
Original Research Article

An Evaluative Study of the Impact of Sand Mining on Water Quality and Public Health in Freshwater Dependent Communities of Rivers State.

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Abstract: Sand mining in freshwater ecosystems significantly alters sediment composition and water quality, fundamentally shifting the socioeconomic landscape of riparian communities. This research evaluated the impact of socioeconomic factors on sand mining in the freshwater ecosystems of Akpajo, Rumuokparaeli, and Chokocho communities in Rivers State, Nigeria. Using an interpretative research philosophy and the Political Ecology framework, the study investigated the transition of ecosystem services from traditional livelihoods to industrial extraction. Data were collected from 380 respondents through structured questionnaires and field observations, analyzed using the Relative Importance Index (RII). The results indicate that prior to intensive mining, these ecosystems provided vital services, including fish farming and clean water supply, which supported local food security. However, current data reveals a stark demographic shift, with 57.89% of the workforce being youths (aged 15–30), driven by unemployment and economic pressure. The RII analysis identifies Food Security and Potable Water as the most degraded services, ranking 1st and 2nd in perceived threat. While sand mining has become a primary income source for 47.37% of respondents, the study finds that the resulting land degradation, loss of aquatic habitats, and displacement of residents outweigh the short-term economic gains. The study concludes that sand mining is driving a "de-development" of host communities and recommends the urgent implementation of sustainable dredging technologies and community-led restoration mandates to safeguard the Niger Delta's freshwater heritage.

Keywords: Sand Mining; Freshwater Ecosystem; Socioeconomic Impact; Environmental Impact; Community Livelihoods

INTRODUCTION

Sand is a crucial source to economic development to both the poor countries of the world and to the developed nations. Development means a process of gradually expansion, becoming bigger, better, more advanced in business, industrial and trade activities. The growth of towns and cities demand more infrastructure and construction of strong structures such as roads, commercial shopping malls and accommodation for ever increasing population (Lorenzo, 2011). As a result of such socioeconomic development, there is probably going to be disturbance of the natural environment. The adverse impacts of sand mining can be either of physical impacts such as general alteration of soil morphology. It can also result into biological impacts such as reducing water quality and ecological impacts including loss of habitats and species disturbance, eruption of diseases among others are the results of sand mining, Sand mining activities have impacted, in one way or another, on the economic, social and environmental aspects of man in mining areas. However, many people resort to the trade of sand so as to earn a living. Since sand mining has economic gains, most community and traditional leaders sell community lands within their domains to miners. This is done because people derive their livelihoods from sand mining to ensure their survival from the natural resources available and accessible to them (Onwuka, 2013).

According to (Kondolf, 1997) despite the importance of sand mining in the state, the details of its economic, environmental, and social geology are not completely clear. The appropriate assessment of environmental impacts is often a hard task; the impacts of sand mining will eventually appear after a long period of time. Apart from water, sand is the most utilized natural resource in the world Filho et al; (2021). It occurs naturally in oceans, lakes, and rivers. Some of its uses include construction, water filtration, glass manufacture, hydraulic fracturing among others. Sand is distributed in the world and many countries depend on importation from other countries. The objectives of this study is to investigate the impact of socioeconomic factors on sand mining in freshwater ecosystem services, identify the available freshwater ecosystem services in the study area, ascertain the current state of the available freshwater ecosystem services in the study area and identify the social impacts that sand mining has on the study area communities.

2. LITERATURE REVIEW

2.1 Theoretical Frameworks

The theoretical frameworks that support the assessment and impact of socio-economic factors on sand mining in freshwater ecosystems are Ecological Modernization Theory, the Political Ecology Framework, and the Sustainable Development Theory. Each of these theories provides a different lens through which to analyze the multifaceted interactions between socio-economic factors and environmental impacts, specifically from the perspective of sand mining. Therefore, this study is anchored on the Political Ecology Framework because it underpins the objectives of the study.

