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Assessment of Mining Activities, Regulatory Compliance, and Environmental Impacts in Nasarawa Local Government Area, Nigeria

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Abstract
This study examines the dynamics of mining activities in Nasarawa Local Government Area (LGA), Nigeria, with a specific focus on the extraction of lithium and mica minerals critical to the global electronics and renewable energy sectors. Utilizing a mixed-methods approach involving Geographic Information Systems (GIS) mapping, field surveys, and stakeholder interviews, the research identifies key mining sites including Farin Dutse, Gidan Kwano, Agogana, Over Sea, and Opa. The research evaluates the effectiveness of existing regulatory frameworks, the level of compliance among operators, and the resultant environmental footprints. Findings reveal a stark dichotomy in compliance; while formal companies largely adhere to licensing requirements, the informal artisanal sector demonstrates weak enforcement of environmental standards, particularly regarding land reclamation and hazardous chemical use. Significant environmental degradation, including deforestation (20% of respondents' primary concern), water pollution (18%), and soil erosion (15%), was identified. The study concludes that the economic potential of Nasarawa's mineral belt is being undermined by unsustainable practices and recommends enhanced regulatory enforcement, capacity building for artisanal miners, and the adoption of cleaner technologies to ensure long-term regional prosperity.

I. Introduction

The global demand for critical minerals such as lithium and mica has surged due to their pivotal role in the transition to renewable energy and the manufacturing of electronic devices. However, the extraction of these resources often presents a paradox of economic development versus environmental degradation. Mining operations, while essential for resource extraction, pose significant challenges including habitat destruction, water and air pollution, and soil degradation (Hilson, 2022). In developing nations, these challenges are often exacerbated by weak policy enforcement and the prevalence of informal, artisanal mining (Andrews-Speed, 2021).

Nigeria, particularly Nasarawa State, is endowed with significant solid mineral deposits. Nasarawa Local Government Area (LGA) has recently emerged as a strategic hub for lithium and mica extraction. Despite this potential, the sector faces scrutiny regarding the sustainability of operations and the effectiveness of regulatory oversight. Previous studies indicate that mining in the region is characterized by a mix of large-scale operations and unregulated artisanal practices, often leading to severe ecological disruption (Akpan, 2017; Obaje, 2019).

This study aims to bridge the gap in spatial and regulatory data by mapping specific mining locations, assessing compliance with the Nigerian Minerals and Mining Act and Environmental Impact Assessment (EIA) requirements, and evaluating the environmental effects on local communities. By providing empirical data on these dynamics, this research contributes to the discourse on balancing mineral wealth extraction with environmental stewardship in sub-Saharan Africa.

II. Literature Review

The mining sector acts as a critical engine for national economic development (World Bank, 2017), particularly as global demand shifts toward minerals essential for modern technology and energy transitions (McKinsey & Company, 2020); however, the sustainability of this extraction is contingent upon effective regulatory governance. While Simatele and Lindsay (2022) argue that African nations have established necessary policy frameworks, the practical implementation of tools like Environmental Impact Assessments (EIAs) often faces significant challenges, with Burgess and Chilundika (2018) noting a disconnect between legislative requirements and on-the-ground enforcement. This implementation gap, as highlighted by Castro and MorenoPérez (2017), undermines the ability to effectively predict and mitigate ecological risks, leading to severe health consequences for host communities, such as respiratory ailments linked to industrial particulate matter (Silva et al., 2018). Consequently, in the Nigerian context, Oladipo (2018) emphasizes that ensuring environmental sustainability against the backdrop of climate change requires a rigorous adherence to these regulatory standards to prevent resource extraction from compromising long-term ecological stability.

