

# Environmental and Social Impact of Sand Mining Activities Along the Odene-Aguleri River, Anambra State Nigeria

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## ABSTRACT

Sand mining along the Odene-Aguleri River in Anambra State, Nigeria, presents significant environmental and social challenges, exacerbated by unregulated extraction methods. This research aimed to evaluate the impacts of these activities, focusing on environmental degradation and the ensuing socio-economic effects on local communities. Data were collected through structured questionnaires and interviews with both community members and stakeholders involved in sand mining. The results indicate severe environmental disruptions, depreciated water quality, riverbank erosion, loss of aquatic habitats, and increased river turbidity, which affect the river's health and local biodiversity. Economically, while sand mining provides significant employment opportunities, it also results in land disputes and alters the socio-economic dynamics of the communities. The community of Odene-Aguleri reported higher incidents of erosion and habitat loss, emphasizing the urgent need for regulatory oversight. The findings of this study suggest that despite its economic benefits, the current practice of sand mining along the Odene-Aguleri River is unsustainable and detrimental. It is recommended that strict environmental regulations be implemented to mitigate the negative impacts.

## INTRODUCTION

Sand, a seemingly abundant natural resource is under increasing pressure due to its critical role in construction. The global demand for sand is projected to deplete its availability by 2050, raising concerns about its sustainability [Rentier & Cammeraat, 2022]. Sand mining which is the process of extracting sand from various locations, fulfills this demand but this comes at a significant environmental cost.

While sand mining contributes to economic development and construction projects [Akanwa, 2020], unregulated practices, particularly in riverine environments, pose substantial threats [Nwobodo, 2023; Rentier & Cammeraat, 2022]. The ecological consequences are vast, ranging from landscape disruption and deforestation to the creation of stagnant water bodies that become breeding grounds for pests [Lawal, 2011]. Habitat destruction due to sand mining can also lead to biodiversity loss and displaces wildlife populations [Aigbedon & Iyayi, 2008].

The slow rate of sand replenishment necessitates a sustainable approach that balances economic benefits with environmental protection [Aliu, Akoteyon, Soladoye, 2022]. Uncontrolled sand extraction can lead to the formation of sinkholes, soil contamination, and coastal erosion, jeopardizing infrastructure and ecosystems [Asabonga, 2017].

The negative environmental impacts of sand mining are well documented. Erosion and sedimentation disrupt the physical environment, impacting river health and agricultural productivity [Dissanayake & Rupasinghe, 1996]. Studies reveal a strong correlation between sand mining activities and a cascade of

environmental issues, including soil erosion, vegetation loss, reduced aquatic biodiversity, and landslides [Asabonga, 2017]. Water pollution from sand mining activities further exacerbates environmental degradation [Sridhar, 2019].

Hydrological and geomorphic processes are also disrupted by sand mining. This disrupts sedimentation rates, alters shorelines, and can even trigger landslides, fundamentally changing the landscape [Amir, 2016]. Aquatic ecosystems are particularly vulnerable, experiencing habitat disturbances, reduced fish populations, and increased river turbidity, jeopardizing entire food webs [Sridhar, Ana & Laniyan, 2019; Tastet, 2019].

The widespread and unregulated sand mining in coastal regions can have far-reaching consequences for both the environment and the socio-economic well-being of local communities [Gondo, Mathada, & Amponsah-Dacosta; 2017]. Land-use conflicts due to sand mining's negative externalities further weaken livelihoods, displacing communities and disrupting traditional ways of life [Turner & Lambin, 2007].

The collapse of a bridge in Portugal attributed to excessive sand mining serves as a stark reminder of the potential dangers of unregulated practices [Molly, 2017]. While sand mining supports urbanization, it can severely undermine environmental sustainability, particularly in ecologically sensitive coastal areas [Aliu, Akoteyon, Soladoye, 2022]. In Nigeria, sand mining has displaced communities and contributed to habitat loss, flooding, and coastal erosion especially due to lack of proper regulations [Mazz, 2023; Aliu, Akoteyon, Soladoye, 2022].

