



LAND USE TRANSITIONS AND ECO-SOCIO/ENVIRONMENTAL IMPACTS OF LATERITE AND SAND MINING IN AWKA, ANAMBRA STATE, NIGERIA: A SOCIO-ECONOMIC AND REMOTE SENSING ANALYSIS FROM 1993–2023

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Abstract

Laterite and sand are essential raw materials whose value to human development is immense. From historical city growth to modern skyscrapers, infrastructure, and industrial products, sand remains central to construction and industrial processes. However, the process of extraction has immense impacts on eco-social life and environmental degradation, particularly in remote African communities where access, governance, and data records are lacking. The Driver-Pressure-State-Impact-Response (DPSIR) was employed within the framework of sustainable development as a framework, this study examines the environmental, social, and economic effects of laterite and sand mining in Okpuno, Awka South LGA, Anambra State. A mixed-methods approach, namely qualitative, quantitative, and remote sensing techniques, was employed. Data was gathered through surveys and interviews with residents, random distribution of 400 questionnaires, and remote sensing and geotechnical techniques from 1993 to 2023. A stratified random sampling method was used to ensure representation from various demographic groups, including miners, farmers, and community members. Findings confirm that laterite and sand mining, coupled with urbanization, have profoundly transformed the Okpuno landscape over the past 30 years. Remote sensing and GIS analyses revealed that vegetation cover declined from 63.4% in 1993 to 30% in 2023, while bare surfaces increased from 24.9% to 43.5%, and built-up areas expanded from 11.7% to 26.5%. These changes indicate intensified land degradation, ecosystem disruption, and socio-economic vulnerabilities linked to weak regulatory oversight. Also, mining has negatively contributed to soil erosion, reduced agricultural productivity, biodiversity loss, and increased susceptibility to flooding. Economically, mining offers short-term jobs and the development of local infrastructure in the area. The application of sustainable strategies, best management practices, community education, and stricter enforcement of environmental laws are recommended. To foster responsible mining that balances economic gains with environmental and social well-being.

Keywords: Eco-social impacts, Health risks, Sand mining, Sustainable mining

INTRODUCTION

Laterite and sand are indispensable raw materials in human development. Globally, it is the most mined solid material, with over fifty billion tonnes extracted annually (UNEP, 2019; Peduzzi, 2014). In Nigeria, demand for laterite and sand has surged due to rapid urbanization, population growth, and expansion of the construction sector, where they are used for roads, bridges, housing, and industrial products (Adegboyega et al., 2020; Okunlola & Adebayo, 2021).

The extraction of these resources, often through dredging and open-cast methods, has intensified to meet market demand. Such practices, especially when conducted without environmental safeguards, have contributed to widespread land degradation, erosion, sedimentation, loss of vegetation, and the destruction of aquatic and terrestrial habitats (Torres et al., 2017; Akanwa & Ngozi-Ikechebelu, 2022). In riverine and floodplain environments, uncontrolled mining disrupts sediment transport, alters geomorphology, and leads to biodiversity loss and reduced ecosystem services (Kondolf et al., 2018). Beyond environmental consequences, there are significant socio-economic impacts, including displacement of livelihoods, reduced fish catches, declining agricultural productivity, and increased health risks from dust and polluted water sources (Adegboyega et al., 2020).

Laterite and sand mining in Nigeria dates back to the 1970s and 1980s, when government policies encouraged mineral resource exploitation to drive industrialization (Akpan et al. 2022). Over time, artisanal and small-scale mining operations have expanded into larger commercial enterprises, providing employment and income to local communities (Okunlola & Adebayo, 2021). However, the economic benefits are unevenly distributed, often concentrated in the hands of local elites and external operators, contributing to social tensions and conflicts (Mark, 2021). Weak enforcement of environmental regulations has allowed unsustainable practices to flourish, exacerbating both environmental and social challenges (Akpan et al., 2023). Considering that sand mining activities that are poorly managed not only degrade the environment, but also undermine long-term economic resilience (Akanwa & Ikegbunam, 2019). In developing countries such as Nigeria, the abundance of sand and laterite combined with rising demand has accelerated extraction rates, estimated at about 85% of local availability, without adequate restoration of mining sites (Akanwa, 2020). This trajectory threatens the sustainability of critical ecosystems and the livelihoods they support.

Globally, concerns about the unsustainable extraction of sand and aggregates have intensified, with calls for more sustainable governance and the recognition of “nature’s rights” in resource management (UNEP, 2019; Mark, 2021). The Driver-Pressure-State-Impact-Response (DPSIR)

theory systemizes a cause-and-effect relationship, describing how drivers, which may be social, economic, or environmental developments, exert pressures on the environment. It aligns with the framework of sustainable development, taking a holistic approach, considering economic, environmental, and social dimensions, thereby examining the broader context and impacts on ecosystems and local communities.

In the context of Anambra State, particularly Awka South Local Government Area, laterite and sand mining have become a significant environmental and socio-economic concern. The area's growing urban footprint and infrastructure expansion have increased resource demand, leading to intensified extraction from rivers, wetlands, and farmlands. The resulting environmental degradation, coupled with regulatory and data gaps, underscores the urgency of evidence-based interventions.

Hence, this study investigates the environmental and socio-economic impacts of laterite and sand mining in Okpuno, Awka South LGA, Anambra State, Nigeria. Findings from this research contribute to informed policymaking, strengthen regulatory frameworks, and promote a balance between economic development and environmental stewardship.

Driver-Pressure-State-Impact-Response (DPSIR) Model within the framework of the Sustainable Development Concept

DPSIR is a systems-thinking approach-based model that assumes cause-and-effect relationships between interacting components of social, economic, and environmental systems. The model DPSIR was initially developed by the Organisation for Economic Co-operation and Development. OECD (1993) was further developed and established by the European Environment Agency (EEA) (1999), and has been used by the United Nations (UN) (Edith and Weterings, 1999).

This model systemises a cause-and-effect relationship, describing how Drivers, which may be social, economic, or environmental developments, exert pressures on the environment. The State of the environment changes as a result of Pressures. This then leads to Impacts (social, economic, or environmental), which may require societal Responses acting as feedback to Drivers, Pressures, States, or Impacts.

DPSIR provides the possibility for multi-species analyses and multi-sector approaches by considering different indicators from different ecological species, disciplines, and sectors. However, sustainable development as a guiding paradigm seeks to balance economic growth, social inclusion, and environmental protection to meet present needs without compromising the ability of future generations to meet theirs (World Commission on Environment and Development (WCED, 1987). As a framework for this study, it offers an integrated approach to addressing complex eco-socio and environmental challenges from sand mining. It emphasizes the interdependence between ecological systems and human well-being, recognizing that

economic activities must operate within environmental limits (Rockström et al., 2009). This aligns with the “triple bottom line” principle, people, planet, and prosperity, which promotes holistic policy design and implementation (Elkington, 1997).

