



MINING SECTOR'S PARTICIPATION IN ADVANCING THE SUSTAINABLE DEVELOPMENT GOALS (SDGs) IN NIGERIA: EXPERIENCES FROM A LARGE-SCALE GOLD MINING COMPANY

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Abstract

This study assesses the contribution of a large-scale gold mining company in Osun State, Nigeria to the Sustainable Development Goals (SDGs). A structured questionnaire was administered across three host communities, which are Iperindo (L1), Odo Ijesha (L2), Imogbara (L3) and aligned with relevant SDG targets. The combination of purposive and random sampling was used. Community L1 had 40 respondents, L2 had 30 respondents and L3 had 30 respondents making a total of 100 respondents. Descriptive and inferential statistics (χ^2 tests) were used to compare responses across communities, while SDG scores were computed to evaluate the extent to which mining activities contribute to or detract from local development outcomes. Results revealed substantial heterogeneity in employment distribution, displacement and compensation patterns, gender inclusion, and environmental impacts. While infrastructure provision, and general employment opportunities were high across communities, L2 and L3 reported significantly higher direct employment and stronger gender-inclusive practices than L1. Environmental outcomes showed that air pollution was universally severe, whereas deforestation, land degradation, and water pollution were unexpectedly low likely due to low agricultural activity, spatial separation between mines and farms, and reliance on boreholes. Governance, mitigation indicators and female participation in decision-making were uniformly weak. The findings highlight the dual role of large-scale mining (LSM) as both an enabler of socio-economic development and a driver of environmental and gender inequalities, reinforcing the paradox of development. In conclusion, to ensure LSM becomes a genuine driver of sustainable development, stronger governance reforms, transparent environmental monitoring, inclusive decision-making, and gender-responsive policies are essential.

Keywords: Large-scale mining (LSM); Mining impacts; Gold mining; Sustainable Development Goals (SDGs).

Introduction

Across Sub-Saharan Africa, mineral extraction remains central to economic growth, state revenue, and rural livelihoods (Hilson, & Maconachie, 2020). Gold mining, in particular, has expanded significantly in the last two decades, driven by global price volatility, foreign investment, and national development strategies prioritizing natural resource exploitation (Guan *et al.*, 2021; Kumah, 2006). Yet the rapid intensification of mining has revived longstanding debates concerning its sustainability, and its capacity to meaningfully advance the United Nations Sustainable Development Goals (SDGs). While the extractive sector is frequently presented as a catalyst for development, evidence across African mining communities continues to reveal persistent social,

economic, and environmental challenges (Worlanyo & Jiangfeng, 2021; Shen *et al.*, 2015).

The relationship between the extractive sector and the SDGs is therefore complex and often contradictory. On one hand, mining, particularly large-scale mining (LSM) is positioned as an enabler of SDG achievement through formal employment, economic growth (SDG 8), industrial development (SDG 9), increased government revenue, and the supply of minerals essential for global green transitions (Worlanyo *et al.*, 2022). Frameworks such as UNDP's Mapping Mining to the SDGs (Sonesson *et al.*, 2016), the ICMM Mining Principles (ICMM, 2024), and the African Mining Vision (Union, 2009) highlight pathways through which LSM can support inclusive development, local procurement, and improved infrastructure. On the other hand, empirical studies show that mining

often undermines SDGs related to poverty reduction (SDG 1), food security (SDG 2), gender equality (SDG 5), clean water (SDG 6), climate action (SDG 13), and biodiversity conservation (SDG 15). Many mining companies selectively report progress on SDGs that are easiest to demonstrate typically infrastructure or corporate social responsibility (CSR)-related, while overlooking more transformative commitments such as environmental restoration, participatory governance, and long-term livelihood diversification (Omotehinse and De Tomi, 2019; 2023).

LSM is often portrayed as better positioned to advance the SDGs due to its technological capacity, formal regulatory frameworks, revenue generation and ability to fund community development (Worlanyo *et al.*, 2022). Yet LSM also faces limitations: its capital-intensive structure generates fewer jobs per unit of gold produced, can intensify socioeconomic inequalities, and may reinforce governance tensions within host communities. These contrasts underscore the need for rigorous, community-level assessments to evaluate whether mining actually contributes to sustainable development rather than merely claiming SDG alignment.