The situation along the Odene-Aguleri River in Anambra State, Nigeria also exemplifies this problem. In Odene-Aguleri, sand mining has reached alarming levels, raising concerns among residents and community leaders. Uncontrolled extraction using heavy duty machineries and dredgers across all sides of the river blatantly disregards environmental well-being. This unregulated activity has even resulted in social conflicts among indigenous communities due to the lack of a proper regulatory framework for sand exploitation and the sharing of revenues collected from tipper drivers.

The intensive sand mining has demonstrably increased coastal erosion and altered the natural course of the river. In response to the escalating gully erosion witnessed along the riverbanks, the Anambra State government recently imposed a ban on illegal mining activities. However, this ban has proven ineffective, as sand mining continues to thrive in the area. As a result, this research aims to study the environmental and social impacts of sand mining along the Odene-Aguleri River, Anambra East LGA, Anambra State. To achieve this aim, three specific objectives are pursued, viz a viz: classification of the type of sand being mined in the study area based on Shaffer 2007 classification; the assessment of the environmental effects of sand mining in Odene-Aguleri river; and finally to examine the socio-economic effects of sand mining on local communities in the study area.

## **MATERIALS AND METHODS**

### **Research Design**

This study will adopt a mixed-methods approach, employing both quantitative and descriptive research designs. Data will be collected from a combination of secondary and primary sources. Secondary data will include scholarly articles, government reports, and relevant online resources that explore sand mining and its environmental and socio-economic impacts. Primary data collection will involve directly engaging with the study area. Semi-structured interviews with community leaders, sand miners, and government officials will gather valuable insights. Additionally, structured questionnaires will be administered to residents in communities directly affected by sand mining activities. Field observations and measurements of the riverbank morphology, erosion patterns, and sand mining activity levels will be conducted. Geospatial data will be collected using GPS mapping, satellite imagery analysis, and Geographic Information Systems (GIS)

software.

A purposive sampling technique will be employed alongside systematic random sampling to ensure focused representation. Communities directly impacted by sand mining activities within the designated 10km study area will be targeted. This combined approach ensures a balance between capturing the diversity of experiences and perspectives within the affected population while maintaining a statistically generalizable sample. This multi-faceted data collection strategy will provide a comprehensive understanding of the environmental and socio-economic effects of sand mining practices along the Odene-Aguleri River.

### **Method of Data Collection**

This study aimed to investigate the environmental and social impacts of sand mining activities along the Odene-Aguleri River in Anambra State and to explore sustainable sand mining practices for the region. To achieve these objectives, the study employed three specific methodological approaches.

Firstly, particle size analyses were conducted to determine the grain size distribution of the sand being mined. This procedure was essential for classifying the sand according to the Shaffer (2007) classification system, providing a detailed understanding of the specific type of sand present in the study area. Secondly, the environmental impacts of sand mining on the Odene-Aguleri River were assessed through a comprehensive evaluation. This involved examining changes in river morphology, aquatic habitat conditions and local resident responses to a questionnaire survey. Data collection was carried out through field observations and questionnaire survey. Thirdly, the social and economic impacts of sand mining on local communities were investigated using a questionnaire survey. This survey gathered data on various aspects, including the dependence of local livelihoods on sand mining, potential conflicts arising from the activity, and any economic benefits accrued by the local population.

Both surveys targeted a representative sample of community members to ensure a comprehensive understanding of the environmental and socio-economic implications of sand mining. By integrating these methodological approaches, the study provided a holistic understanding of the environmental and social impacts of sand mining and proposed sustainable practices for sand mining in the Odene-Aguleri River region.