The diagram (Fig. 1) shows the comprehensive interconnectivity between the three pillars of sustainable Development, which includes social, economic, and environmental sustainability (UN, 2015).

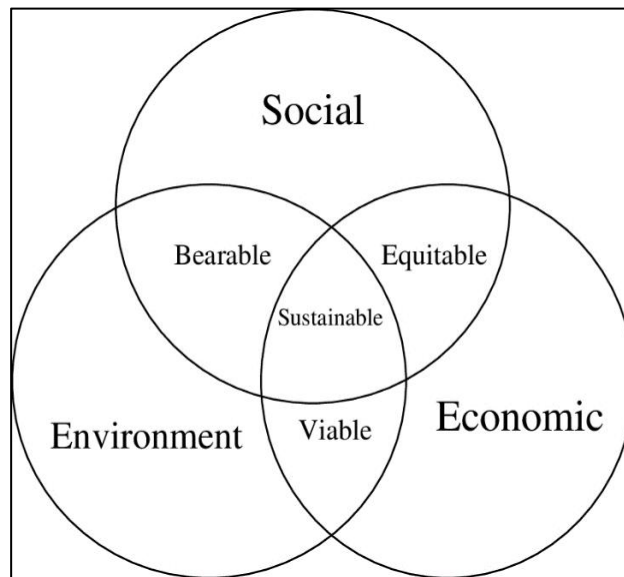


Figure 1: Sustainable Development Diagram

Source: Barnier (1987)

The environmental sustainability dimension of the framework focuses on minimizing the negative impacts of sand mining on the natural environment and promoting the long-term preservation of ecosystems and natural resources. This includes addressing issues related to resource depletion, biodiversity loss, habitat degradation, and environmental pollution. The environmental sustainability pillar refers to maintaining natural productivity and ecosystem performance, in addition to protecting different wild species and preserving biodiversity (Akanwa, 2020). The economic pillar of sustainability is defined as the balance between the environmental and social aspects in relation to economic goals, which can include the limitations that the human population must place on economic growth to minimize the economic activities’ ecological impacts (Meseguer et al., 2022).

The social sustainability dimension of the framework focuses on the equity, inclusiveness, and well-being of the communities and stakeholders impacted by laterite and sand mining activities. This includes addressing issues related to livelihood security, community cohesion, social justice,

and the equitable distribution of benefits and burdens. In sand mining processes and due to the harmful environmental impact of using intensive monoculture systems, population growth has created a high social demand for suitable practices (Sidhou, 2021). Social damage and the loss of economic growth with intensive agriculture necessitate implementing sustainable strategies of land use and management practices, which include improving rural communities' long-term quality of life (Latruffe, 2016).

Applying this framework enables researchers and policymakers to evaluate interventions not only for their immediate benefits but also for their long-term impacts on community resilience and environmental health. In the context of this study, sustainable development provides a lens for assessing how socio-economic practices, environmental management strategies, and institutional policies can be harmonized. For example, integrating community participation into environmental decision-making fosters social equity while enhancing the sustainability of interventions (Pretty, 2003). Likewise, promoting resource-efficient technologies and climate-resilient infrastructure supports both environmental conservation and economic stability.

It also highlights the importance of adaptive governance, systems capable of responding to uncertainties and emerging risks, ensuring that strategies remain relevant over time (Folke et al., 2005). Ultimately, this framework encourages cross-sectoral collaboration and evidence-based planning, critical for building resilient communities and ecosystems.

Study Area

Okpuno is a peri-urban settlement in Awka South Local Government Area, the capital city of Anambra State, and southeastern Nigeria. It is situated between latitude 6.22° N-6.24° N and longitude 7.07° E-7.09° E (Fig. 2- 4). Okpuno is bounded by Amansea to the west, Nibo to the east, Umuawulu to the south, and Isiagu to the north. Based on the 2006 Nigerian population census, the household population of the community was 12,276. Using the recorded annual growth rate of 2.5% over 18 years, the 2024 population is projected at approximately 19,146. This growth reflects both natural increase and the area's expanding urban influence from Awka, the state capital (National Population Commission (NPC, 2006). The community lies within the tropical rainforest belt but exhibits derived savanna vegetation due to land-use changes such as farming, construction, and sand/laterite mining (Ibe, 2017). The climate is marked by a distinct wet season from April to October and a dry season from November to March, influenced by the moist southwesterly monsoon and the dry northeasterly Harmattan winds (Ayoade, 2004). Annual rainfall ranges from 1,500 to 2,000 mm, and mean annual temperatures average 26–28°C, supporting both subsistence and commercial agriculture (Odjugo, 2010).

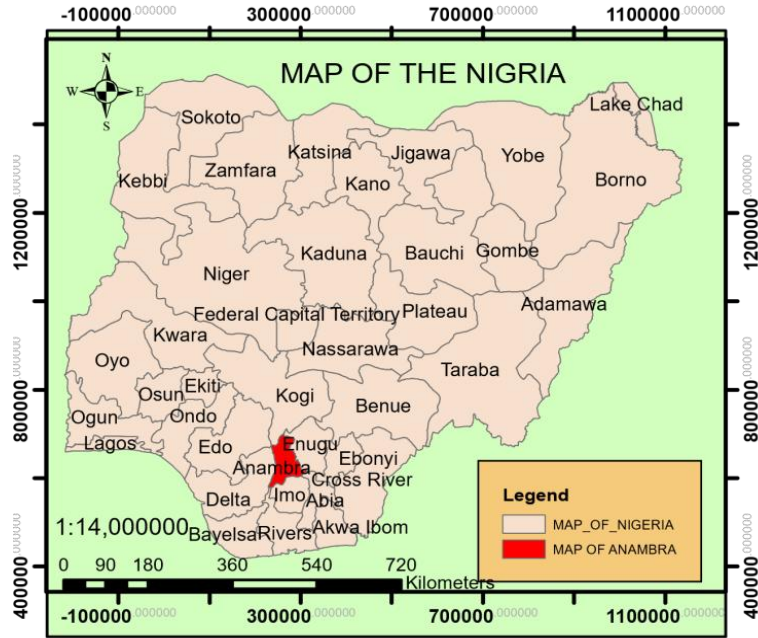


Figure 2: Map of Nigeria showing Anambra State
Source: Fieldwork (2025)