Scholarly literature frequently conceptualizes these contradictions as part of the “resource curse” or “paradox of development (Auty, 2002; Basedau & Lay, 2009),” where resource-rich regions experience persistent inequality, environmental degradation, and fragile governance despite substantial mineral wealth. Evidence from Ghana, Nigeria, and Tanzania shows that although mining can create new

economic opportunities, it often contributes to land dispossession, declining agricultural productivity, heightened conflicts, and increased pressure on local governance institutions (Andrews, 2018; Omotehinse & Ogunlade, 2022). These dynamics reinforce the need for empirical studies that move beyond national-level economic indicators toward community-centered assessments aligned with the SDGs’ emphasis on inclusion, equity, and environmental integrity.

Sustainability theory further highlights the importance of balancing economic growth with environmental integrity and social equity, the “triple bottom line” (Omotehinse & De Tomi, 2020; Elkington & Rowlands, 1999). Even where companies adopt sustainability frameworks such as UNDP’s SDG mapping tools, implementation tends to be selective, emphasizing SDGs related to economic growth (SDG 8) and infrastructure (SDG 9) while paying less attention to environmental restoration (SDG 15) and accountable, participatory governance (SDG 16) (Kemp & Owen, 2019; Wilson, 2020).

This study contributes to these debates by translating SDG targets into measurable community-level indicators, integrating socio-economic and environmental assessments, and foregrounding issues of governance and inclusivity. Using comparative evidence from three mining-affected communities in Osun State, Nigeria, the study provides a nuanced understanding of how large-scale gold mining company can simultaneously advance and undermine sustainable development.

Table 1: Negative impacts of mining classified under the three thematic area of sustainable development

Negative impacts of mining activities	Examples of impacts	References
Economic	Bribery and corruption; Unemployment; Poverty; Increased cost of living.	(Tuija Mononen <i>et al.</i> , 2022; Sonesson <i>et al.</i> , 2016).
Environmental	Deforestation; Land degradation; Air, Soil & water pollution; Flooding and erosions; Climate change; Biodiversity loss; Noise hazards; Waste generation; Carbon emissions, Greenhouse gases and effluents;	(Tuija Mononen <i>et al.</i> , 2022; Sonesson <i>et al.</i> , 2016; Shen <i>et al.</i> , 2015; Omotehinse & Ako, 2019).
Social	Displacement; Conflicts and violence; Human trafficking; Prostitution; Child labour; Crime; Insecurity; Sexual abuse; Alcohol and substance abuse	Tuija Mononen <i>et al.</i> , 2022; Sonesson <i>et al.</i> , 2016; Shen <i>et al.</i> , 2015; Franks, 2012; Kitula, 2006; Mancini & Sala, 2018).

Methodology

This study adopted a quantitative research design to assess the contribution of a large-scale gold mining company in Osun State, Nigeria, to the Sustainable Development Goals (SDGs). The adverse impacts

were particularly used for these classifications premised on recent works by different authors (Table 1) and some adaptation based on the authors understanding of local peculiarities in developing mining environment of Ghana and Nigeria.

