

Original Research Article

Impact of Socioeconomic Factors on Sand Mining in Freshwater Ecosystems in Selected Areas in Rivers State of Nigeria

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Abstract: Alterations in freshwater ecosystems due to sand mining lead to changes in sediment structure, water chemistry, and community dynamics of aquatic organisms. This study assessed the socioeconomic factors and their impact on sand mining in freshwater ecosystem services in selected areas of Rivers State, Nigeria, namely Akpajo, Rumokparaeli, and Chokocho communities. The study examined the available freshwater ecosystem services before sand mining, the current state of these services, and the social and economic impacts of sand mining activities on the host communities. A descriptive research design was adopted, and data were obtained through questionnaires, field observations, and relevant literature. The collected data were analyzed and interpreted in line with the research questions. The findings revealed that freshwater ecosystems in the study area provided vital ecosystem services before sand mining, including fishing activities, water supply, and livelihood support for the communities. However, continuous and intensive sand mining activities have significantly altered the freshwater ecosystems. Evidence from the study indicated land degradation caused by sand mining, abandonment of fish ponds, abandonment of homes, destruction of riparian vegetation, reduced water quality, and decline in freshwater ecosystem services. The study further showed that socioeconomic factors such as population growth, economic activities, and increased demand for construction materials have intensified sand mining activities in the study area. The study concluded that sand mining has negatively affected freshwater ecosystem services and the socio-economic conditions of the communities. It emphasized the need for proper management, regulation, and sustainable sand mining practices to reduce environmental degradation and ensure the sustainability of freshwater ecosystems in the study area.

Keywords: Sand Mining; Freshwater Ecosystem Services; Socioeconomic Factors; Environmental Degradation; Rivers State

1. INTRODUCTION

In the history of Rivers State, rivers were created as a natural resource that could support the life functions of organisms to stay alive. Sand mining is done by people using manual methods. Equipment used was a shovel and carrying poles. The majority of sand mining was done by the community's people. Sand content in the river was abundant. Sand thickness was about one to one and a half meters, especially during the rainy season when the river experienced a flood. Sand contained in the river came from sediments resulting from the sedimentation of materials in the river. Nicholas (2009) defined sedimentation as a deposition process of materials transported by water, wind, ice or glaciers in a basin. The sedimentation process comprises weathering, erosion, transportation and deposition. Materials found in the river consisted of stones and other materials that were eroded and settled, and became sand. Miners used a shovel and a stainless steel tool in a rectangular shape with a size of 40x30 cm to dig sand in the riverbed. Sand in the river was excavated and put in a basket. When the baskets were full, the miners would carry them using carrying poles to be collected in the courtyard.

Sand mining causes degradation and severe effects on fish, causing problems for people who rely on fishing for their livelihoods. Sand excavation causes the removal of beachside buildings and disrupts tourism activities on the beaches. Many residents complained about the problems caused by the sand mining activities, which likely reduced their water quality, loss of wildlife, loss of aquatic life and habitat and also affected the river channel, threatening bridges and riparian habitat and livelihood because most people depend on the freshwater ecosystems. The activities of the sand mining industry in Akpajo, Rumokparaeli and Chokocho certainly bring positive or negative impacts on the socio-economic conditions of the community. Based on this background, the researcher intends to conduct a study on the recent impact that sand mining on freshwater ecosystem conditions has caused on the communities of Akpajo, Rumokparaeli and Chokocho. The objectives of this study are to identify the economic impact of sand mining on the freshwater ecosystem services in the study area and evaluate the environmental conflicts and governance issues surrounding sand mining in the freshwater ecosystem in the study area.

2. LITERATURE REVIEW

Sand Mining in Nigeria

According to the Nigerian Bureau of Statistics-NBS (2017), sand is the fourth highest mined solid mineral in the country as of 2017, when a figure of over 1.3 million metric tonnes was recorded. However, this figure could be very far less than the amount of actual sand extracted in the country, considering the fact that sand mining is largely informal, illegal, unrecorded and unchecked in many states and local governments. Sand mining is increasingly becoming an ecological problem (Lawal, 2011), as demand rises in several states of Nigeria's industry and building sectors. Mining is carried out both legitimately and illegally, resulting in environmental degradation. Sand mining takes place on a small and large scale in many locations in the country. With a 16 million housing deficit (Ezekiel et

al, 2011) and infrastructure development in Nigeria, sand and other construction materials will continue to be in high demand in developing locations like Ado-Ekiti, the capital of Ekiti State in Southwest Nigeria (Omole & Ajakaiye, 1998).

