions affect livelihoods. Environmental enforcement is more likely to be sustainable when it is based on reliable evidence and recognises the people who depend on the resource.

2.6 Research gap

Published research has examined both the socio-economic benefits of sand mining in Kaduna Metropolis and broader environmental pressures affecting the Kaduna River corridor. Nuhu et al. (2026) provides evidence of income generation and household asset acquisition among miners, while Wuyep et al. (2024) document encroachment and associated environmental concerns. Research along the Odene–Aguleri River provides comparative evidence of erosion, water-quality concerns, habitat disturbance and community conflict.

Nevertheless, these studies differ in objectives, geographic coverage and methods. Their results cannot be combined to calculate the actual prevalence of mining-related environmental or socio-economic impacts along the selected River Kaduna corridor. A corridor-specific field study measuring extraction intensity, environmental conditions and household experiences would help address this gap. The present paper contributes by synthesising available evidence

and identifying the principal questions that require local measurement.

## III. MATERIALS AND METHODS

### 3.1 Research design

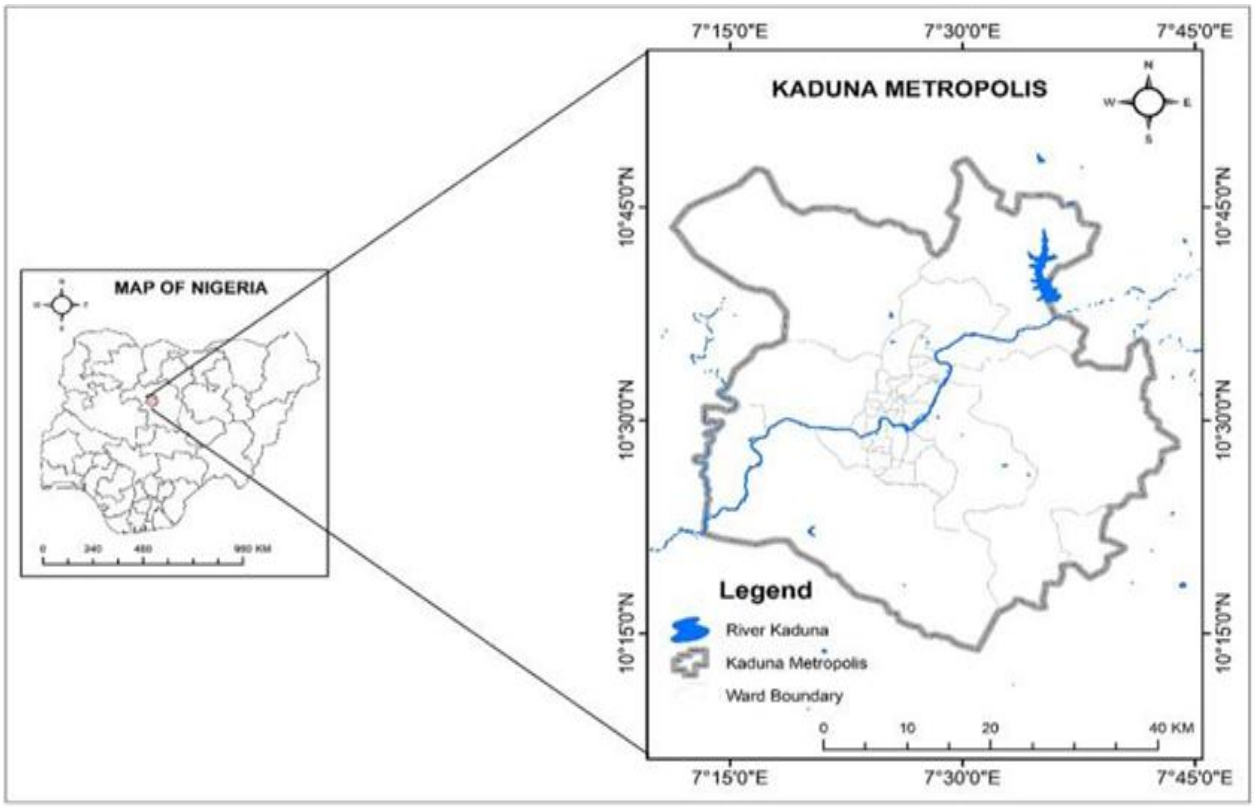
The paper adopted a secondary-data research design based on a structured narrative synthesis of published studies. This design is appropriate for integrating findings from research conducted in Kaduna Metropolis and other Nigerian riverine settings with recent reviews of the environmental and socio-economic consequences of river sand mining.