Ecological Modernization Theory

Ecological Modernization Theory (EMT) posits that economic development and environmental protection are not mutually exclusive but can be harmonized through technological innovation and progressive policies (Hajer, 1995). This theory emphasizes the role of technology and institutional frameworks as facilitators of sustainable practices in industries, including sand mining. Ecological modernization theory suggests that economic development can be reconciled with environmental protection through technological innovation and changes in political institutions. This theory suggests that industrialized societies can manage environmental issues through improved technology, regulatory frameworks, and shifting public perceptions (Giddens, 1994). It promotes the idea that modern societies can achieve sustainable practices by integrating environmental considerations into economic and social policies.

Political Ecology Framework

The Political Ecology Framework integrates political, economic, and social dimensions to understand environmental issues. It highlights how environmental degradation, such as occurs through sand mining practices, is often rooted in socio-economic inequalities and power dynamics (Robbins, 2012). This approach emphasizes that environmental issues cannot be understood in isolation but must be contextualized within broader socio-political systems. Application to Sand Mining: In this context, political ecology would analyze how the benefits of sand extraction often accrue to a specific group while the costs are borne by local communities and ecosystems. It raises questions about who has the power to make decisions about sand mining and how those decisions affect the ecological integrity of freshwater ecosystems. The socio-economic factors, such as income inequality and governance, significantly influence both the practices of sand mining and the resultant ecological impacts (Bryant & Bailey, 1997). For instance, impoverished communities may rely on sand mining for subsistence, leading to conflicting interests regarding resource management.

Political Ecology focuses on the complex relationships between political, economic, and social factors and environmental issues (Blaikie & Brookfield, 1987).

This approach emphasizes:

1. The role of power relations, policy regimes, and institutions in shaping human environment interactions.
2. Vulnerable groups are more affected by environmental degradation due to their limited control over resources.
3. The Sustainable Livelihood Framework is the dependency of rural livelihoods on natural resources (Ellis, 2000).

This framework shows how: Employment pressures, financial incentives, and vulnerability to poverty drive individuals toward unsustainable sand extraction. This degrades freshwater habitats, adding stress to both human livelihoods and ecosystem health. Sand mining is not just a technical or economic activity; it is always a political

process influenced by policy decisions, ownership rights, power imbalances, and competition for resources (Rinaldi et al., 2005; Sreebha & Padmalal, 2008).

Sustainable Development Theory

Sustainable Development Theory focuses on meeting the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland, 1987). This theory incorporates environmental sustainability, economic viability, and social equity, making it a holistic framework for assessing activities like sand mining.

Application to Sand Mining: The principles of sustainable development can guide the assessment of socio-economic factors in sand mining. It implies that assessments should consider long-term environmental impacts alongside immediate economic benefits. For instance, policies that promote responsible mining practices can help ensure that the extraction of sand remains viable for future generations, thereby balancing ecological needs with socio-economic opportunities (United Nations, 2015). The challenges of applying sustainable practices in sand mining illustrate the complexities of integrating environmental sustainability within socio-economic frameworks.

2.2 Conceptual Framework

The study has independent and dependent variables. The independent variables in this study include: causes of sand mining activities, including the rise in the social and economic status of the people and the demographic characteristic changes. The dependent or outcome variable depended on what the independent variable did to it (Fraenkel & Wallen, 2000). The dependent variable in this study was the impact of sand mining activities on the people's livelihood and environment in the study area.

Land use

Land use practices across different regions of the world. According to the United Nations Food and Agriculture Organization (FAO) Water Development Division, land use encompasses both the products or benefits derived from the land and the human activities undertaken to obtain those benefits. As such, land use and land management practices play a crucial role in shaping natural resources, including soil, water, nutrients, plants, and animal life (Bunning & Pauw, 2017).

Land Policy in Nigeria

In Nigeria, land policy existed long before the advent of the colonial administration. Land Management was traditionally left under the control of the administrator of the geopolitical group, such as heads of ethnic groups, communities, clans, and families. Kayode (2010) observed that customary tenure is the cornerstone of land holding in Nigeria. Accordingly, under this system, land is held by the community, which is held in trust by the family, the village or the clan. Udo (1990) maintains that land under this system is seen as belonging to the living members of the community, as well as those who are dead

and are buried in the land and to those members of the community who are yet unborn. It was outright prohibited under the customary land policy for sales of land.

