

Assessment of the Impact of Mineral Resources Exploitation on the Ecosystem of the Mambilla Plateau, Sardauna Lga Taraba State, Nigeria

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DOI: <https://doi.org/10.51584/IJRIAS.2026.11010024>

Received: 04 January 2026; Accepted: 10 January 2026; Published: 24 January 2026

ABSTRACT

This study provides a comprehensive assessment of the ecological impacts of mineral resource exploitation on the Mambilla Plateau, Taraba State, Nigeria. The study focused on eleven key mining communities—Mayo Sina, Titong, Njah, Bongo, Yurum Kenor, Yana, Tunga Shuaibu, Papaa, Tikobi, Bundi, and Tunga Luger—within Sardauna Local Government Area. A total population of 8,600 residents was considered, from which a representative sample size of 351 was determined using the Krejcie and Morgan sampling table. Data were collected through randomly administered questionnaires and analyzed using descriptive statistics. Findings reveal that mineral exploitation on the Mambilla Plateau are largely unregulated, reflecting significant gaps in environmental governance. Respondents reported severe ecological impacts, including deforestation (Mean = 4.18), water pollution (Mean = 4.05), soil erosion, and widespread landscape degradation. The composite index confirmed that current exploitation practices are unsustainable and environmentally destructive. The study concludes that unregulated artisanal mining poses a profound threat to the Mambilla Plateau's environmental integrity and community well-being. It recommends urgent policy intervention through strengthened regulatory frameworks, adoption of sustainable mining technologies, and large-scale ecological restoration to safeguard the Plateau's fragile environment and enhance the resilience of affected communities.

Keywords: Mineral exploitation, Environment, Mambilla Plateau, Ecological disturbance Impact and mining

INTRODUCTION

The influence of resource exploitation and its degradational impact to the ecosystem cannot be overemphasized. Since the birth of industrial revolution, man has continued to introduce hazardous materials into the environment at an alarming rate. These materials mostly consisting of inorganic substances (heavy metals) pose serious health and environmental threat. In mid 1990s it was reported that on an annual basis, about 700 million kilograms of metals in mine tailings were disposed on land globally (Warhurst 2000).

Exploitation of natural resources is an essential condition of human existence. Throughout the history of mankind, humans have manipulated natural resources to produce the materials they needed to sustain growing human populations. Natural resources are an important material base for a stable natural economy and social development; they can be divided into two; the exhaustible: such as minerals and the inexhaustible: such as forests and grasslands. With industrialization and urbanization, mankind's great demands for natural resources and their large-scale exploitation and consumption have resulted in weakening, deteriorating and exhaustion of these resources (Babagana, Aji & Magaji, 2012).

The increasing challenges posed by human activities (mining inclusive) have become a source of concern in recent times. Human beings depend on the resources in the environment for their life support and existence. In the process of exploiting these resources, damages are caused to the environment. To protect the environment from damages resulting from human activities, many nations have enacted legislation in that regard (Babagana *et al.*, 2012).

Mineral resources are essential to our everyday lives, but are finite and can be depleted if not managed responsibly. Unfortunately, many natural resources have been exploited and depleted due to unsustainable mining practices and over-consumption. This has led to environmental degradation in many parts of the world, with deforestation, air and water pollution, and soil erosion as expected consequences (Udiba *et al.*, 2012). The depletion of mineral resources has also impacted the global economy, with lower-than-expected yields from mining operations leading to decreased production and profits. The depletion of mineral resources also has a direct impact on human life. Without access to these resources, people may not be able to access the essential goods and services necessary for a good quality of life. This can lead to further exploitation of natural resources, such as over-fishing and over-harvesting of forests, as people struggle to meet their basic needs (Udiba *et al.*, 2012).

In Nigeria, the growing anxiety of rising environmental pollution and degradation has been stressed. Following the exploitation of land for its abundant resources, various forms of pollution contributes to the reduced environmental quality (Udiba *et al.*, 2012). This however question the safety of nearby water bodies and air quality inhaled by residence within the mining sites because of the Acid Mine Drainage (AMD) and mercury amalgamation method used by locals. Unlike the developed society, there has not been accurate data quantifying the numbers of abandoned mine in Nigeria. Though the current dominance of petroleum industry as the nation economic stream has tampered on the progress of this sector for decades, informal miners and companies (sometime unlicensed) have become very active and strive even with the absence of a clearly defined policy, standards and sound regulations and reforms. (Udiba *et al.*, 2012).