### **Data Analysis and Presentation**

A multifaceted approach will be employed to analyze the data collected in this study. Quantitative data, such as survey responses and field measurements, will be analyzed using descriptive statistics like frequencies and percentages. This will be facilitated by software like Microsoft Excel for basic calculations and visualizations, while SPSS will enable more advanced analyses such as chi-square tests to assess the significance of sand mining activity levels. Qualitative data from interviews will undergo thematic analysis to identify recurring themes and patterns in the experiences and perspectives of stakeholders. Geospatial data collected through GPS mapping, satellite imagery, and GIS will be processed and analyzed using ArcGIS software to generate spatial maps depicting the extent and distribution of sand mining activities. Finally, a chi-square test will be conducted on data regarding the number of sand mining sites. This multi-pronged data analysis approach will provide valuable insights to formulate recommendations for addressing the environmental and socio-economic challenges arising from sand mining practices along the Odene-Aguleri River.

### **Study Area**

The study area is Odene-Aguleri, one of the communities that make up Aguleri town in Anambra East LGA, Anambra State, Nigeria. It is located between latitude 6<sup>0</sup> 12' N and longitudes 6.88' E and latitude 6.23' N

and longitude 6.53' E respectively. It is bounded by Umueri, Ana and Nando in the west; Anaku, Omor, and Omasi in the east; Igaah and Ojijor in the south and Odeke of Ibaji LGA, Kogi State in the north (Isichei, 1997). The tradition history traces the origin of Aguleri (including Odene-Aguleri) to a man named Eri. Eri settled at the river bank of the river where he made his altar at the confluence of Ezuna-Omabala Rivers. Due to annual flooding of the place Eri moved upland to Eri-aka near odanduli stream and finally to where he erected Obu Uga (Obu Gad) (Chikwenze, 2004). Figures below (1.1 and 1.2) show maps of Nigeria, Anambra State and Anambra East LGA showing the study area. The maps provide a visual representation of the geographic location of the study area.



Fig 1.1: Map of Anambra State showing Anambra East LGA

Source: Ezenwaji and Nzomiwu (2018)



Fig 1.2: Map of Anambra East showing study area

Source: Google Map (2023)

## RESULTS

### Classification of the Type of Sand Being Mined in the Study Area Based On Shaffer 2007 Classification

From the sieve analysis results shown in table 1 below, fineness modulus of Odene-Aguleri River sand indicates that, very fine to medium grain particle sizes are widely found in the river. Site 1 (S1) has predominantly fine sand, especially in the 300 micron size range. Sand from (S2) site have very fine particle size. Site 3 (S3) has the highest percentage (98.23%) while there are variations, fine sand dominates across all particle size categories at Site 1,. Fineness modulus value is within the standard values as per IS. The Gradation of fine aggregates shows, mostly poor graded sand as shown in Table 4.3. Poor graded aggregates

require blending for good results in structures (Nayaju and Tamrakar, 2019).

Table 1: Sieve Analysis of the Soil aggregates being mined in the Study Area

Particle Size	S1	S2	S3	S4	Visibility
10mm	0.82	0.15	0.26	0.83	Natural Eyes
4.75mm	7.08	0.64	0.41	0.84	Natural Eyes
2.36mm	12.72	0.95	0.77	11.24	Natural Eyes
1.18mm	22.34	9.82	2.76	17.11	Natural Eyes
600micron	60.48	29.49	51.94	42.72	Electron Microscope
300 micron	86.85	81.89	91.04	83.12	Light Microscope
150 micron	96.56	94.55	98.23	94.16	Light Microscope
Sum	286.81	217.49	245.51	258.51	
Fineness Modulus	2.86	2.17	2.45	2.53	

Source: Field Study, 2024

### The Environmental Effects of Sand Mining in Odene-Aguleri River

An analysis of respondent data revealed several concerning environmental effects associated with sand mining activities in the Odene-Aguleri River.

**Deteriorating Water Quality:** A majority of respondents expressed concerns about the declining water quality of the river. Increased turbidity and sedimentation were frequently reported, negatively impacting aquatic life and the suitability of the water for domestic purposes.