The paper does not claim to be a systematic review conducted under a registered protocol. Instead, it uses selected, relevant publications to identify recurring themes, compare findings and develop management implications for the River Kaduna corridor.

### 3.2 Study area

The study focuses on the sand-mining corridor along River Kaduna within Kaduna Metropolis, Kaduna State, north-western Nigeria. The river supports several economic activities, including agriculture, fishing and sand extraction for construction. Previous research delineated a 32.7-kilometre stretch of the river from Malali in Igabi Local Government Area to the Railway Bridge at Rigasa, within approximately 10°28′–10°36′ N and 7°21′–7°35′ E (Ogbozige et al., 2018).

The proposed host communities are Kukumake, Malalin Gabas, Rafin Guza, Hayin Mallam Bello and Kabala West, which have been identified in previous research on sand-mining activities in Kaduna Metropolis (Nuhu et al., 2026). Their inclusion will be confirmed through field reconnaissance to establish the locations of active or recent extraction sites. GPS coordinates will be recorded to delineate the actual mining corridor and prepare a study-area map. This will provide a spatial basis for examining the environmental impacts and socio-economic implications of sand mining on the selected host communities.




Source: *Kaduna State and Local Government Boundaries From the Office of Surveyor General of the Federation.*

### 3.3 Sources of evidence

The principal publications used in the synthesis were:

- Nuhu et al. (2026), on the socio-economic benefits of sand mining in selected riverine communities of Kaduna Metropolis.
- Wuyep et al. (2024), on encroachment along the Kaduna River in Kaduna Metropolis.
- Ogbo et al. (2024), on environmental and social impacts of sand mining along the Odene–Aguleri River in Anambra State.
- Tripathi et al. (2025), on methods, impacts and implications of river sand mining.
- Park et al. (2026), on global drivers, impacts and pathways for sustainable management of river sand and gravel mining.

The publications were considered for their relevance to environmental change, employment and income, community livelihoods and environmental management. Their findings were kept distinct according to the locations and methods of the original studies.

3.4 Data analysis

The evidence was organised into five thematic categories: river morphology and erosion; water quality and aquatic habitats; income and employment; community livelihoods and social concerns; and environmental governance.

Reported statistics were retained only where they could be attributed to the relevant publication. Qualitative findings were compared to identify recurring concerns and differences across study settings. Because the original datasets were not available for reanalysis, no pooled statistical estimates or new hypothesis tests were produced.

3.5 Methodological limitations

The analysis depended on the coverage and quality of existing publications. Differences in study design and geographic coverage limit direct comparison between locations. Furthermore, the available evidence does not establish the current volume of sand extracted from the selected River Kaduna corridor, the exact area affected, the current water-quality status or the proportion of local households experiencing particular impacts.

These limitations mean that the paper should be interpreted as a synthesis of existing evidence and a framework for future investigation, not as a report of newly collected field measurements.

## IV. RESULTS AND DISCUSSION

4.1 Socio-economic contributions of sand mining in Kaduna Metropolis

The available local evidence indicates that sand mining is an economically significant activity for some households in Kaduna Metropolis. Nuhu et al. (2026) surveyed 60 miners across five riverine communities and reported income generation and household asset acquisition as important benefits.