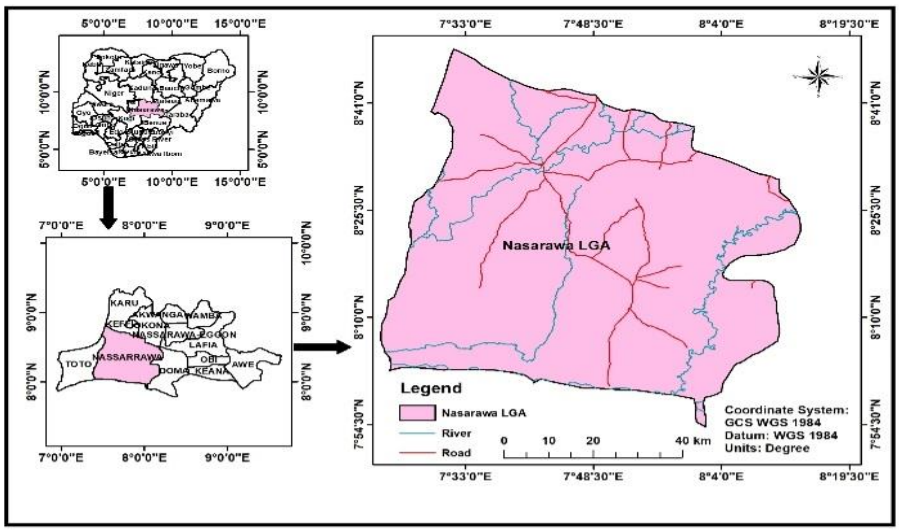
III. Methodology

Study Area

The study was conducted in Nasarawa LGA, Nasarawa State, North-Central Nigeria (Latitude 8° 32’ N, Longitude 7° 42’ E). The area covers approximately 2,395 square kilometers (see Figure 1) and is characterized by the Nigerian Basement Complex, containing ancient crystalline rocks like granite and schist, which host significant mineral

mineralization.

Figure 1: Map of the Study Area



Research Design and Data Collection

The research adopted a mixed-methods design.

Spatial Mapping

Key mining sites were identified through field visits and mapped using Global Positioning System (GPS) coordinates. Satellite imagery was analyzed to corroborate field data.

Survey and Interviews

A sample of 350 respondents, including mining operators, local government officials, and community leaders, provided valid responses to a structured questionnaire. Purposive sampling was used to select key informants for in-depth interviews regarding regulatory enforcement.

Data Analysis

Spatial data were processed using GIS software (ArcGIS 10.5). Quantitative survey data were analyzed using descriptive statistics to determine compliance levels and perception of environmental impact.

IV. Results and Discussion

Spatial Distribution of Mining Activities

The study successfully identified and mapped five major mining locations within Nasarawa LGA that form a significant mineral belt. These sites are strategically important for the extraction of Lithium and Mica (see Table 1).

Table 1: Identified Mining Locations in Nasarawa LGA

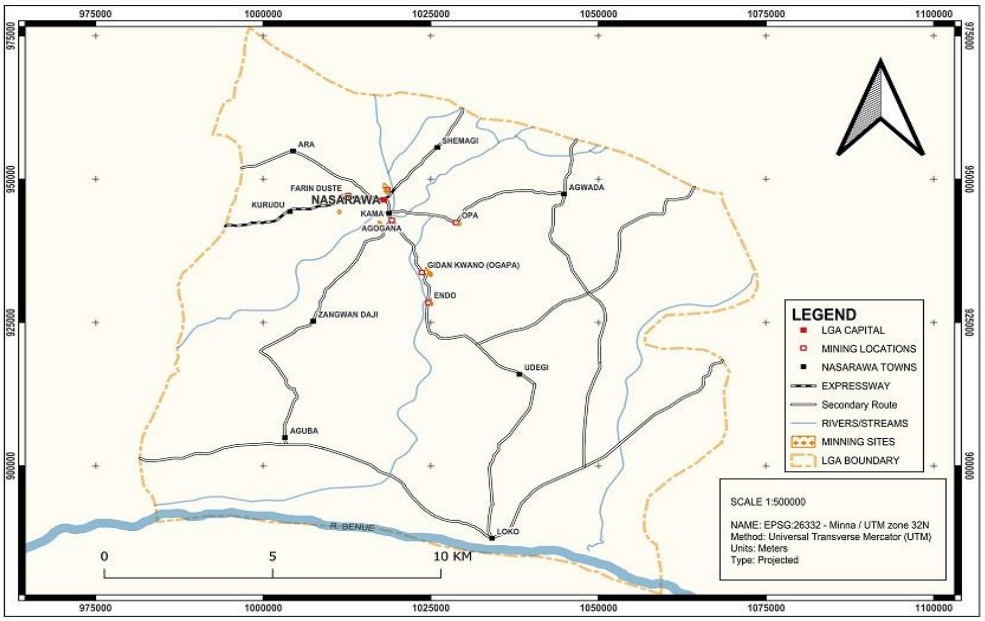
Location Name	Primary Minerals	x Coordinate	y Coordinate
Farin Dutse	Lithium	351606.02	944780.37
Gidan Kwano	Lithium	362665.79	930808.10
Agogana	Lithium, Mica	360493.13	936502.50
Over Sea	Lithium	356750.43	945971.47

Opa	Lithium	360368.85	934663.89

Source: Field Survey, 2025

The clustering of these sites in Farin Dutse, Gidan Kwano, Agogana, Over Sea, and Opa shows a high-potential zone for industrial extraction (see Figure 2). However, the proximity of these sites to agricultural communities raises concerns regarding land-use conflict.

Figure 2: Map showing Mining Locations in Nasarawa LGA



Regulatory Compliance and Governance

The results of the compliance survey conducted among miners and other respondents in Nasarawa LGA reveal varied levels of adherence to key regulatory policies in the mining sector (see Table 2).