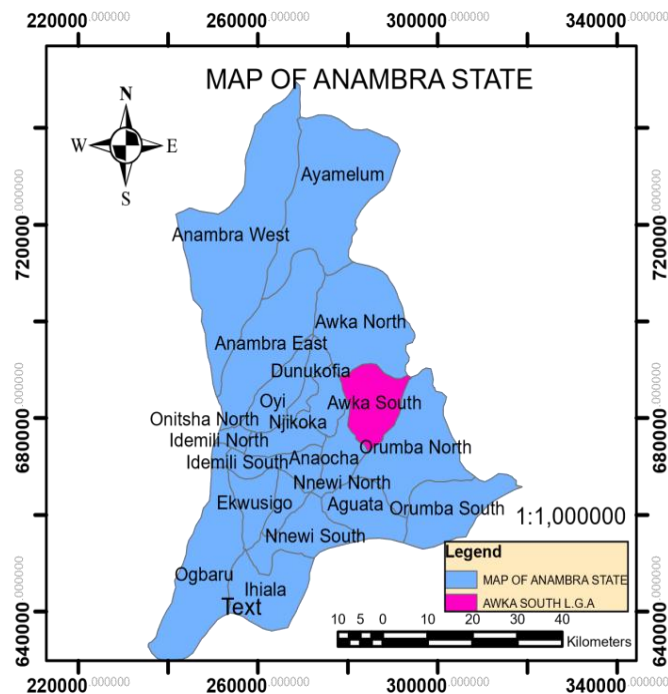


Figure 3: Map of Anambra state showing Awka South LGA.
Source: Fieldwork (2025)

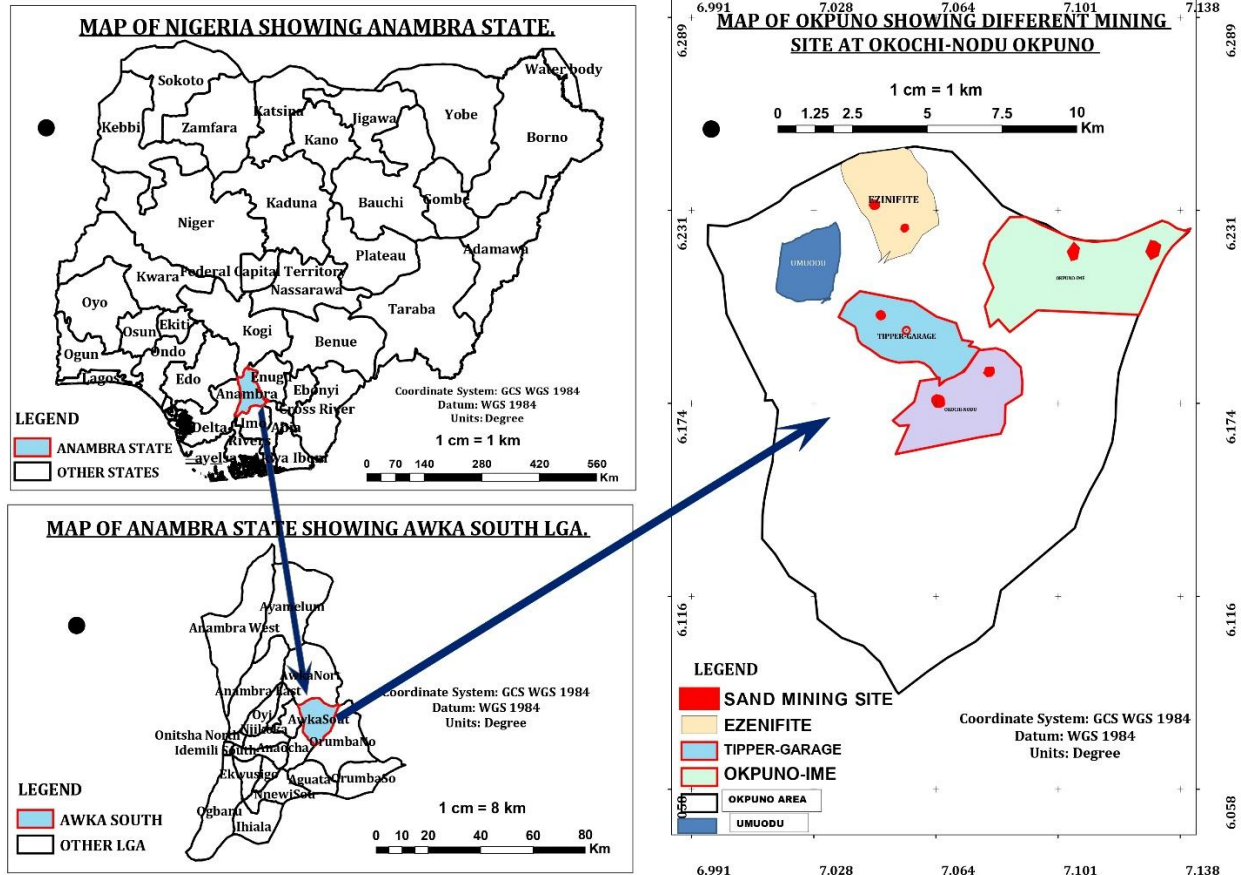


Fig. 4: Map of Nigeria showing Anambra State, Map of Anambra State showing Awka South LGA, and Map of Okpuno showing different mining sites within the area

Source: Fieldwork (2025)

It is underlain by sedimentary formations characteristic of the Anambra Basin. The dominant lithology comprises sandy lateritic soils and loose, unconsolidated sands, valuable for construction but highly erosion-prone when vegetation is removed (Ofomata, 2002; Reymont, 1965). These soils are generally well-drained yet low in organic matter, requiring nutrient supplementation for sustainable agriculture (Lekwa & Whiteside, 1986). The area is gently undulating, with elevations between 100 and 200 meters above sea level. Drainage is provided by small seasonal streams that connect to larger river systems in the state, though poor urban drainage infrastructure contributes to localised flooding during intense rainfall (Egboka & Okpoko, 1984).

It is located near Awka, situated at the interface of rural and urban land uses, with increasing conversion of agricultural land to residential and commercial purposes. The accessible laterite and sand deposits support construction demands but also drive environmental challenges such as land degradation, vegetation loss, and soil instability (Akanwa & Ngozi-Ikechebelu, 2022).

The community has a rich cultural heritage and is known for its agricultural activities, particularly the cultivation of yams, cassava, and various vegetables. Okpuno is also home to several institutions, including the Anambra State Secretariat, and a significant portion of the Anambra state government's administrative offices. Okpuno, a vibrant community in Awka, Anambra State, traces its origins to the early Igbo settlement patterns in the region, with the community being founded by an Igbo ancestor known as Okpu.

MATERIALS AND METHODS

This study adopted a mixed-methods approach, combining quantitative, qualitative, and remote sensing techniques to examine the environmental and socio-economic consequences of laterite and sand mining in Okpuno, Awka South Local Government Area (LGA), Anambra State, Nigeria, from 1993 to 2023. The research design was descriptive and analytical, enabling systematic data collection, interpretation, and correlation between mining activities and their effects (Creswell & Plano Clark, 2018).

Based on the 2006 Nigerian population census, the household population of Okpuno was 12,276. Applying the recorded annual growth rate of 2.5% over 18 years (2006–2024), the estimated 2024 population is approximately 19,146. This projection was derived using the compound growth formula $P_t = P_0 (1+r)^t$, where P_0 is the base population, r is the growth rate, and t is the number of years. Rounded to the nearest hundred, the 2024 estimate stands at about 19,100 people.