**Decline in Aquatic Habitat:** Residents reported a noticeable decrease in fish populations and the disappearance of specific aquatic species since the commencement of sand mining activities. Some respondents directly attributed this loss to habitat destruction caused by dredging and the disturbance of riverbeds.

**Erosion of Riverbanks:** Several respondents raised concerns regarding the heightened erosion along the riverbanks, which they linked to extensive sand extraction. Instances of riverbank collapse and increased vulnerability to flooding in nearby agricultural lands and residential areas were noted.

**Deepening and Widening of the River Channel:** Physical observations revealed a significant deepening and widening of the Odene-Aguleri River channel due to excessive sand mining. These morphological changes are indicative of altered hydraulic characteristics, potentially impacting sediment transport and the overall dynamics of the river.

These findings highlight the significant environmental consequences of unregulated sand mining on the Odene-Aguleri River. The deterioration of water quality, decline in aquatic habitat, erosion of riverbanks, and altered river morphology all pose serious threats to the ecological health and sustainability of the river ecosystem.

### Impact of Sand Mining Activities Erosion along Odene-Aguleri River

The mean likert score of approximately 1.98 suggests that on average, respondents leaned toward agreement with the statement that sand mining activities caused erosion along Odene-Aguleri River. The standard deviation of 1.326 indicates a moderate level of variability in the responses, implying that while there is a

general consensus, there are some variations in the opinion of the respondents. The high frequency of “Strongly Agree and Agree” responses (80 and 70 respondents respectively) showed that a significant portion of the respondents acknowledge the connection between sand mining and river erosion in the study area. The “Neutral” responses from 30 participants indicate a subset of respondents who might be unsure or have mixed opinions. The result therefore suggests a significant agreement among respondents that sand mining contributes to river erosion in Odene-Aguleri River.

Table 2: Impact of Sand Mining on Erosion along Odene-Aguleri River

	SA(%)	A(%)	NS(%)	D(%)	SD(%)	Mean	STD
Sand mining activity causes erosion along Odene-Aguleri river	80(40)	70(35)	30(15)	14 (7)	6(3)	1.98	1.326
Criterion mean =2.50							

Source: Field Study, 2024

### Socio-Economic Effects of Sand Mining in the Study Area

The findings show that, there are both negative and positive effects due to sand mining activity on socio-economic lives of the residents. On the side of negative there are conflicts among villagers, on the other side there is an employment opportunity to youths.

### Employment Opportunity

The study reveals a general awareness among the population regarding sand mining activities and their associated benefits. Sand mining offers employment opportunities for local residents, particularly in roles such as truck loading and sales. This positive impact is reflected in the high number of individuals directly involved in sand mining activities.

As shown in Table 3 below, approximately 65% (130 respondents) participate directly in sand mining.

Table 3: Job opportunities Influenced by Sand Mining

Item	Options	Frequency	Percentage
Do you engage in sand mining activities?	Yes	230	65
	No	70	35
Total		400	100

Source: Field Study, 2024

### Income Generation from Sand Mining in the Study Area

The standard deviation (STD) of approximately 1.236 suggests a relatively low level of dispersion in the likert scale responses. In the context of this research on sand mining and household income generation in Odene-Aguleri community, this implies that the respondents’ opinions clustered around the mean Likert scale response of 2.075. a lower standard deviation indicates that the majority of responses are close to the mean, reinforcing the significance of the proportion of respondents who strongly agree and agree. This could be interpreted as a higher level of consensus among the participants regarding the positive impact of sand mining on household income generation. Overall, the finding suggests a prevailing positive perception among the surveyed population regarding the positive impact of sand mining on household income in

Odene-Aguleri.