The Mambilla Plateau, known for its rich biodiversity and natural resources, has experienced increasing mineral resource exploitation in recent years. While mining activities provide economic opportunities and support local development, they also pose significant threats to the environment. The unchecked exploitation of mineral resources has led to land degradation, deforestation, soil erosion, water pollution, and the loss of biodiversity in the region. According to recent research carried out by (Jibrin. & Nano, 2024) states that this detrimental process, often driven by human activities and further exacerbated by natural phenomena, tends to be most profound in rural regions where dependence on land and ecosystem services is the most significant. Despite the visible impacts, there is a lack of comprehensive studies that quantify the extent of environmental damage and evaluate the long-term ecological socio-economic consequences of mining activities on the Mambilla Plateau. Without a clear understanding of these effects, it is difficult to implement sustainable resource management practices or develop effective policies to mitigate environmental harm (Ezekiel, *et al.*, 2024).

This research therefore aims to fill this knowledge gap by assessing the environmental impact of mineral resource exploitation on the Mambilla Plateau, examining its effects on ecosystems, local communities, and proposing sustainable practices and regulatory measures to minimize ecological damage while promoting responsible economic development.

MATERIALS AND METHODS

Description of the Study Area

Sardauna Local Government Area of Taraba State came in to existence in 1976. It is located between latitude $5^{\circ} 31'$ and $7^{\circ} 18'$ north of the equator and longitude $10^{\circ} 18'$ and $11^{\circ} 37'$ east of the Greenwich meridian. It is located at about 1,850 m above sea level in Mambilla Plateau. It is bordered to the north by Gashaka Local Government Area, to the southeast by Republic of Cameroun and to the west by Kurmi Local Government Area. The Local Government Area has a total landmass of about 3, 765.2 km² (Oruonye & Ahmed, 2016).