Using the Taro Yamen formula (1967), a total of 400 questionnaires were obtained, using Yamane's (1967) formula, a sample size of 400 was obtained and randomly distributed among residents of mining-affected communities, targeting household heads, traders, Miners, farmers, and artisans. The study community covered five locations, namely Ezinifite Okpuno, Umuodu, Tipper Garage Okpuno, Okpuno Ime, and Okochi-Nodu. 80 questionnaires were distributed in each of these areas.

The questionnaire captured demographic information, perceptions of environmental changes, and health, socio-economic impacts. The random sampling method ensured each member of the population had an equal chance of selection, reducing bias (Kumar, 2019). Direct field observation and photographs were employed to document visible environmental impacts, such as land degradation areas. Photographs and field notes were used to capture the extent of open pits, erosion gullies, and sedimentation in nearby water bodies. 4 Key informant interviews were conducted with the community leader, a local government officials, and two (2) environmental

officers to gain deeper insights into mining practices, governance, and community responses. Semi-structured interview guides allowed for probing questions while maintaining flexibility (Bryman, 2016).

Survey techniques involved the collection of socio-economic data on livelihoods, and income changes. Remote sensing and Geographic Information System (GIS) analyses were used to detect and map land use/land cover (LULC) changes over the 30 years. Landsat imagery for 1993 and 2023 was processed using supervised classification to identify mining expansion and associated environmental transformations (Jensen, 2015).

Data from questionnaires were analyzed using descriptive statistics (percentages, means, and frequency tables), while qualitative data from interviews and observations were thematically analyzed. The integration of remote sensing outputs with field data provided spatial and temporal perspectives on mining impacts, enhancing the validity and robustness of findings (Foody, 2002). This multi-pronged methodology ensured that both the physical and socio-economic dimensions of laterite and sand mining were comprehensively evaluated, enabling evidence-based recommendations for sustainable land resource management in Awka South LGA.

Findings on Eco-social and Health Implications of Laterite and Sand Mining

A total of 400 participants responded to the survey, complemented by observations, photographs, and key informant interviews. Table 1 showed the gender of the participants, indicating that males were 43.75%, and females were 56.25%. Women were higher than men.

Table 1: Distribution of Respondents' Gender

Gender	Frequency	Percentage
Male	175	43.75
Female	225	56.25
Total	400	100

Source: Fieldwork (2025)

Table 2 indicates that 26.50% of the respondents were single, 36.75% were married, 21.75% were widowed, and 15% were divorced. This shows that the majority of the respondents were married.

Table 2: Marital Status

Marital status	Frequency	Percentage
Single	106	26.50
Married	147	36.75
Widowed	87	21.75
Divorced	60	15.00
Total	400	100

Source: Fieldwork (2025)

Table 3 reveals that 17.25% of the respondents were under 18, 30% were aged 18-30, and 21.25% of the respondents were aged between 31 and 45. 16.75% were aged between 46 and 55, and 14.75% were above 55. This shows that the majority of the residents were within the ages of 18 and 30.

Table 3: Age Distribution

Age	Frequency	Percentage
under 18	69	17.25
18-30	120	30.00
31-45	85	21.25
46-55	67	16.75
Above 55	59	14.75
Total	400	100

Source: Fieldwork (2025)

Table 4 confirms that 19.5% of the respondents have FSLC, 21.25% have WAEC, 30.5% have B.Sc. or Diploma; however, 28.75% have no formal education. This shows that the majority of the respondents have obtained a BSc.

Table 4: Educational Qualifications

Educational qualification	Frequency	Percentage
Primary education (FSLC)	78	19.50
Secondary education (WAEC)	85	21.25
Tertiary education (Diploma, B.SC.)	122	30.50
No formal education	115	28.75
Total	400	100

Source: Fieldwork (2025)

Table 5 indicates that 36.75% of the respondents were self-employed, 20% were unemployed, 23.25% were students, and 20% were categorized as others. This shows that the majority of the respondents were self-employed.

Table 5: Distribution of Occupation

Occupation	Frequency	Percentage
Self-employed	147	36.75
Unemployed	80	20.00
Student	93	23.25
Others	80	20.00
Total	400	100

Source: Fieldwork (2025)

Table 6 captures that 19.25% of the respondents have resided in the area for less than 1 year, 28.25% have resided in the area for 1-3 years, 23.25% have resided in the area for 4-6 years, 18% have resided in the area for 7-10 years, while 11.25% have resided in the area for more than 10 years. This shows that the majority of the respondents have resided in the area for 1-3 years.

Table 6: Duration of Residence

Duration of residence	Frequency	Percentage
Less than 1 year	77	19.25
1-3 years	113	28.25
4-6 years	93	23.25
7-10 years	72	18.00
More than 10 years	45	11.25
Total	400	100

Source: Fieldwork (2025)

Table 7 indicates that 36.75% of the respondents' average monthly income is 5,000-20,000, 22.5% of the respondents' average monthly income is 25,000-50,000, 25.75% of the respondents' average monthly income is 55,000-100,000, 15% of the respondents' average monthly income is 100,000 and above. This shows that the majority of the respondents' average monthly income is 5,000-20,000.

Table 7: Income Distribution

Average monthly income	Frequency	Percentage
5,000-20,000	147	36.75
25,000-50,000	90	22.50
55,000-100,000	103	25.75
100,000 and above	60	15.00
Total	400	100

Source: Fieldwork (2025)

Table 8 reveals the volume of laterite and sand mined from different locations of sand mining areas in Okpuno. The largest site was Ezinfite Okpuno with a volume of 2000 liters, while the lowest was Okochi-Nodu with 800 liters.

Table 8: Volume of Mined Resources Using Standard-Sized Bucket with a known volume of 5 liters

Location	Volume (liters)	Number of 5-Liter Buckets Used
Ezinfite Okpuno	2000	400
Okpuno ime	1500	300
Tipper garage	1250	250
Okochi-Nodu	800	360
Umuodu	1700	340
Total	8,250 L	1,650 buckets

Source: Fieldwork (2025).

Table 9 shows the sizes of farmland losses as a result of laterite and sand mined in different locations in the Okpuno area. Tipper garage has the highest of 1500m², while Okpuno-Ime has the lowest of 850 m².

Table 9: Sizes of farmland lost due to laterite and sand mining

Location	Size of farmland loss. Area (m²)
Ezinifite Okpuno	1200
Okpuno ime	850
Tipper garage	1500
Okochi-Nodu	1100
Umuodu	950
Total	5,600m²

Source: Fieldwork (2025).

Table 10 reveals that 75% of the respondents indicated that their properties/goods were damaged as a result of the erosion resulting from mining activities, while 25% were not affected.