Table 4.9: Income Generation from Sand Mining in the Study Area

Sand mining activity increase household income generation in Odene-Aguleri community	SA(%)	A(%)	NS(%)	D(%)	SD(%)	Mean	STD
	100(50)	60(30)	10(5)	5(2.5)	5(2.5)	2.075	1.236
Criterion mean =2.50							

Source: Field Study, 2024

### Sand Mining and Agricultural Activities near Odene-Aguleri River

The mean likert scale response for the above is 3.8, indicating a general agreement among respondents that sand mining negatively affects agricultural activities in Odene-Aguleri. This mean value suggests a moderate to strong agreement on average. The standard deviation of approximately 1.174 implies that the responses are somewhat dispersed around the mean. While there is a consensus on the negative impact of sand mining on agriculture, there are variations in individual opinions. This could be attributed to diverse perspectives within the surveyed population. The findings reveal a prevalent concern among the individuals in Odene-Aguleri community, regarding the negative impact of sand mining on agricultural activities in Odene-Aguleri.

Table. 4.6: Sand Mining and Agricultural Activities near Odene-Aguleri River

Sand Mining negatively affects agricultural activities in Odene-Aguleri community	SD(%)	D(%)	N(%)	A(%)	SA(%)	Mean	STD
	20(10)	20(10)	20(10)	60(30)	80(40)	3.8	1.174
Criterion Mean= 2.50							

Source: Field Study, 2024

### Existing Conflicts Over Land Use in the Study Area

Discussions with key stakeholders revealed ongoing conflicts reported to both traditional rulers and government agencies. The primary conflict concerned the unequal distribution of sand mining royalties among youth leaders in different Odene-Aguleri villages. This dissatisfaction has led to some instances of obstructing sand mining operations. Additionally, damage caused by heavy trucks transporting sand to other towns emerged as another concern. One stakeholder described how the community leader temporarily halted sand mining activities due to fears of bridge collapse. However, the stakeholder further alleged that mining investors used government connections to resume operations.

Interviews with a government official yielded a contrasting perspective on the bridge's structural integrity. They asserted that the bridge was designed to withstand the weight of multiple heavy-duty trucks simultaneously, denying any safety concerns. This conflicting information highlights a potential lack of consensus between community leaders and government officials, potentially hindering enforcement of environmental regulations and promoting sustainable practices.

These findings resonate with Aromolaran's (2012) study on the effects of sand mining on rural communities in Ogun State, Nigeria. While some residents acknowledged the benefits of sand mining, the negative



environmental impacts on their land outweighed those benefits.

## DISCUSSION

This study investigated the multifaceted impacts of sand mining activities in the Odene-Aguleri River area. The findings highlight a complex interplay between environmental consequences, socio-economic benefits, and land-use conflicts.

Sieve analysis identified fine sand as the dominant type being mined. A study by [Koirala, Madhav & Joshi, Buddhi, 2017] emphasizes that these factors significantly influence the suitability of sand for various construction applications.

The study also revealed concerning environmental effects associated with sand mining. These include deteriorating water quality, decline in aquatic habitat, erosion of riverbanks, and altered river channel morphology. These findings are consistent with those reported by [Koehnken, & Rintoul 2018], who documented similar consequences in riverine ecosystems due to sand extraction activities.

Our findings highlight positive socio-economic aspects of sand mining, particularly job creation for youths and increased household income generation. This aligns with the observations of [Onwuka, Duluora & Amaechi, 2013], who found that sand mining activities can provide a source of livelihood for local communities in resource-limited settings.

The study identified conflicts related to royalty sharing, infrastructure damage by heavy trucks, and disagreements between community leaders and government officials. These conflicts might stem from unclear regulations or lack of transparency in governance. Examining the root causes of these conflicts is crucial for establishing a more harmonious and sustainable approach to sand mining.

## CONCLUSION AND RECOMMENDATIONS

In conclusion, the investigation into sand mining activities in the Odene-Aguleri River area exposed a complex web of environmental consequences, socio-economic benefits, and land-use conflicts. The environmental impacts, including declining water quality and habitat loss, necessitate stricter monitoring and the implementation of mitigation strategies. On the positive side, sand mining offers employment opportunities and income generation, echoing findings from other studies. However, a deeper look into income distribution within the community is warranted. Land-use conflicts was significant and highlights the need for clearer regulations and improved communication between stakeholders.