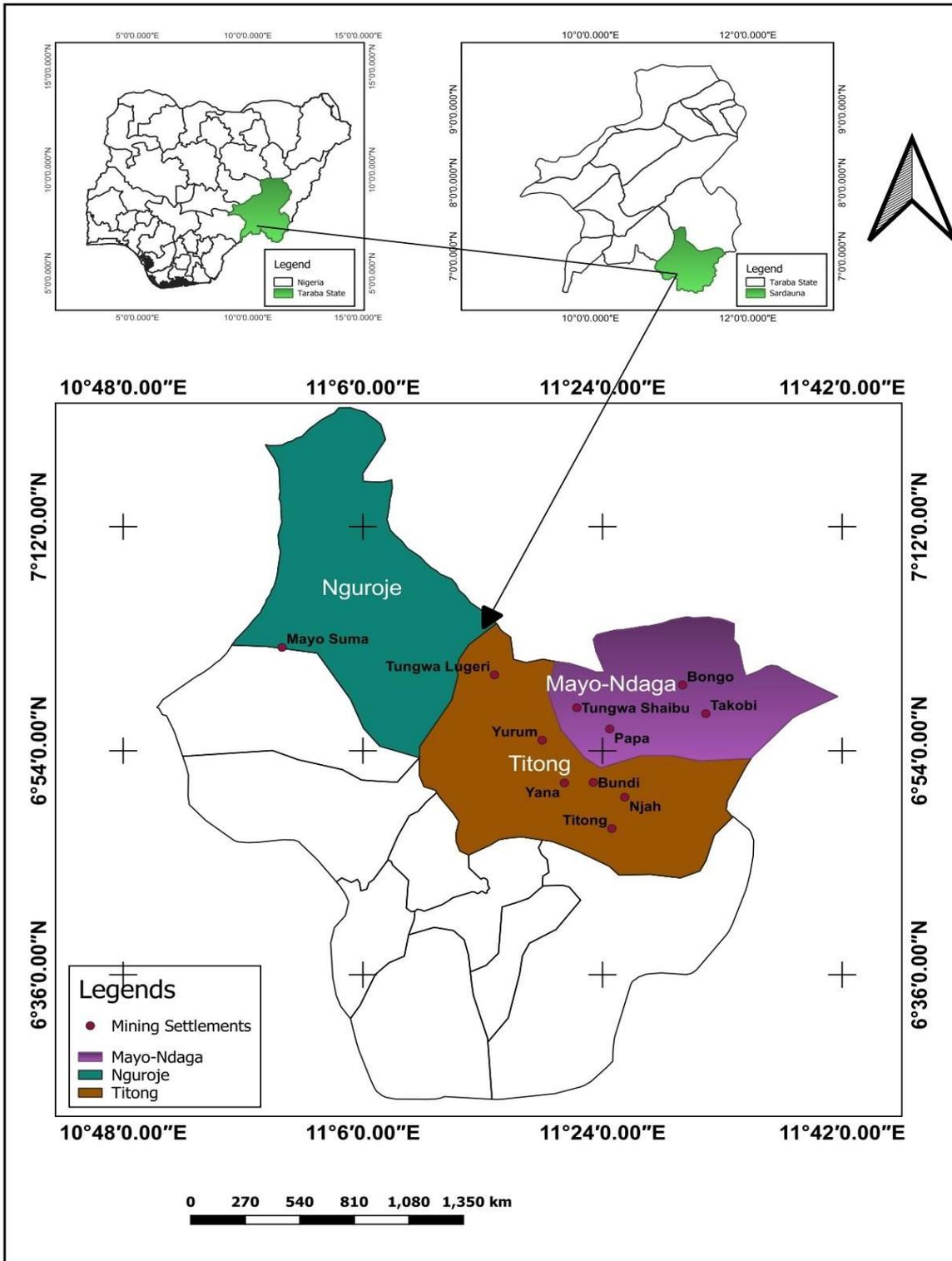


Figure 1: Map of the Study Area

Source: TAGIS, 2025

Mambilla Plateau is situated near the border with Cameroon; the Plateau forms the western extension of the Adamawa Highland. It belongs to the uplifted parts of Eastern Nigeria on the southern flank of the Benue Trough. The plateau consists of Gotel Mountains with Paleocene to Miocene basalts in the North and the Mambilla Mountains with Precambrian gneisses in the South. The Pan African basement complex is built up mainly of migmatite gneisses, some strongly folded metasediments, granites, and, in a few places, Charnokitic intrusions. Quartz veins mostly cut the migmatites. Basalt flows cover the northern part of the plateau. They belong to the 700 km long NE trending Cameroon volcanic Line, a continental segment of a 1,600 km volcanic chain that straddles the West African continental margin, characterized by Maastrichtian Recent alkaline magmatism (Wilson & Guiraud, 1992; Oruonye & Ahmed 2016). At Bambouto and Oku (50 – 200km SE of

the Mambilla Plateau), K/Ar model ages range from 23 – 14 Ma. (Lower to Mid Miocene) (Fitton & Dunlop, 1985; Oruonye *et al.*, 2016). The volcanism is strongly bimodal composed of alkali basalt, Trachyte, trachyphonolite, transitional alkali basalt, quartz Trachyte, and rhyolite. The geology of the study area is composed mainly of Basement Complex rocks of the Precambrian age, especially in the southern and northern part with a series of isolated granitic hills towards the north. The rocks are predominantly granite gneiss, migmatites, and coarse medium-grained biotite granites. This granitic rock usually occurs in uplifted positions. (Oruonye & Ahmed, 2016)

Soil is the topmost layer of the earth surface that is diverse in complexity with mixtures of minerals and organic materials, aqueous and gaseous components, which are capable of supporting plants and animals' life. The type of soil is bauxite has been discovered on the Mambilla Plateau. Laterite is developed on gneisses and basalt, while on trachytic parent rocks low-silica bauxite occurs with a thickness of more than 5 m and covering an area of at least 1 km². This bauxite consists of gibbsite and goethite. And the dominant rock types in the Mambilla Plateau are basalt and trachytic rocks, which significantly influence the soil types. (Schwarz, & Strack 1999; Omisore & Olorunfemi, 2017)

The climate of the plateau is comparatively cold. Daytime temperatures hardly ever exceed 25 °C (77.0 °F) making it the coolest region in Nigeria.(NS Energy, 2018) Strong winds prevail during the daytime and the rainy season lasts from mid-March until the end of November. As a result of its high elevation, the plateau experiences temperate weather conditions but on a smaller scale because of its location in a tropical environment. The rainy season on the Mambilla Plateau is associated with frequent and heavy rainfall because of orographic activities on the plateau involving moist winds from the south Atlantic Ocean in southern Nigeria and the steep escarpments of the plateau. The Mambilla Plateau receives over 1,850 millimetres of rainfall annually. (Oruonye & Ahmed, 2016)