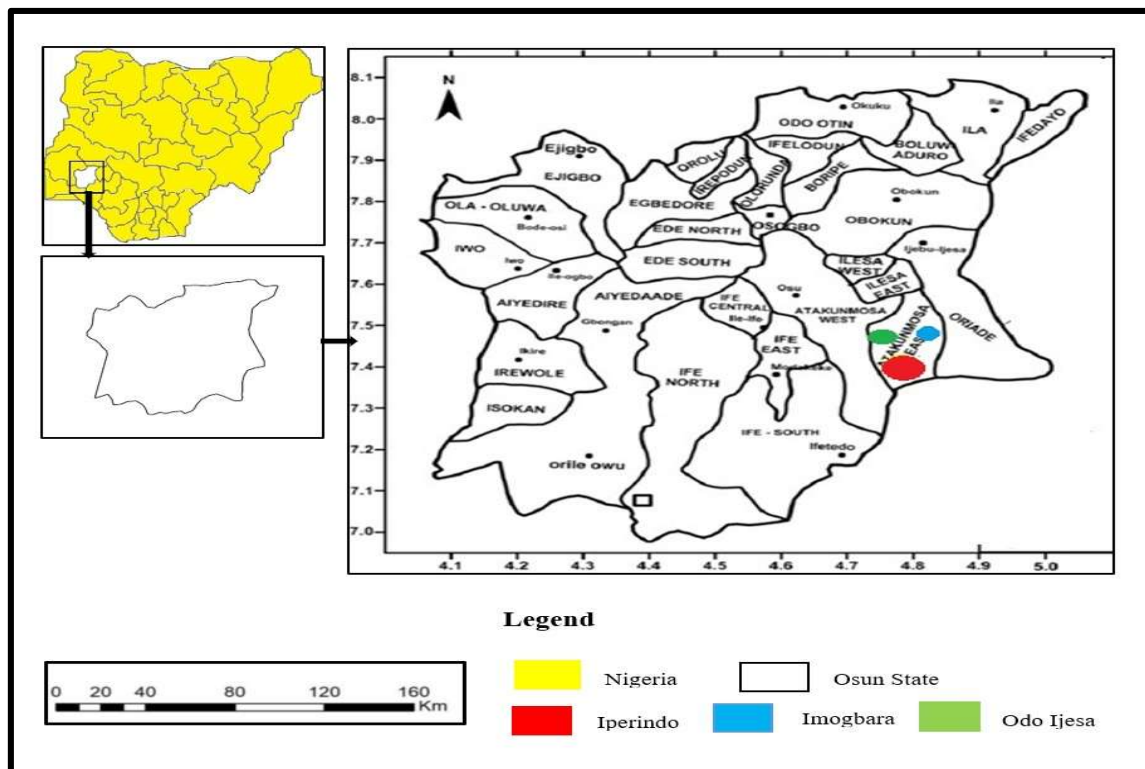


Figure 1: Map of Nigeria with showing the study areas

Description of Study Area

The areas under study are the three host communities to Segilola Gold Mine. Segilola Gold Mine is the first large-scale, commercial gold mine, situated in Osun State, Nigeria, and the gold is both mined by artisanal and large-scale mining methods. Osun state is in the south-western part of Nigeria bordered by the Republic of Benin to the west, Ondo state to the east, Oyo state to the north, and Lagos state and the Atlantic Ocean to the south. It is located between latitudes 7.5629°N and longitudes 4.5200°E of the Greenwich Meridian. A map showing the study area is provided in Figure 1.

These three communities which are the host communities for the project are Iperindo, Imogbara, and Odo Ijesa (L1, L2, and L3 respectively) in Atakunmosa east Local Government Area. Iperindo is the local government headquarters of Atakunmosa east and it is located approximately 2 kilometres south from the Segilola Gold Mine with 7°30'8" N latitude and 4°49'33" E longitude, Imogbara is situated approximately about 2.5 kilometres north from the Segilola Gold mine. 7°32'25" N latitude and 4°49'54" E longitude and Odo-Ijesa is located approximately 2 kilometres north from the Segilola Gold Mine 7°32'30" N latitude and 4°49'20" E longitude.

Segilola Gold Mine was chosen as a case study for two reasons. One, it is the first LSM in the entire south west because the south western part of Nigeria is dominated by quarries including limestone quarries, and secondly, it is the first large scale gold mine in Nigeria. These communities were selected because of their proximity to the large-scale gold mining operation and their direct exposure to its socio-economic and environmental impacts. The communities vary in size, livelihood patterns, and exposure to mining activities, making them appropriate case studies for understanding differential experiences of mining.

The approach used was a combination of purposive and simple random sampling was used. Purposive sampling was applied to identify the SDG targets. Random sampling was applied using questionnaires to evaluate the extent to which mining activities contributed to or undermined sustainable development outcomes. Community L1 has 40 respondents, community L2 has 30 respondents and L3 has 30 respondents making a total (N) of 100 respondents.

Questionnaire Development and SDG Operationalization into Measurable Indicators

A structured questionnaire was designed and each questionnaire item was operationalized into a

measurable SDG indicator through a **standardized coding rule**. For instance, the question “**How does mining affect your job as a farmer?**” informed indicators such as deforestation rate, land degradation or reduce land quality, and soil contamination levels. Similarly, the question “**To what extent does mining influence water quality?**” was operationalized using quantifiable parameters including presence of heavy metal, and waste. **Socioeconomic disruption** was measured using displacement counts, changes in household income, and conflict occurrences. Each survey item was mapped to one or more SDG targets based on the thematic focus of the question. Responses were then coded numerically to indicate whether the outcome reflected progress toward, no change in, or regression from the SDG.