Table 1. Reported socio-economic contributions of sand mining in Kaduna Metropolis

| Indicator | Finding reported in the source study |
|---|---|
| Number of miners surveyed | 60 |
| Communities covered | Kukumake, Malalin Gabas, Rafin Guza, Hayin Mallam Bello and Kabala West |
| Daily earnings | ₦3,000–₦5,000 among many miners |
| Weekly earnings | ₦20,000–₦40,000 among many miners |
| Household assets associated with mining income | Housing, farmland and motorcycles |
| Labour-force characteristics | Adult and older people were prominent; youth participation was reported as low |

Source: Nuhu et al. (2026). These are findings from the cited study, not original survey results collected for the present paper.

The reported income ranges suggest that sand mining can support household consumption and asset acquisition. The purchase of housing, farmland and motorcycles indicates that some participants use mining income for purposes extending beyond daily expenditure. Such assets may contribute to household security and provide productive resources for other economic activities.

Nevertheless, the findings should be interpreted cautiously. Reported earnings do not necessarily represent net income after operating costs, transport, equipment, labour payments and other expenses. Nor do the figures establish the income distribution among all miners in Kaduna Metropolis. The source study provides evidence of economic benefits among its

participants, but additional data would be needed to determine how widespread these benefits are and how stable they remain over time.

The findings also have implications for environmental regulation. Where households depend on sand mining, restrictions may affect income and employment. Effective management should therefore combine controls on environmentally damaging practices with realistic livelihood support. This would help avoid placing the burden of environmental protection disproportionately on households with limited alternative employment.

4.2 Environmental concerns associated with sand mining

The literature identifies several environmental concerns associated with river sand mining, including channel alteration, riverbank erosion, turbidity, water-quality deterioration and habitat disturbance. Tripathi et al. (2025) and Park et al. (2026) identify these as recurring issues in river systems affected by extraction, especially where the quantity removed exceeds the natural replenishment of sediment.

Table 2. Environmental issues identified in the reviewed literature

| Environmental issue | Evidence from the reviewed studies | Implication for the River Kaduna corridor |
|---|---|---|
| Riverbed and channel alteration | Identified as a major consequence of excessive extraction in the international reviews | Requires measurements of channel depth, cross-sections and extraction intensity |
| Riverbank erosion | Reported among the environmental concerns in the Odene–Aguleri River study | Requires site-specific assessment to determine the locations and causes of erosion |
| Turbidity and water quality | Reported in the Odene–Aguleri River study and discussed in international reviews | Requires water-quality sampling upstream and downstream of mining sites |
| Aquatic habitat disturbance | Identified in the comparative Nigerian study and international reviews | Requires ecological observations and habitat assessment |
| Groundwater changes | Identified as a potential consequence of excessive extraction in the international review | Requires local groundwater-level measurements |
| River-corridor encroachment | Documented along the Kaduna River by Wuyep et al. (2024) | Requires integrated land-use and mining-site mapping |

Sources: Tripathi et al. (2025), Park et al. (2026), Ogbo et al. (2024) and Wuyep et al. (2024). The table synthesises published findings and identifies local assessment needs; it does not claim that every listed impact has been measured along the study corridor.

The evidence suggests that environmental monitoring should be a central part of sand-mining management. However, it is important to distinguish between impacts documented in the general literature and impacts confirmed at a particular location. For example, channel incision is a recognised risk of excessive extraction, but determining whether it has occurred at a specific River Kaduna site requires repeated measurements of channel depth and shape.

Similarly, water-quality deterioration cannot be established solely from the appearance of water or the presence of mining activity.

Appropriate testing should measure parameters such as turbidity, total suspended solids, pH, electrical conductivity and other relevant indicators. Sampling should cover different seasons and, where feasible, compare upstream and downstream locations to help determine whether observed changes are associated with mining.

This approach would provide a stronger basis for identifying environmental priorities and designing measures proportionate to the risks demonstrated by the evidence.

4.3 River encroachment and wider environmental pressure in Kaduna Metropolis

Wuyep et al. (2024) investigated encroachment along the Kaduna River using satellite imagery, GIS and field surveys for the period 2000–2022. The study reported increasing pressure on sections of the river corridor and identified flood risk, habitat fragmentation and biodiversity loss among the associated concerns. The highest encroachment percentage reported in the study was 47% in the Lower Left Reach Bank Community.