Table 10: Damage of Properties/Goods from Mining

Response	Frequency	Percentage
Yes	300	75
No	100	25
Total	400	100

Source: Fieldwork (2025).

Table 11 revealed that 50% of the respondents confirmed displacement and subsequent return to their location as a result of the erosion resulting from mining activities, while 50% indicated that they were not displaced.

Table 11: Displacement and Return due to Mining Activities

Response	Frequency	Percentage
Yes	200	50
No	200	50
Total	400	100

Source: Fieldwork (2025).

Table 12 showed that 35% of the respondents indicated that they suffered health risks due to mining activities, while 65% indicated negative.

Table 12: Health Risks during the mining activities

Response	Frequency	Percentage
Yes	140	35
No	260	65
Total	400	100

Source: Fieldwork (2025)

Table 13 showed that 75% of the respondents accepted that the erosion resulting from mining activities damaged their farmland, while 25% declined.

Table 13: Mining Impact on Farms

Response	Frequency	Percentage
Yes	300	75
No	100	25
Total	400	100

Source: Fieldwork (2025)

Table 14 showed that 75% of the respondents affirmed that erosion resulting from mining activities resulted in reduced crop yield, while 25% declined.

Table 14: Sand Mining and Low Crop Yield

Response	Frequency	Percentage
Yes	300	75
No	100	25
Total	400	100

Source: Fieldwork (2025).

Table 15 revealed that 55.25% of the respondents strongly agreed, 30% agreed, 10% were undecided, 4.75% disagreed, 0% strongly disagreed. This showed that the majority of the respondents strongly agreed that laterite and sand mining have led to soil degradation in Okpuno.

Table 15: Laterite and Sand mining and soil degradation.

Responses	Frequency	Percentage %
Strongly agree	221	55.25
Agreed	120	30
Undecided	40	10
Disagreed	19	4.75
Strongly Disagree	-	-
Total	400	100

Source: Fieldwork (2025).

Table 16 showed that 55.25% of the respondents strongly agreed, 30% agreed, 10% were undecided, 4.75% disagreed, 0% strongly disagreed. This shows that the majority of the

respondents strongly agreed that Laterite and Sand mining have contributed to deforestation in Okpuno.

Table 16: Sand Mining and Deforestation

Responses	Frequency	Percentage %
Strongly agree	221	55.25
Agreed	120	30
Undecided	40	10
Disagreed	19	4.75
Strongly Disagree	-	-
Total	400	100

Source: Fieldwork (2025).

Table 17 revealed that 55% of the respondents strongly agreed, 30% agreed, 10% were undecided, 5% disagreed, 0% strongly disagreed. This showed that the majority of the respondents strongly agreed that Laterite and Sand mining have caused water pollution in nearby water bodies in Okpuno.

Table 17: Laterite and Sand Mining and Water Pollution

Responses	Frequency	Percentage %
Strongly agree	220	55
Agreed	120	30
Undecided	40	10
Disagreed	20	5
Strongly Disagree	-	-
Total	400	100

Source: Fieldwork (2025).

Table 18 confirmed that 62.5% of the respondents strongly agreed, 30% agreed, 5% were undecided, 2.5% disagreed, 0% strongly disagreed. This shows that the majority of the respondents strongly agreed that Laterite and Sand mining have disrupted the traditional way of life in Okpuno.

Table 18: Laterite and Sand mining have disrupted the traditional way of life in Okpuno

Responses	Frequency	Percentage %
Strongly agree	250	62.50
Agreed	120	30
Undecided	20	5
Disagreed	10	2.50
Strongly Disagree	-	-
Total	400	100

Source: Fieldwork (2025).

Table 19 revealed that 55% of the respondents strongly agreed, 30% agreed, 10% were undecided, 5% disagreed, 0% strongly disagreed. This showed that the majority of the respondents strongly agreed that Laterite and Sand mining have increased the incidence of conflicts within the local community in Okpuno.

Table 19: Laterite and Sand mining have increased the incidence of conflicts within the local community in Okpuno

Responses	Frequency	Percentage %
Strongly agree	220	55
Agreed	120	30
Undecided	40	10
Disagreed	20	5
Strongly Disagree	-	-
Total	400	100

Source: Fieldwork (2025).

Table 20 showed that 62.50% of the respondents strongly agreed, 27.5% agreed, 8.75% were undecided, 1.25% disagreed, and 0% of the respondents strongly disagreed. This showed that the majority of the respondents strongly agreed that Laterite and Sand mining have created job opportunities for the local community in Okpuno.

Table 20: Laterite and Sand mining have created job opportunities

Responses	Frequency	Percentage %
Strongly agree	250	62.50
Agreed	110	27.50
Undecided	35	8.75
Disagreed	5	1.25
Strongly Disagree	-	-
Total	400	100

Source: Fieldwork (2025)

Table 21 shows that 62.50% of the respondents strongly agreed, 27.5% of the respondents agreed, 8.75% were undecided, 1.25% disagreed, and 0% of the respondents strongly disagreed. This shows that the majority of the respondents strongly agreed that Laterite and Sand mining have increased the income of the local community in Okpuno.

Table 21: Laterite and Sand mining have increased the income

Responses	Frequency	Percentage %
Strongly agree	250	62.50
Agreed	110	27.50
Undecided	35	8.75
Disagreed	5	1.25
Strongly Disagree	-	-
Total	400	100

Source: Fieldwork (2025).

Table 22 showed that 18.75% of the respondents strongly agreed, 25% agreed, 18.75% were undecided, 18.75% disagreed, and 18.75% of the respondents strongly disagreed. This showed that the majority of the respondents agreed that Laterite and Sand mining have led to the development of local infrastructure in Okpuno.

Table 22: Laterite and Sand mining have led to the development of local infrastructure in Okpuno

Responses	Frequency	Percentage %
Strongly agree	75	18.75
Agreed	100	25
Undecided	75	18.75
Disagreed	75	18.75
Strongly Disagree	75	18.75
Total	400	100

Source: Fieldwork (2025).

Table 23 showed that 10% of the respondents strongly agreed, 18.75% agreed, 25% were undecided, 27.5% disagreed, and 18.75% strongly disagreed. This showed that the majority of the respondents disagreed that the local community is actively involved in the decision-making process regarding sand mining activities in Okpuno.

Table 23: Involvement of Locals in the Sand Mining Decision-making Process

Responses	Frequency	Percentage %
Strongly agree	40	10
Agreed	75	18.75
Undecided	100	25
Disagreed	110	27.5
Strongly Disagree	75	18.75
Total	400	100

Source: Fieldwork (2025).

Table 24 showed that 7.5% of the respondents strongly agreed, 15% agreed, 15% were undecided, 37.50% disagreed, and 25% strongly disagreed. This showed that the majority of the respondents disagreed that the government of Anambra State has provided adequate support and resources for the regulation and management of sand mining activities.