Environmental Problems of Dredging and Their Mitigation

Dredging is crucial for various purposes and poses significant environmental challenges that require careful consideration and mitigation measures. Here, we explore some of the environmental problems associated with dredging and discuss strategies for mitigating their impacts:

1. Sediment Disruption:

Problem: Dredging disturbs and suspends sediments on the seabed or riverbed, leading to increased turbidity and reduced light penetration in the water column.

Mitigation: To address this issue, sediment curtains, also known as turbidity barriers, can be deployed around the dredging area to contain and settle suspended sediments. Additionally, scheduling dredging during non-spawning seasons for aquatic life can reduce the impact.

2. Habitat Destruction:

Problem: Dredging can harm benthic bottom-dwelling ecosystems and the organisms that rely on them by physically removing or altering habitats.

Mitigation: Efforts can be made to identify and protect critical habitats before dredging commences. In some cases, beneficial reuse strategies may involve using dredged materials to create new habitats or restore damaged ones.

3. Water Quality Degradation:

Problem: Increased turbidity, along with the release of contaminants from dredged materials, can negatively affect water quality.

Mitigation: Implementing sediment control measures, such as sediment ponds or settling basins, can help remove suspended particles before discharge. Additionally, thorough testing and treatment of dredged materials may be necessary to mitigate contamination risks.

4. Noise Pollution:

Problem: Dredging operations can generate underwater noise, which can disrupt marine life and communication between aquatic species.

Mitigation: Noise-reducing technologies, quieter equipment, and scheduling dredging activities to minimize their impact on sensitive species can help mitigate noise pollution.

5. Invasive Species Spread:

Problem: Dredging can inadvertently transport invasive species from one water body to another, leading to ecological imbalances.

Mitigation: Implementing strict biosecurity measures and cleaning equipment to prevent the spread of invasive species is crucial. This includes decontaminating dredgers and equipment before and after use.

6. Chemical Contamination

Problem: Dredging can release chemicals, heavy metals, or other contaminants trapped in sediments into the water, posing risks to aquatic life and human health.

Mitigation: Rigorous testing of sediments, proper disposal of contaminated materials, and adherence to environmental regulations are essential to prevent chemical contamination. Remediation of contaminated sediments may also be necessary (Cooper et al., 2008).

7. Erosion and Shoreline Impact:

Problem: Dredging can alter sediment dynamics, leading to increased erosion in some areas and sediment deposition in others.

Mitigation: Implementing shoreline stabilization measures and carefully planning dredging projects to minimize unintended erosion and sediment transport can help mitigate these impacts.

8. Cultural and Historical Heritage:

Problem: Dredging can potentially damage or destroy submerged cultural and historical heritage sites (Ohimain et al., 2004).

Mitigation: Conducting thorough surveys to identify and protect cultural and historical sites in dredging areas is crucial. Dredging plans should be adjusted to avoid impacting such sites whenever possible.

Mitigating the environmental problems associated with dredging requires a comprehensive approach that considers the specific characteristics of each project and its ecological context.

Environmental impact assessments, stakeholder engagement, and adherence to relevant regulations are essential components of responsible dredging practices. As technology advances and environmental awareness grows, the progress and acceptance of inventive and eco-friendly dredging methods will increasingly aid in reducing the ecological impact of this crucial process (Peter et al., 2021).