This evidence is relevant because sand mining takes place within a broader river-corridor environment influenced by urban growth and other human activities. Management decisions should therefore consider the combined pressures acting on the river rather than treating sand extraction in isolation.

However, the 47% figure relates to the encroachment finding reported by Wuyep et al.; it is not the percentage of the Kaduna River affected by sand mining. The distinction is important because encroachment can arise from residential development, infrastructure construction, vegetation removal and other forms of land-use change.

A future investigation should map active mining locations and compare them with riverbank condition, land cover and infrastructure. Satellite imagery can help identify changes over time, while field verification can establish whether particular locations are being mined and whether observable changes are associated with extraction. Combining these methods would provide a clearer account of the spatial distribution of sand mining and its possible relationship with river-corridor degradation.

4.4 Comparative evidence from other Nigerian river systems

The study by Ogbo et al. (2024) provides a useful comparison because it examined both environmental and social consequences of sand mining along the Odene–Aguleri River in Anambra State. The authors reported riverbank erosion, increased turbidity, deteriorating water quality and aquatic habitat loss, alongside employment benefits and social concerns.

These findings suggest that the consequences of sand mining are not limited to the physical removal of construction material. Extraction may affect ecological conditions and interact with local livelihoods, especially where people depend on river-related resources.

Nevertheless, comparative evidence should be used to identify questions for investigation rather than to assume identical conditions across locations. Differences in geology, river flow, sediment supply, mining intensity, extraction methods and land use can influence the nature and magnitude of impacts. The findings from Anambra State therefore support the selection of relevant indicators for Kaduna, but they do not establish the severity of impacts in Kaduna Metropolis.

4.5 Relationship between environmental conditions and livelihoods

The evidence indicates that sand mining can provide immediate economic benefits while creating potential environmental costs.

Nuhu et al. (2026) documented income generation and asset acquisition among miners in Kaduna Metropolis, while the wider literature identifies risks associated with channel alteration, bank instability, water-quality deterioration and habitat loss.

Table 3. Potential pathways linking sand mining with community livelihoods

| Mining-related activity | Possible environmental or social change | Potential livelihood implication |
|---|---|---|
| Sand extraction from riverbeds | Changes in channel form and sediment distribution | Possible effects on river-dependent activities and nearby land |
| Disturbance of riverbanks | Bank instability and erosion | Potential loss or damage to land, paths and nearby assets |
| Disturbance of sediment | Increased turbidity or altered aquatic habitat | Possible implications for water use and fishing |
| Employment in mining and transportation | Income generation | Greater ability to meet household needs and acquire assets |
| Competition over mining sites or benefits | Disputes between stakeholders | Possible disruption of community relationships and economic activities |
| Poorly controlled extraction | Accumulation of environmental pressures | Potential longer-term costs for households and public authorities |

Source: Analytical synthesis based on Nuhu et al. (2026), Ogbo et al. (2024), Tripathi et al. (2025) and Park et al. (2026). The pathways are potential relationships requiring field verification, not measured causal effects for the River Kaduna corridor.

The table illustrates why an assessment of the socio-economic implications of mining should consider both direct and indirect effects. Income earned by miners is a direct benefit, while costs associated with environmental change may affect a wider group of residents. Some households may also benefit from mining income while experiencing other costs, meaning that the overall effect on household welfare may be mixed.

A balanced evaluation would therefore consider income, operating expenses, employment conditions, land use, water access, occupational safety, environmental damage and the distribution of benefits. It would also examine whether local communities have effective ways to participate in decisions and raise concerns about mining activities.

The available evidence does not permit a quantitative calculation of the net economic effect of sand mining along the River Kaduna corridor. Such a calculation would require original data on household income, environmental conditions and the economic costs attributable to mining.

### 4.6 Implications for environmental governance

Park et al. (2026) emphasise that sustainable management requires a connection between the drivers of sand demand, the extent of extraction, environmental impacts and management responses. Tripathi et al. (2025) similarly highlight sediment budgeting as a way to balance the demand for construction materials with the need to preserve river systems.