## SUGGESTIONS FOR CONFLICT RESOLUTION

To address the conflicts identified in the study, a detailed and comprehensive framework for conflict resolution among stakeholders is essential. This approach involves several interconnected strategies designed to promote transparency, collaboration, and sustainable practices in sand mining activities.

First, community engagement sessions are pivotal in fostering dialogue and mutual understanding among stakeholders. Regular dialogues should be established, involving community members, sand mining operators, and government officials. These sessions aim to create a platform where grievances can be aired and concerns addressed. Participatory decision-making processes must be integrated into these sessions, ensuring that local communities have a voice in decisions regarding sand mining activities. This inclusive approach can help mitigate conflicts by making community members feel valued and heard, ultimately leading to more acceptable and sustainable solutions. Research by Ampofo *et. al* (2022) emphasizes the

importance of community engagement and participatory decision-making in managing environmental resources sustainably.

Second, the development and implementation of transparent royalty distribution mechanisms are crucial. Clear guidelines for royalty distribution need to be established to ensure transparency and equity. These guidelines should be developed in consultation with all stakeholders, detailing how royalties are calculated, collected, and distributed. Public disclosure of this information is essential, as it builds trust and accountability. Ensuring that all stakeholders have access to information regarding royalty payments and distributions can help reduce disputes over financial matters, fostering a sense of fairness and transparency. According to Brusca, Rossi, and Aversano (2018), transparency in resource revenue management is key to reducing corruption and building trust among stakeholders.

Third, a comprehensive infrastructure management plan is necessary to address the negative impacts of sand mining on local infrastructure. This plan should include regular maintenance and repair of roads and other infrastructure affected by heavy trucks used in sand mining operations. Collaborating with mining companies to share the cost of infrastructure maintenance and improvement can alleviate the financial burden on local communities and government bodies. Additionally, impact mitigation strategies should be developed, focusing on minimizing the adverse effects of sand mining on local infrastructure. This could involve using alternative routes for heavy trucks or implementing weight restrictions to protect vulnerable areas. Studies by Angelstam et al. (2017) have shown that collaborative infrastructure management can effectively mitigate the adverse impacts of resource extraction on local infrastructure.

Fourth, the formation of conflict resolution committees can provide a structured approach to managing and resolving disputes. These committees should comprise representatives from all stakeholder groups, including community members, mining operators, and government officials. The role of these committees is to mediate disputes, facilitate dialogue, and ensure the implementation of agreed-upon solutions. Capacity-building initiatives are essential to equip committee members with conflict resolution techniques and best practices. Training sessions and workshops can enhance their ability to effectively manage and resolve conflicts, promoting a more harmonious relationship among stakeholders. Oyedokun and Lawal (2017) highlights the effectiveness of locally grounded conflict resolution committees in managing and resolving community disputes. The study highlighted that community leaders effectively used dialogue, village committees, and law enforcement agencies to mediate disputes, which helped in managing conflicts effectively

Finally, the enhancement of the regulatory framework governing sand mining activities is imperative. A thorough review and revision of existing policies and regulations are necessary to address gaps and ambiguities that contribute to conflicts. In situations where no policy, exist, one should be created. To do this, involving and consulting with stakeholders to identify areas of concern and incorporating their input into policy revisions is critical. Strengthening enforcement mechanisms is also critical to ensure compliance with regulations. A study by Maliganya and Bengesi (2023) underscores the importance of effective regulatory frameworks and enforcement mechanisms in ensuring sustainable mining practices.

By integrating these strategies, the root causes of conflict can be addressed. The emphasis on transparency, community engagement, infrastructure management, conflict resolution, and regulatory enhancement provides a holistic approach to promoting sustainable and harmonious sand mining practices in the Odene-Aguleri River region.

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