Land Use Policy and Administration in Rivers State

In Rivers state, land policy was customarily carried out as generally operated in the southern region. The traditional rulers, heads of families and clans, were in charge of land allocation. Despite the application of the Land Use Acts as a mandatory acceptable tool in Nigeria, Rivers State has certain procedures for the acquisition of land for public purposes in the state. The Government of Rivers State (2012) outline the following procedures.

1. Preliminary discussion with identified land owner(s)
2. Conduct perimeter survey
3. Issue/ publication notice of revocation of rights of occupancy
4. Enumeration and assessment of compensations
5. Payment of compensation to the claimant

Concept of Sand

The Concept of Sand: There are many definitions of sand. Shaffer (2006) defined sand as a material generally known to have loose, gritty particles of worn or disintegrated rock usually deposited along the shores of water bodies, in river beds, or desert dunes. Structurally, Geologists define sand more specifically as a natural loose, granular material made of separate mineral or rock particles from 0.0625 to 2.00 millimetres (mm) in size (Barksdale, 1991). Larger particles are granules, pebbles, cobbles, or boulders (>256 mm), and smaller grains are silt (0.0625-0.00 mm) or clay (<0.004 mm) (Shaffer, 2006). Sand is an underground geological resource formed from eroded mountain rocks carried by streams and rivers (Atejioye & Odeyemi, 2018). Genetically, sand is a naturally occurring granular material composed of finely divided rock and mineral particles formed due to weathering of rocks by mechanical forces (Meador & Lahyer, 1997).

Sand Mining

Sand mining can be classified into various types based on the specific materials being extracted from the earth. These include sand mining, gravel mining, stone mining, as well as the extraction of base metals and precious minerals such as gold, iron, uranium, coal, diamonds, limestone, oil shale, salt, and potash. According to Scott Dunbar (2012), mining activities are broadly categorized into two main types. The first is **surface mining**, which is commonly used for extracting materials like sand, gravel, and certain minerals located near the earth's surface. (Khan & Sugie, 2015). Ayenagbo et al (2011) argued that wide inequality and social injustice are caused by profitable activities of sand extraction (Ayenagbo et al, 2011). The second is **underground or deep mining**, typically employed to access valuable resources found at greater depths, such as petroleum, natural gas, and uranium. Sand mining has been on the rise due to the increasing demand for sand in the building industry for concrete and glass-making purposes (Leow, 2020).

3.1 METHODOLOGY

Akujuru (2014) described methodology as the strategy, plan of action, process, or design lying behind the choice of particular methods and linking the choice and use of methods to the desired outcomes. This implies that the researcher must follow research principles so that the audience can comprehend the strategy, approach and methods employed in the research. The methodology for this study is grounded in an interpretative research philosophy, which prioritizes the lived experiences and subjective views of participants over purely clinical data. Following the frameworks established by Creswell (2003) and Saunders (2009), the researcher approaches the freshwater ecosystem as a social and environmental phenomenon that can only be fully understood through the eyes of those who interact with it daily. To achieve this, the study focuses on three distinct Local Government Areas in Rivers State: Akpajo, Rumuokparaeli, and Chokocho. These areas were selected because they represent the frontline of the conflict between economic sand extraction and traditional river-based livelihoods.

To ensure the data is both representative and reliable, a multi-stage sampling approach was employed. The researcher utilized purposive sampling to identify the specific geographical clusters affected by mining, followed by snowball sampling to reach specialized groups such as periwinkle farmers and local landowners whose insights might otherwise remain hidden. Using the Taro Yamane formula to account for the population density of these regions, a sample size of 380 respondents was established. Information was gathered through a rigorous instrumentation process involving both primary field observations and structured questionnaires, ensuring that the final analysis captures the technical reality of the ecosystem alongside the socioeconomic reality of the people.