Sand Budget

In general, the sediment budget is defined as the material transport volume balance for a selected segment of the coast or river. The elements of the budget are processes that increase (sources) or decrease (sinks) the quantity of sand in a defined control volume (Coastal Engineering Research Centre, 1984). Determining the sand budget for a particular stream or catchment requires site-specific topographic, hydrologic, and hydraulic information. This information is used to determine the amount of sand that can be removed or mined from the area or environment without causing undue erosion or degradation,

either at the site or at a nearby location, upstream or downstream (Ghani et al., 2003). Sand and gravel mining in or near the channel alters the sediment budget and can cause significant temporal and spatial changes in channel hydraulics (Brown, 1996). Minimizing the detrimental consequences of sand-and-gravel mining necessitates a thorough understanding of the channel's sensitivity to perturbations caused by mining. The definition of a reference state, i.e., a minimally acceptable or agreed-upon physical and biological condition of the channel, as well as the sand budget, is required for decisions on where to mine, how much, and how often (Chauhan, 2010).

Freshwater Ecosystem

A freshwater ecosystem is a body of water with low salt concentration, less than 1% and includes lakes, ponds, rivers, streams, and wetlands. These ecosystems support a variety of plants and animals adapted to the specific conditions. They are crucial for providing drinking water, supporting agriculture, and maintaining biodiversity. Freshwater is a fundamental resource for human life, and the services provided by surface freshwater ecosystems underpin global water security, food security and economic productivity (Hanjra & Qureshi, 2010). Freshwater ecosystems occur in freshwater systems, including lakes, ponds, streams and rivers, and in the wetlands, marshes, swamps and bogs associated with these waterbodies. Freshwater systems provide multiple services to both humans and the environment, including;

1. Providing water for consumption, energy, and transportation;
2. Cultural amenities such as recreation, tourism and religious significance;
3. Maintaining water quality, flood and erosion control, and
4. Supporting biodiversity and ecosystems.

Functions such as nutrient and carbon cycling and primary production (Aylward et al, 2005). The intensifying exploitation of freshwater resources to meet the water, energy and food needs of a rapidly growing global population often places biodiversity and other ecosystem functions at risk. The degradation of these services is exacerbated by climate change and variability. Surface freshwater is among the most anthropomorphically modified ecosystems on Earth (Carpenter et al, 2011), and is exceptionally vulnerable to climate change. Freshwater ecosystems support 10% of the world's animal species, and nearly 35% of all vertebrate species (Stendera et al, 2012). Unfortunately, freshwater ecosystems have the highest rates of biodiversity loss globally, and may be the most endangered ecosystems in the world. During that period of sand mining, the community suffered losses. (Dudgeon et al., 2006). Freshwater ecosystems are also increasingly recognized as an important factor in the global carbon cycle. Carbon emissions from surface inland waters are estimated to be on the same order of magnitude as carbon emissions from deforestation or carbon uptake from oceans (Tranvik et al, 2009).

3. METHODOLOGY

This study adopted an interpretative research philosophy to investigate the socioeconomic and environmental impacts of sand mining on freshwater ecosystem

services in selected communities of Rivers State, namely Akpajo, Chokocho, and Rumuokparalie. The interpretative approach was considered appropriate because it focuses on understanding social phenomena through the perspectives, experiences, and meanings that individuals attach to them. Since the study sought to examine how sand mining affects community livelihoods, environmental quality, and freshwater ecosystem sustainability, it was necessary to gather insights directly from those who live and work within the affected areas.

A descriptive research design was employed to provide a systematic and comprehensive assessment of the current conditions of freshwater ecosystems and the associated social and economic implications of sand mining. The population of the study consisted of youths, landowners, fishermen, sand miners, community stakeholders, employees, and chairpersons who depend directly or indirectly on freshwater resources for their livelihoods. These groups were selected because of their direct exposure to sand mining activities and their practical knowledge of environmental changes within the communities.

Data collection was carried out using both primary and secondary sources. Primary data were obtained through structured questionnaires, interviews, and direct field observations. The questionnaire design incorporated a five-point Likert scale to measure respondents' perceptions of environmental, social, and economic impacts. Secondary data were gathered from textbooks, journal articles, conference papers, government documents, and other relevant publications to provide theoretical and empirical support for the study. The use of both primary and secondary sources enhanced the validity and reliability of the research findings.

The study adopted a mixed-method approach to data analysis, integrating both qualitative and quantitative techniques. Quantitative data were analyzed using descriptive statistics and the Relative Importance Index (RII) to rank the severity and significance of identified impacts. Qualitative responses were analyzed interpretatively to provide deeper insight into community experiences and perceptions. This combined analytical approach ensured a balanced and comprehensive evaluation of the issues under investigation.