Vegetation on the plateau comprises low grasses with trees being noticeably absent except for manmade forest planted by German colonialists during the period of German administration of the Cameroon (1906-1915) and other Nigerian government tree planting programs. The predominant vegetation cover is the low, velvet grass akin to the English rat-tail grass, known locally here as "gwur" grass. It is a major ritual emblem of the local traditional religion. The plateau is the only region of Nigeria that grows the tea plant on a large scale and there are several tea farms, although the sector remains mostly underdeveloped. It is also home to the Gashaka Gumti National Park, which is the largest national park and protected area in all of Nigeria, as well as the Majang Forest known officially as Ngel Nyaki Forest Reserve, both of which harbor rare and endangered West/Central African plant and animal species endemic to the area. (Oruonye & Ahmed, 2016)

The eucalyptus tree and the abundance of low lush green grasses on the plateau has attracted a large number of cattle, whose advent beginning during British rule affected the plateau's vegetation. This has resulted in overgrazing and widespread erosion on the plateau and has created problems between the cattle herders, referred to as the Fulanis and the indigenous people, the Mambila.(Oruonye *et al.*, 2017)

The Mambilla plateau is known for its favorable climate and conditions for Agriculture; particularly crop farming and livestock rearing, plantation of Eucoleptus tree. While farming is widespread, access to land and resources can be limited, impacting the livelihood of many residents. Additionally, artisanal mining especially for blue sapphires, provides an alternative source of income for some people in the Mambilla Plateau. Some residents are also involves in trading, petty trading and other informal sector.

Research Design

Research design is the framework of research methods and techniques chosen by a researcher. In this study, a survey research design was used (Opeyemi, 2006; Danjuma, 2023). The questionnaire method was used to elicit information on the different activities within the mining sites and their impact on the ecosystem.

Data Needs/Source

Primary data were required to achieve the expected aim of this study. Questionnaires were used to elicit information from the residents of the study area to determine the impact of mineral resource exploitation on the ecosystem.

Instrument for Data Collection

Questionnaires were used in this study to obtain information from the mining communities on the impact mineral

exploitation on the natural ecosystem.

Study Population

The population of this study comprises of all eleven (11) mining communities in Sardauna Local Government Area.

Sample and Sampling Technique

Table 1: Population of the Mining Settlements

S/N	COMMUNITY	TOTAL POPULATION	SAMPLED OPULATION	PERCENTAGE (%)
1	Mayo Suma (Sina)	1000	41	11.62
2	Titong	620	26	7.21
3	Njah	550	23	6.40
4	Bongo	910	32	10.58
5	Yurum (Kenor)	750	31	8.72
6	Yana.	660	27	7.67
7	Tunga Shuaibu	1010	42	11.74
8	Papaa	650	27	7.58
9	Tikobi	720	30	8.37
10	Bundi	530	22	6.16
11	Tunga Luger	1200	50	13.95
	TOTAL	8,600	351	100

Source: Author’s field work, (2025)

From Table 1 above, the total population of the mining communities is 8,600. Using Krejcie and Morgan table, the sample size of 8,600 is 351. Since the mining communities do not have the same population all over, the sample size for each of them was determined thus: total population of a given community divided by the sum total of the population of the 11 communities then multiplied by the total sampled population (Table 1). So, a total of 351 multiple choice questionnaires were produced and administered randomly to the respondents by the researcher. These were later retrieved and the results carefully analyzed

RESULTS

Impact of mining activities on the natural ecosystem

Table 2: Impact of mining activities on the natural ecosystem

Statements	N	Mean	Std. Deviation	Decision
1. Mineral exploitation has caused widespread deforestation on the Mambilla Plateau.	351	4.18	.654	Accepted
2. Mining activities have significantly polluted local water sources.	351	4.05	.815	Accepted
3. Soil erosion and land degradation have increased due to mining operations.	351	3.94	1.045	Accepted
4. The visual landscape and natural beauty of the Plateau have been negatively impacted by mining.	351	3.74	1.063	Accepted
5. Soil organisms are largely affected by the mining activities.	351	4.13	.716	Accepted
6. Mineral exploitation has disrupted the ecological balance in the region.	351	4.03	.987	Accepted