Table 24: The Role of Local Government in Managing Sand Mining in the Area

Responses	Frequency	Percentage %
Strongly agree	30	7.5
Agreed	60	15
Undecided	60	15
Disagreed	150	37.50
Strongly Disagree	100	25
Total	400	100

Source: Fieldwork (2025).

Discussion

Demographic data revealed that women (56.25%) were more represented than men (43.75%), suggesting that women are central stakeholders in the socio-economic and environmental outcomes of mining (Table 1). This gender dimension is significant, as women often experience disproportionate livelihood impacts from resource degradation, particularly in rural communities (Oyinloye et al., 2022).

The marital and age distributions (Tables 2 and 3) show that most respondents were married (36.75%) and within the 18 -30 age group (30%), pointing to a predominantly youthful population with family responsibilities. This indicates that mining impacts extend to household stability and community resilience. Educational data revealed that 30.5% of respondents had a tertiary education, while 28.75% had no formal education (Table 4). The relatively high proportion of uneducated respondents suggests limited awareness of environmental regulations, thereby exacerbating unsustainable mining practices (Okonkwo & Onwuka, 2023).

Occupationally, most respondents were self-employed (36.75%) (Table 5), relying directly on local natural resources for income. About 36.75% earned between ₦5,000–₦20,000 monthly (Table 7), underscoring poverty-driven dependence on sand and laterite mining. This finding resonates with Adeola et al. (2021), who argued that rural households often turn to extractive livelihoods despite their environmental costs, given limited employment alternatives.

Environmentally, the photographs (Figure 5) illustrate the visible impacts of sand mining activities and associated environmental degradation in the study area. The results show significant farmland losses due to mining (Igwe & Nwosu, 2022). For instance, 1,500 m² of farmland was lost at the Tipper Garage site alone (Table 9). Seventy-five percent of respondents

confirmed erosion-induced damage to property and farmland (Tables 10 and 13), while 75% also attributed reduced crop yield to sand mining (Table 14). These findings align with Ezeaku et al. (2022), who reported that sand mining depletes soil fertility and contributes to long-term food insecurity in south-eastern Nigeria.

The study also reveals serious ecological degradation. A majority (55.25%) strongly agreed that sand and laterite mining contribute to soil degradation (Table 15), deforestation (Table 16), and water pollution (Table 17). Deforestation not only destroys vegetation cover but also accelerates gully erosion in fragile landscapes such as Anambra State (Nwafor & Okoye, 2021; Eludoyin et al., 2021). Furthermore, water pollution from sedimentation threatens aquatic biodiversity and drinking water safety, as documented in similar Nigerian contexts (Nwachukwu et al., 2023).

Social impacts were equally profound. About 62.5% of respondents strongly agreed that mining disrupted traditional ways of life (Table 18), while 55% indicated an increase in community conflicts (Table 19). Such findings suggest that extractive activities destabilize social cohesion, often triggering disputes over land ownership and access to resources (Ikejiofor et al., 2022). Displacement was also reported by 50% of respondents (Table 11), indicating forced mobility and resettlement pressures.

Findings on the health impacts indicated that 35% of respondents reported health risks (Table 12). Mining activities typically generate dust, noise, and polluted water, which are linked to respiratory diseases, skin infections, and waterborne illnesses (Ibrahim et al., 2023). Prolonged exposure to particulate matter from mining sites increases the incidence of respiratory problems, especially among women and children who are more vulnerable (Ogunjimi et al., 2022).

Interestingly, the study also highlighted the perceived benefits of mining. A majority of respondents affirmed that sand and laterite mining created job opportunities (62.5%) and improved local income (62.5%) (Tables 20 and 21). However, fewer respondents strongly agreed that mining contributed to infrastructure development (Table 22). This duality reflects the “resource paradox,” where short-term economic benefits coexist with long-term ecological damage (World Bank, 2022).

Governance and regulation emerged as weak points. Most respondents (37.5% disagreed, 25% strongly disagreed) indicated inadequate government support for managing mining activities (Table 24).



Figure 5: Activities of Sand Mining and Environmental Degradation in the Study Area
Source: Fieldwork (2025)

Similarly, findings from interviews correspond with the outcomes from questionnaires, where Key informant interviews with the community leader, miners, locals, and environmental officers provided deeper insights into the dynamics of laterite and sand mining in Okpuno. The community leader emphasized the scale of land degradation, reporting that “what used to be fertile farmland is now bare ground and gullies.” Farmers confirmed that soil fertility had drastically declined, affecting crop yields, and has worsened flooding, blocked drainage channels, and polluted local water sources.” Miners acknowledged the economic benefits of mining, describing it as “the only quick source of income for many youths,” but also admitted that operations were often carried out without proper professional guidance, considering that the open-pit mining technique is prevalent (Akanwa et al. 2016).

Local government officials admitted to regulatory challenges, citing limited manpower and resources, and inaccessibility of some of the sites since they were located at remote hideouts,

while an environmental officer remarked that “laws exist on paper, but enforcement is very weak.” Participants also highlighted the exclusion of communities from decision-making, with one elder stating, “Permits are issued, but the people most affected are rarely consulted.” Women and youth described themselves as highly vulnerable, pointing to lost livelihoods and health risks from dust and water contamination. Overall, the interviews revealed tensions between short-term economic survival and long-term environmental sustainability, indicating the urgent need for stronger governance and participatory resource management.

Obviously, community involvement in decision-making is limited, with 46.25% disagreeing or strongly disagreeing that they were engaged in mining governance (Table 23). Weak institutional oversight has been identified as a critical driver of unsustainable sand mining across Africa (Mensah et al., 2021). This governance gap perpetuates illegal mining, poor reclamation, and unchecked exploitation of communal lands.

The eco-social and environmental implications of sand and laterite mining in Okpuno are significant. While mining provides income and employment, it simultaneously undermines food security, health, biodiversity, and social cohesion (Eze & Eze, 2021). The predominance of self-employed and low-income respondents demonstrates that mining persists as a livelihood strategy driven by poverty rather than choice. Environmental degradation, soil loss, water pollution, and deforestation have severe effects on agriculture, health, and community resilience, further entrenching cycles of vulnerability.

The findings reinforce calls for sustainable resource governance in Nigeria. Effective regulation, environmental impact assessments, and community participation are critical in mitigating mining’s adverse effects (Akpan et al., 2023). Alternative livelihoods such as agroforestry, eco-tourism, and sustainable agriculture should be promoted to reduce dependence on extractive activities (Ekwunife & Okorie, 2022a; Ekwunife & Okorie, 2022b). Additionally, capacity building on environmental education can empower local communities to advocate for better regulation and resource stewardship.

This study demonstrates that while laterite and sand mining generate short-term socio-economic benefits in Okpuno, their environmental, health, and eco-social costs are profound. Addressing these challenges requires stronger institutional regulation, inclusive governance, and investment in sustainable alternatives. Without such measures, the community risks long-term ecological collapse, food insecurity, and health crises.