4.1 RESULTS AND FINDINGS

The findings of this study reveal a stark demographic and economic shift within the freshwater communities of Rivers State. The data indicate that the sand mining industry is an almost exclusively male-dominated sector, with 89.47% of participants being men. More strikingly, the workforce is overwhelmingly comprised of the youth, with 57.89% falling between the ages of 15 and 30. This suggests that the decline of traditional sectors and the lack of corporate employment have pushed the most physically capable segment of the population into labor-intensive mining. While these individuals possess a relatively high level of literacy, many being graduates or secondary school leavers, the economic pressure of the Niger Delta has left them with few alternatives but to exploit the very riverbeds that once sustained their ancestors.

Quantitatively, the research utilized the Relative Importance Index (RII) to rank the impact of mining on various ecosystem services. The results show that Food Security and Drinking Water are the most severely compromised services, ranking 1st and 2nd in terms of perceived threat. Although sand mining has become the primary source of income for 47.37% of the respondents, this economic gain is offset by the loss of traditional occupations. Fish farming, once a staple of the region, has dwindled to just 13.16% of the occupational share. This data paints a picture of a community in a "survival trap," where

short-term cash flow from sand extraction is systematically destroying the long-term biological foundations of their food and water security.

5.1 DISCUSSION OF FINDINGS

The discussion highlights a tragic transformation of the Rivers State landscape. Prior to the escalation of industrial-scale sand mining, the freshwater ecosystems of Akpajo, Rumuokparaeli, and Chokocho served as the lifeblood of the community, providing clean water, abundant fish stocks, and natural flood regulation. However, the interpretation of the field data confirms that these services are now in a state of advanced deterioration. The constant dredging and excavation have led to severe land degradation and the physical destabilization of riverbanks, which in turn has caused the siltation and eventual abandonment of local fish ponds. Furthermore, the discussion establishes that the socioeconomic consequences extend beyond the loss of jobs. The environmental decay has reached a point where residents are beginning to abandon their ancestral homes due to the encroaching threat of erosion and the loss of potable water. The study confirms that while sand mining is often framed as a "developmental" activity because it supports the construction industry, it is actually causing a "de-development" of the local riparian communities. The natural functionality of the ecosystem has been so thoroughly altered that it can no longer support the diverse range of livelihoods it once did, leaving the community vulnerable and dependent on a single, destructive industry.

RECOMMENDATIONS

The current trajectory of sand mining in Rivers State is environmentally unsustainable and socially volatile. While the industry provides a temporary economic vent for unemployed youths, it does so at the cost of the region's ecological integrity. The degradation of freshwater services, specifically in the realms of water purification and flood control, poses a long-term threat to the survival of these communities that far outweighs the immediate financial benefits of sand sales. Without a shift in how these resources are managed, the "marine ecosystem" upon which these people depend will likely reach a point of total collapse, leading to greater poverty and environmental displacement.

To mitigate these dangers, the study recommends a three-pronged approach. First, there must be an immediate transition toward sustainable mining technologies, such as dredging equipment designed to minimize turbidity and sediment disruption. Second, the regulatory framework in Nigeria must be strengthened; the government must move beyond simply issuing permits and begin enforcing strict "restoration mandates" that require miners to rehabilitate sites after extraction. Finally, community engagement must be modernized. Local residents should not just be passive observers but active stakeholders in the decision-making process. By integrating indigenous knowledge with modern regulation, Rivers State can create a balanced system where economic needs are met without sacrificing the freshwater ecosystems that define the region's heritage.