Table 4.8: Health and Environmental Protection Policies

Regulatory Policies	Fully Compliant	Mostly Compliant	Partially Compliant	Not Compliant	Not Applicable	Total Responses
Mining License	100 (28.6%)	120 (34.3%)	80 (22.9%)	30 (8.6%)	20 (5.7%)	350 (100%)
Environmental Impact Assessment	90 (25.7%)	130 (37.1%)	70 (20%)	40 (11.4%)	20 (5.7%)	350 (100%)
Health and Safety Guidelines for Miners	110 (31.4%)	115 (32.9%)	75 (21.4%)	40 (11.4%)	10 (2.9%)	350 (100%)
Reclamation	80	100	90	50	30	350

and Rehabilitation Guidelines	(22.9%)	(28.6%)	(25.7%)	(14.3%)	(8.6%)	(100%)
Regulation of Artisanal and Small-Scale Mining Guidelines	120 (34.3%)	90 (25.7%)	70 (20%)	40 (11.4%)	30 (8.6%)	350 (100%)
Forest Protection and Mining Guidelines	95 (27.1%)	110 (31.4%)	85 (24.3%)	40 (11.4%)	20 (5.7%)	350 (100%)
Sustainable Mining Practices Guidelines	105 (30%)	115 (32.9%)	75 (21.4%)	35 (10%)	20 (5.7%)	
Minerals Processing Guidelines	90 (25.7%)	120 (34.3%)	80 (22.9%)	40 (11.4%)	20 (5.7%)	350 (100%)
Guidelines for the Use of Cyanide and Other Hazardous Chemicals	70 (20%)	100 (28.6%)	90 (25.7%)	50 (14.3%)	40 (11.4%)	350 (100%)

Source: Field Survey, 2025

The assessment of regulatory adherence reveals a complex landscape. Compliance was highest for administrative requirements, such as obtaining Mining Licenses (62.9% fully or mostly compliant). However, compliance dropped significantly for operational and environmental safeguards.

Reclamation and Rehabilitation

Only 51.4% of respondents reported compliance with land reclamation guidelines. This suggests that nearly half of the mining operations leave land degraded post-extraction.

Hazardous Chemicals

Compliance with guidelines for the use of cyanide and other hazardous chemicals was low (48.6% fully or mostly compliant). This is a critical finding given the health risks associated with chemical leaching.

Informal Sector Challenges

Interviews indicated that while formal companies generally adhere to protocols, the artisanal sector operates largely outside the regulatory net. Enforcement is hampered by limited government resources and the sheer number of informal operators.

Environmental Impacts

Survey results highlight severe environmental degradation resulting from mining activities. The most pressing environmental concerns identified by respondents were:

Deforestation (20%)

Large tracts of vegetation are cleared for site access and extraction, disrupting local ecosystems.

Water Pollution (18%)

Contamination of water bodies, likely due to improper disposal of mining by-products and chemical runoff, poses a threat to aquatic life and community health.

Soil Erosion (15%)

The physical alteration of the landscape has accelerated soil erosion, further degrading agricultural land.

Land Degradation (14%)

The destruction of arable land directly impacts the livelihoods of the local population, 73.3% of whom are engaged in farming.

Assessment of Mitigation Measures

Current mitigation efforts show mixed effectiveness. While the Environmental Impact Assessment (EIA) process is largely adhered to by larger firms (80% implementation level), its effectiveness is rated as "High" only for those specific projects. Conversely, waste management and the promotion of sustainable mining practices suffer from poor enforcement and low compliance (30-35%). Reclamation efforts have reduced some soil erosion, but vegetation recovery remains slow, indicating that rehabilitation protocols are either insufficient or poorly executed.

V. Conclusion

Nasarawa LGA stands at a critical juncture where economic opportunity meets environmental vulnerability. The region's wealth in lithium and mica offers substantial economic promise, particularly in the context of global supply chains. However, this study confirms that the benefits are currently undermined by weak enforcement of environmental regulations, particularly within the informal sector. The prevalence of deforestation, water pollution, and non-compliance with rehabilitation standards threatens the long-term sustainability of the region's ecosystem and the livelihoods of its agrarian communities.

VI. Recommendations

To ensure sustainable mining practices in Nasarawa LGA, the following measures are recommended:

Strengthened Enforcement

The establishment of a dedicated environmental monitoring task force equipped to conduct regular, unannounced inspections of both formal and informal mining sites.

Capacity Building

Implementation of training programs for artisanal miners focusing on safer extraction techniques, proper chemical handling, and the legal obligations of land

reclamation.

Community Integration

Formalizing community-based resource management committees to ensure local stakeholders have a voice in mining decisions and benefit-sharing.

Adoption of Technology

Incentivizing the use of cleaner mining technologies and investment in research for effective land rehabilitation specific to the geological context of Nasarawa.

Regulatory Reform

Updating enforcement mechanisms to hold operators accountable for lifecycle environmental costs, ensuring that "polluter pays" principles are strictly applied to land reclamation.

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