Findings on Land Use/Land Cover Changes of Laterite/ Sand Mining for 30 Years

Remote sensing and GIS provided a robust framework for quantifying the land cover changes over time. The 30-year dataset highlights the capacity of geospatial technology to detect spatial patterns and monitor environmental impacts (Lillesand et al., 2015). Such evidence-based insights are critical for sustainable land use planning, environmental monitoring, and policy

formulation in rapidly developing regions like Awka South LGA. Figures 6 and 7 and Tables 25 and 26 revealed the 1993 and 2023 Okpuno Land Use, Land Cover changes, respectively, showing the Bare surface, Built up area, and Vegetation.

The findings confirmed that in 1993 (Figure 6), the area had vegetation of 63.4%, bare surface of 24.9% and built-up area of 11.7%, but in 2023 (Figure 7), the built-up area increased to 26.5%, vegetation reduced to 30% and bare surface decreased to 43.5%.

The GIS analysis of land cover changes in Okpuno from 1993 to 2023 reveals significant environmental transformation driven primarily by anthropogenic activities, particularly laterite and sand mining.

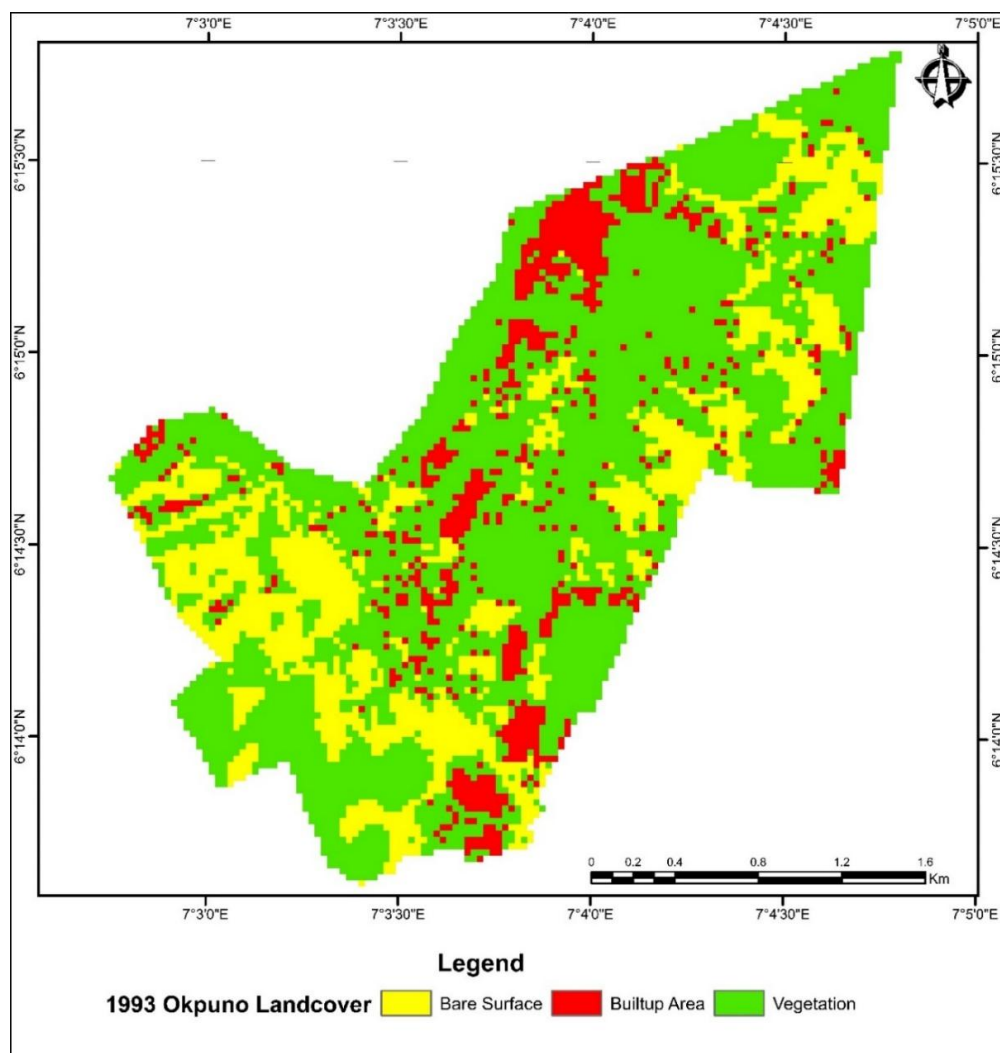


Figure 6: Land use/Land Cover Change, 1993
Source: Fieldwork (2025)

Table 25: Showing Land use /Land cover change 1993

Type	Area	Percentage
Bare Surface	172.9	24.9
Built-up Area	81.0	11.7
Vegetation	440.4	63.4
Total	694.2	100.0

Source: Fieldwork (2025)

This shift indicates a progressive conversion of vegetated land into mining sites, urban infrastructure, and exposed soil surfaces (Foody, 2002).

The reduction in vegetation is consistent with findings from similar studies where mining activities contributed to deforestation and habitat fragmentation (Asabonga et al., 2017). Removal of topsoil during laterite extraction exposes the underlying soil to erosion, which, combined with reduced vegetative cover, increases land degradation risks (Aigbedion & Iyayi, 2007). In Okpuno, these changes have altered the microclimate, reduced biodiversity, and disrupted natural drainage patterns, leading to environmental instability.

The increase in bare surfaces from 24.9% to 43.5% suggests intensified surface exposure, which has direct implications for soil erosion, sedimentation of nearby water bodies, and loss of arable land (Oladipo, 2019). Such land degradation has been shown to compromise agricultural productivity and increase vulnerability to flooding, especially in areas where land use regulations are weakly enforced (Adepoju et al., 2019).

The built-up area expansion from 11.7% to 26.5% reflects rapid urbanization, partly driven by population growth and infrastructural development. This urban sprawl often occurs without adequate environmental planning, thereby encroaching on previously restricted zones (Miller & Small, 2003). In the case of Okpuno, GIS data confirms that some mining activities have extended into environmentally sensitive areas, amplifying the ecological footprint (Akanwa et al. 2024).

Remote sensing and GIS provided a robust framework for quantifying these land cover changes over time. The 30-year dataset highlights the capacity of geospatial technology to detect spatial patterns and monitor environmental impacts (Lillesand et al., 2015; Akanwa and Iko-ojo, 2025). Such evidence-based insights are critical for sustainable land use planning, environmental monitoring, and policy formulation in rapidly developing regions like Awka South LGA.