References

1. Akujuru V. A. (2014). A Framework for Determining the Compensable Value of Damages due to Contamination on Wetlands, PhD Thesis submitted to the University of Salford, School of the Built Environment, Salford, UK.
2. Brundtland, G. H. (1987). *Our Common Future: Report of the World Commission on Environment and Development*. Oxford University Press.
3. Bryant, R. L., & Bailey, S. (1997). *Third World Political Ecology*. Routledge.
4. Giddens, A. (1994). *Beyond Left and Right: The Future of Radical Politics*. Polity Press.
5. Hajer, M. A. (1995). *The Politics of Environmental Discourse: Ecological Modernization and the Politics of the Environment*. Oxford University Press.
6. Khan, A. & Cheri, L. 2016. An Examination of Poverty as the Foundation of Crisis in Northern Nigeria. *Insight on Africa*, 8(1), 59-71.
7. Kondolf, G. M. (1997). Hungry Water: Effects of Dams and Gravel Mining on River Channels.” *Environmental Management*.
8. Onwuka, S. V., Duluora, J. O., & Amaechi, I. E., 2013. Socio-Economic impacts of Sand and Gravel Mining activities in Nsugbe, Anambra State, Nigeria. *Albanian Journal of Agricultural Science*, 12 (2), 229-235
9. Rempel, L., & Church, M. (2009). Physical and ecological response to disturbance by gravel mining in a large alluvial river. *Canadian Journal of Fisheries and Aquatic Sciences*, 66, 52–71.
10. Rice J. 2009. The Transnational Organisation of Production and Uneven Environmental Degradation and Change in the World Economy. *International Journal of Comparative Sociology*, 50 (3-4), 215-235.
11. Rinaldi, M. et al. (2005). “Morphodynamics of River Sand Extraction. *Geomorphology*. Sivaram, S. et al. (2021). “Socioeconomic Impact of Sand Mining on River Ecology and Livelihoods.” *Journal of Hydrology and Water Resources*.
12. Rudy A. P. and Konefal J. 2007. Nature, Sociology, and Social Justice. *American Behavioral Scientist*, 51(4), 495-515
13. Rukmana D., Salman D., Alimuddin I., Arsyad. Economic and environmental impacts of sand mining activities at Sadang river, Pinrang Regency, South Sulawesi, *IOP Conf Ser Earth Environ Sci.*, 575(1): p.012043, 2020.
14. Saidani, K.; Ajam, L.; Ouezdou, M.B. Barite powder as sand substitution in concrete: Effect on some mechanical properties. *Constr. Build. Mate.* 2015, 95, 287–295.
15. Salam, A., 2020. Internet of Things for Sustainable Mining. Faculty Publications. Paper 30. DOI:10.1007/978-3-030-35291-2_8
16. Schulz M.S. (2015). Inequality, Development, and the Rising Democracies of the Global South. *Current Sociology monograph*, 63(2), 261-279.211
17. Schütze, T., Wibowo, A., & Pratiwi, G. (2019). Sand mining and its effects on river ecosystems. *Environmental Management*, 63(6), 971-981.
18. Sengupta, M. Mining and the Environment. In *Environmental Impacts of Mining: Monitoring, Restoration, and Control*; Lewis Publishers: Boca Raton, FL, USA, 1993; pp. 1–34.
19. Sharma, B.K. Types of water pollution. In *Water Pollution*, GOEL Publishing House: Meerut, India, 2005; pp. 40–72.
20. Shitima C. and Suykens B. 2023. Formalisation of Sand Mining in Dar es Salaam, Tanzania. *Resources Policy*, 82, 1-13. <https://doi.org/10.1016/j.resourpol.2023.103589>
21. Simon, H. A. (1959). “Theories of Decision Making in Economics and Behavioral Science.” *American Economic Review*, 49(3), 253–283.
22. Singh, G. Environmental Impact Assessment of Mining Projects. In *Proceedings of the International Conference on TREIA-2008*, Nagpur, India, 23–25 November 2008.
23. Smit, J. A. (2018). "The Economic Contributions of Sand Mining in Developing Economies." *Journal of Economic Perspectives*.

24. Sreebha, S. & Padmalal, D. (2008). "Environmental Impact of Sand Mining: A Case Study from the River Catchments of Vembanad Lake, Southwest India." *Environmental Geology*, 54(4), 879–889. DOI: 10.1007/s00254-007-0881-z
 25. Taigor, S.R.; Rao, R. J. (2008). Sand mining practices on the Chambal River banks and their impact on the aquatic animal biodiversity. *J. Environ. Res. Dev.*, 2, 644–650.
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