Source: Author’s field work (2025)

Table 2: shows the various ways in which mining activities on the Mambila Plateau impact on the ecosystem. Statement one (1) on the table states that “Mineral exploitation has caused widespread deforestation on the Mambilla Plateau”. This was accepted with a mean of 4.18 and standard deviation of .654, followed by statement five (5) which states that “Soil organisms are largely affected by the mining activities”. This was accepted with a mean score of 4.13 and standard deviation of .716, while the least was statement four (4) which states that “The visual landscape and natural beauty of the Plateau have been negatively impacted by mining” with mean score of 3.74 and standard deviation of 1.063

DISCUSSION

The major finding of this study is that mining activities on the Mambilla Plateau have severe and multidimensional ecological consequences. Respondents overwhelmingly agreed that mining contributes to deforestation, soil erosion, landscape degradation, water pollution, and destruction of soil organisms, ultimately leading to the disruption of ecological balance. The composite ecosystem impact index (Mean = 3.94, SD = 1.045) reflects strong agreement on the harmful effects of mining. These results corroborate earlier studies that identified artisanal mining as a significant driver of environmental degradation in sub-Saharan Africa. For instance, Gutti *et al.*, (2012) highlighted that artisanal mining often leads to deforestation as vegetation is cleared for mining pits, while downstream water bodies are polluted with sediments and heavy metals. The findings in this study particularly the strong agreement that mining leads to water pollution and soil erosion align with these regional patterns. Locally, research by Aigbedion & Iyayi, (2007) observed similar ecological consequences of mining in Plateau and Nasarawa States, Nigeria, where artisanal miners degraded agricultural lands and contaminated water resources. The current study extends these findings by providing evidence specific to the Mambilla Plateau, which has unique ecological characteristics, including highland forests and fragile soils.

The strong perception of ecosystem disruption also resonates with the global debate on sustainable mining. According to the United Nations Development Programme (UNDP, 2005) and Babagan *et al.*,(2012) artisanal mining contributes disproportionately to biodiversity loss and ecosystem fragmentation in tropical regions.

This study demonstrates that the Mambilla Plateau, despite being an ecologically sensitive highland, is already experiencing similar pressures due to unregulated mining.

By highlighting the ecological consequences of deforestation, erosion, water pollution and biodiversity loss, this study makes it clear that artisanal mining in the area is not merely an economic livelihood activity but also a driver of ecological crisis. In line with (Babagana, Aji, and Magaji, 2012) artisanal mining, when left unregulated, poses a serious challenge to sustainable development goals (SDGs 13, 14, and 15: climate action, life below water, and life on land).

CONCLUSION

The study concludes that mining on the Mambilla Plateau is largely artisanal, unregulated, and environmentally unsustainable. While it provides a source of livelihood for local populations, it comes at the cost of widespread ecological damage, including deforestation, soil erosion, water pollution, and biodiversity loss.

The findings confirm global and Nigerian evidence that artisanal mining, in the absence of proper regulation and environmental management, exacerbates ecological crises and undermines sustainable development goals (SDGs 13, 14, and 15).

RECOMMENDATIONS

Based on the findings and conclusions, the following recommendations are made:

- i. **Policy and Governance:** The Taraba State Government, in collaboration with the Federal Ministry of Mines and Steel Development, should establish stronger regulatory frameworks for artisanal mining, including mandatory environmental compliance and reclamation measures. There should be enforcement of Environmental Impact Assessments (EIA) before any form of mining is permitted, regardless of scale.
- ii. **Environmental Management:** Mining pits should be reclaimed and rehabilitated through communitybased reforestation and land restoration programmes. Government and NGOs can provide technical and financial support for these efforts. Continuous environmental monitoring should be introduced, with periodic audits of soil, water, and forest conditions in mining zones.
- iii. **Community Engagement and Capacity Building:** Local miners should be trained and supported to transition from harmful artisanal methods to safer and more sustainable mining techniques
- iv. **Alternative Livelihoods:** To reduce dependence on artisanal mining, government and development agencies should invest in alternative livelihood programmes, such as modern agriculture, agroprocessing, and small-scale enterprises.
- v. **Access to microfinance** should be expanded for miners willing to diversify their sources of income, thereby reducing pressure on the environment.

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