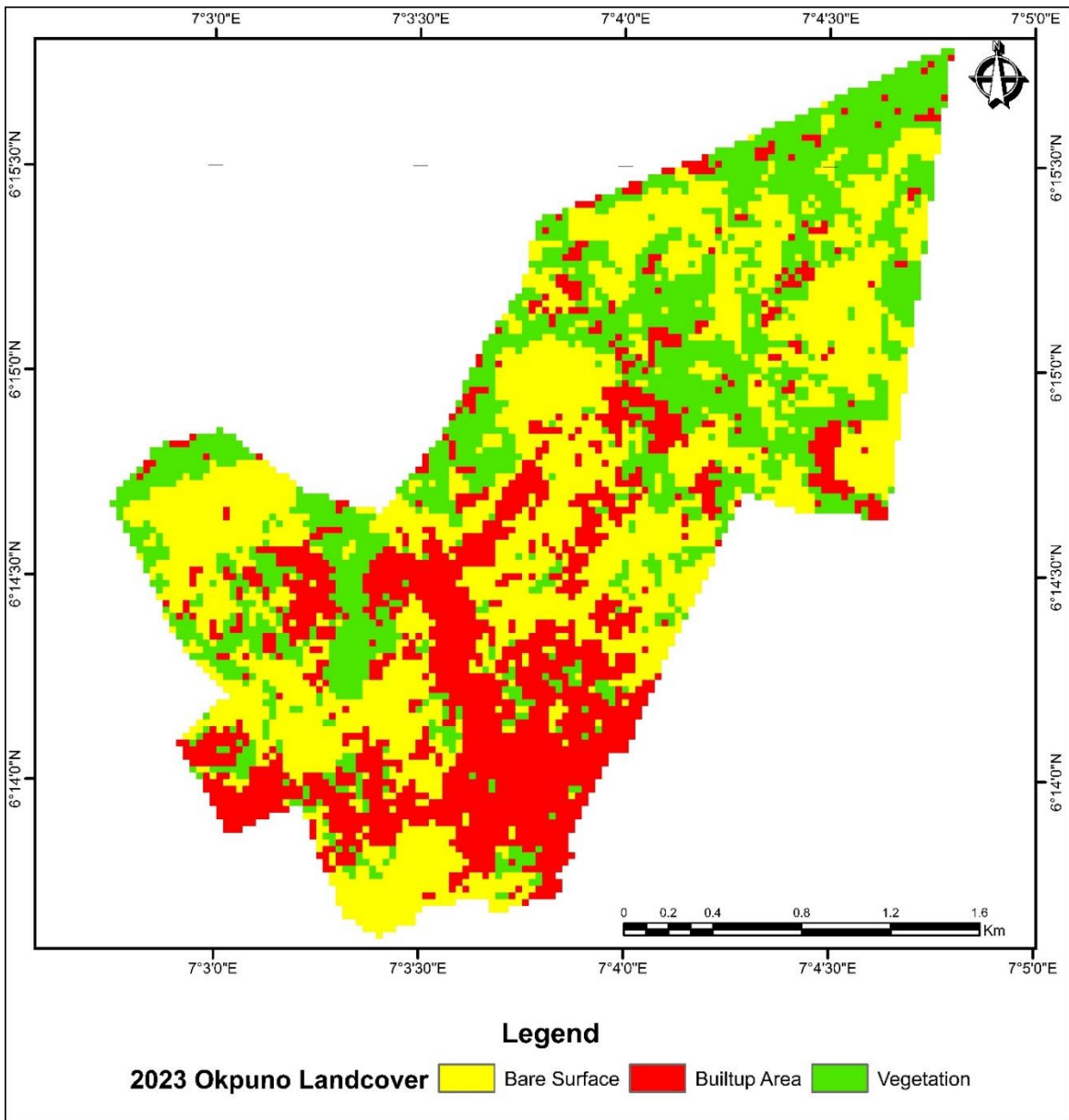


Figure 7: Land Use/Land Cover Change 2023

Source: Fieldwork (2025)

Table 26: Showing Land use /Land cover change 1993

Type	Area	Percentage
Bare Surface	301.7	43.5
Built-up Area	183.9	26.5
Vegetation	208.6	30.0
Total	694.2	100.0

Source: Fieldwork (2025).

In summary, the spatial analysis from 1993 to 2023 indicates a shift from a vegetation-dominated landscape to a heavily disturbed environment with far-reaching ecological and socio-economic impacts. Without sustainable mining practices and strong regulatory enforcement, these changes could lead to irreversible ecosystem damage, loss of livelihoods, and worsening environmental hazards in Okpuno. There is a need for restoration programs, reforestation initiatives, and the integration of geospatial monitoring into local governance could help reverse some of the degradation trends observed between 1993 and 2023.

Policy Recommendations

The findings revealed significant land cover changes in Okpuno, largely driven by laterite and sand mining, unregulated urban expansion, and weak governance. To address these issues, policy interventions should prioritize sustainable land management and stricter regulation of extractive activities (Akanwa & Ikegbunam, 2019). Government agencies must establish a transparent licensing framework for sand and laterite mining, ensuring compliance with environmental impact assessments (EIAs) before operations begin. Community participation in decision-making should be institutionalized, as local knowledge is vital for monitoring illegal mining and restoring degraded lands. Integrating Remote Sensing (RS) and GIS tools into governance will enhance real-time monitoring of land use changes, thereby improving enforcement mechanisms. Furthermore, reforestation programs and soil restoration initiatives should be mandated as part of post-mining reclamation policies. Urban development planning must adopt geospatial datasets to prevent uncontrolled expansion into ecologically sensitive areas. Economic policies should also balance livelihood opportunities from mining with agricultural sustainability by promoting alternative income-generating activities. Finally, inter-agency collaboration between environmental, mining, and urban planning authorities is critical to reduce overlapping responsibilities and improve policy coherence. Such integrated, evidence-based approaches will mitigate environmental degradation, enhance food security, and safeguard community resilience against long-term ecological and socio-economic risks.

Conclusion

This study demonstrated that laterite and sand mining, coupled with urbanization, have profoundly transformed the Okpuno landscape over the past 30 years. Land transitions evidence revealed that vegetation cover declined severely by 30%, while bare surfaces increased by 18.6 %, and built-up areas expanded by 14.8% in 30 years. These changes indicate intensified land degradation, ecosystem disruption, and socio-economic vulnerabilities linked to weak regulatory oversight. Mining has contributed to soil erosion, reduced agricultural productivity, biodiversity loss, and increased susceptibility to flooding. The rapid urban sprawl has compounded these challenges, occurring largely without adequate environmental planning or enforcement. The study indicated the critical role of geospatial technologies in tracking land use dynamics and providing evidence-based insights for policy. Notably, it highlights that without urgent intervention through reforestation, reclamation, stronger governance, and participatory management, the degradation trends may become irreversible. By integrating scientific evidence with community engagement and policy reform, sustainable land use planning can be achieved. This will not only restore ecological stability but also enhance the resilience of local communities in Awka South LGA. Thus, the findings serve as a guide for future environmental monitoring and sustainable resource governance.

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