4. RESULTS AND FINDINGS

The results of the study reveal that sand mining has become a dominant economic activity in the selected communities. A significant proportion of respondents indicated active involvement in sand mining, highlighting its importance as a source of employment and income generation. The findings show that sand mining contributes to infrastructure development, including the construction of roads, bridges, and residential buildings. Additionally, it generates government revenue through taxes and permits and provides job opportunities for both skilled and unskilled labor. These economic benefits explain the rapid expansion and continued reliance on sand mining within the study area.

However, despite these economic advantages, the study identified substantial environmental degradation resulting from sand mining activities. The destruction of aquatic

vegetation and wetlands ranked as the most significant environmental impact. Respondents reported that continuous sand excavation has altered riverbanks, increased erosion, and disrupted natural water flow patterns. Changes in sediment transport and water depth were also identified as major environmental concerns. Furthermore, water quality degradation, reduction in biodiversity, and damage to fish habitats were observed, all of which have weakened the capacity of freshwater ecosystems to provide essential services.

The findings also highlight significant social consequences associated with sand mining. Social conflict emerged as the most critical issue, reflecting tensions between mining operators and community members. Health risks were also reported, particularly due to dust pollution, noise from heavy equipment, and unsafe environmental conditions. Food insecurity and loss of livelihood were identified as major concerns, especially among fishermen and farmers whose economic activities depend on healthy freshwater ecosystems. In some cases, displacement of residents and abandonment of homes were reported due to environmental degradation and safety concerns. These findings demonstrate that the social costs of sand mining extend beyond economic calculations and deeply affect community well-being.

5. DISCUSSION OF FINDINGS

The discussion of findings indicates that prior to the intensification of sand mining activities, freshwater ecosystems in the selected communities were relatively stable and capable of supporting sustainable livelihoods. Fishing, small-scale farming, and domestic water use were common economic activities supported by clean and functional freshwater systems. However, the introduction and expansion of large-scale sand mining have significantly disrupted the ecological balance.

The destruction of wetlands and aquatic vegetation has reduced habitat availability for aquatic organisms, leading to declining fish production and reduced biodiversity. Alterations in water flow and sediment patterns have contributed to riverbank instability and increased flooding risks. Water quality deterioration has further limited the availability of safe water for domestic use and agricultural purposes. These environmental changes have directly impacted community members who depend on freshwater resources for survival.

The study further reveals that socioeconomic pressures such as unemployment, rapid population growth, urban expansion, and increasing demand for construction materials have intensified sand mining operations. These pressures have created a situation where economic survival often takes precedence over environmental sustainability. The absence of strict monitoring and enforcement mechanisms has allowed environmentally harmful practices to persist. Consequently, the long-term sustainability of freshwater ecosystem services is threatened, and the overall resilience of affected communities is weakened.

RECOMMENDATIONS

The study concludes that sand mining in the selected communities of Rivers State presents a complex interaction between economic development and environmental sustainability. While the activity contributes to employment generation, infrastructure growth, and increased government revenue, its environmental and social costs are profound. The destruction of aquatic vegetation, alteration of hydrological systems, water quality degradation, loss of biodiversity, and increased social conflicts collectively demonstrate that the negative impacts outweigh the short-term economic gains.

The findings emphasize the urgent need for sustainable management of sand mining activities. Effective environmental regulations must be developed and strictly enforced to prevent further degradation of freshwater ecosystems. Regulatory frameworks should incorporate reclamation plans, environmental monitoring systems, and accountability mechanisms to ensure compliance. Stakeholder participation, including community leaders, landowners, sand miners, and local authorities, is essential in promoting responsible practices and preventing future conflicts.

Furthermore, public awareness and community sensitization programs should be strengthened to educate residents on the environmental and social implications of unsustainable sand mining. Sustainable extraction techniques and rehabilitation measures must be prioritized to restore damaged ecosystems and protect long-term community livelihoods. Only through coordinated governance, responsible mining practices, and active community involvement can a balance be achieved between economic benefits and environmental protection. Ultimately, the protection of freshwater ecosystem services is critical for ensuring sustainable development and improving the quality of life in the affected communities.

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