For Kaduna Metropolis, these findings support a management approach based on reliable information about extraction locations, quantities and environmental conditions. Authorities should identify suitable extraction areas, establish locally appropriate limits, protect vulnerable river reaches and monitor compliance with applicable environmental requirements.

Community participation is also essential. Miners may be concerned about employment and income, while farmers, fishers and nearby residents may be more concerned about land, water and infrastructure. Involving these groups can help identify practical solutions and reduce conflict. Where mining restrictions affect household income, alternative livelihood programmes may improve the social acceptability of environmental controls.

The most appropriate management approach is therefore neither unrestricted extraction nor a policy based solely on prohibition. It is a system in which extraction is permitted only under conditions consistent with the river's environmental capacity, and where monitoring, enforcement and livelihood considerations are integrated.

## V. CONCLUSION

This paper examined the environmental and socio-economic implications of sand mining on host communities along the River Kaduna corridor in Kaduna Metropolis through a synthesis of published research.

The reviewed evidence indicates that sand mining can provide income, employment and opportunities for household asset acquisition. The study by Nuhu et al. (2026) demonstrates the economic importance of the activity among surveyed miners in selected riverine communities in Kaduna Metropolis. However, the broader literature identifies environmental risks associated with excessive or poorly controlled extraction, including channel alteration, bank erosion, groundwater changes, water-quality deterioration and habitat disturbance. Research on encroachment along the Kaduna River further demonstrates the importance of managing the river corridor in the face of wider human pressures.

The findings indicate that sand mining should be managed as both an economic activity and an environmental issue. Sustainable management requires reliable information on extraction intensity, monitoring of river conditions, enforcement of appropriate regulations and meaningful participation by host communities. Livelihood support is also important where households depend on mining income and may be affected by restrictions.

A key limitation of this paper is its reliance on secondary evidence. It does not establish the current quantity of sand extracted from the selected corridor, the extent of mining-related erosion, the present water-quality status of the river or the proportion of households affected by specific impacts. These

questions require an original field investigation. The principal contribution of this paper is therefore to synthesise available evidence, clarify the management implications and identify priorities for future research on sand mining along the River Kaduna corridor.

## VI. RECOMMENDATIONS

Based on the reviewed evidence, the following recommendations are proposed.

1. Conduct a corridor-specific environmental assessment. Identify active and inactive mining locations and assess riverbank stability, channel conditions, adjoining land use and nearby infrastructure.
2. Establish an environmental monitoring programme. Measure turbidity, total suspended solids, pH and other relevant water-quality parameters at selected upstream and downstream locations. Monitor river cross-sections and bank conditions over time.
3. Determine extraction limits from local evidence. The quantity and location of extraction should be informed by river characteristics, sediment replenishment and the vulnerability of nearby settlements and infrastructure.
4. Protect sensitive river reaches. Establish appropriate restrictions or exclusion zones around vulnerable banks, bridges, water-intake points, settlements and ecologically important areas, based on local assessment and applicable regulations.
5. Strengthen regulatory enforcement. Relevant authorities should verify permits, inspect mining sites, document extraction volumes and enforce applicable environmental requirements consistently.
6. Promote community participation. Involve miners, farmers, fishers, residents, traditional authorities and relevant government agencies in monitoring, planning and grievance resolution.
7. Support alternative livelihoods. Provide skills development and support for alternative economic activities where environmental restrictions reduce household dependence on sand mining.
8. Improve occupational safety. Encourage safe access to extraction sites, appropriate equipment, safe loading and transportation practices, and procedures for responding to accidents.
9. Require restoration where damage is established. Operators should undertake appropriate rehabilitation of disturbed sites in accordance with applicable environmental requirements.
10. Undertake original empirical research. A field study should combine household questionnaires, key-informant interviews, mining-site coordinates, environmental observations and water-quality measurements. This would allow the environmental and socio-economic implications to be quantified specifically for the selected River Kaduna corridor.

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