Chi-Square Test was used for the computation of the SDG scores. The raw frequencies (Yes/No/Not sure) were used to compute the χ^2 statistic, the Degrees of freedom (df) = (rows-1)(columns-1) = (df = (r-1)(c-1)) and the p-value. This tested whether mining impacts or benefits significantly differed among the three communities.

Interpretation: $p < 0.05$ = significant difference in impact or mitigation across communities; Mean scores < 2 = high negative impact; Mean scores > 2.5 = positive or well-managed outcome; Mean ≈ 1 = severe negative impact; Mean ≈ 3 = no impact (for negative-impact questions) or effective action (for positive-action questions).

Results and discussion

Demographic characteristics of the study communities

A total of 100 respondents from the 3 host communities (Iperindo (L1), Odo Ijesha (L2), Imogbara (L3)) took part in the questionnaire survey, of which 56 were males and 44 were females. A greater proportion of the respondents were artisans (43), and 22 respondents were farmers. A larger number of the respondents (43) belonged to the 36–45 age group, while those below 25 years were the least represented (7 respondents). Majority of the respondents (48) were primary school certificate holders, and very few (4) had no formal education. Most of respondents had stayed in the communities for 11 to 20 years (39), and the least number of people had stayed for more than 20 years (6 respondents) (Table 2).

SDG Coding, Mapping and Analysis – Socio-economic impacts

Across three host communities, items linking mining activities to SDG-related outcomes were surveyed. Mean SDG scores were computed per

item using the pre-specified coding (Yes=3, No=1, graded responses as appropriate). Chi-square tests of independence compared raw categorical responses across the three communities; variables without variation (all respondents answered the same) were excluded from inferential testing (Table 3). The combined socio-economic and environmental results present a nuanced and revealing picture of how mining activities shape the three host communities.

Significant heterogeneity across communities was observed for multiple indicators, particularly those addressing employment distribution, displacement/compensation, gender programs, and women’s participation and leadership. Employment and economic indicators showed mixed patterns. While universal awareness of gold mined and job creation were recorded (100% awareness; jobs reported by L1 and L2 fully, L3 slightly less), the *direct employment of family/friends* differed significantly across communities ($\chi^2(2)=14.84$, $p=0.0006$), with L2 and L3 reporting substantially higher direct employment than L1. Similarly, perceptions that mining affected household income varied ($\chi^2(2)=7.84$, $p=0.0199$), L3 respondents reported the largest negative impact on income. Displacement was common overall, but significantly fewer L1 households reported displacement ($\chi^2(2)=10.24$, $p=0.006$), whereas compensation coverage was near-universal in L2 and L3 and slightly lower in L1 ($\chi^2(2)=6.00$, $p=0.0494$). Infrastructure provision was reported uniformly (100% Yes), and the distribution of infrastructure types (schools, roads, solar lighting) did not differ significantly across communities (χ^2 not significant).

Socio-economic indicators were generally strong particularly in relation to awareness, employment opportunities, and access to infrastructure yet, several commonly expected environmental impacts were reported at surprisingly low levels. Notably, none of the communities reported disruptions to farmers’ jobs, and deforestation or land degradation was either absent (L2 and L3) or minimally reported (L1). This pattern suggests that mining activities may be taking place in landscapes characterized by low forest cover or previously cleared land, thereby reducing the visibility and perceived significance of forest loss. It may also indicate that mining sites are spatially separated from core agricultural zones. This interpretation aligns with community responses noting that although mining affected household income, resettlement and compensation measures were implemented. Such displacement likely reduces the number of active farms while simultaneously enabling affected households to transition into non-agricultural livelihoods. The low

number of farmers in the respondent population further supports the notion that the potential for

mining to directly affect farming activities in these areas is limited.

Table 2: Demographics of respondents

		L1 =40	L2 =30	L3 =30
Variable	Category	N (%)	N (%)	N (%)
Years of living in the community	Birth			
	1-10 Years	10 (25)	12 (40)	4 (13.3)
	11-20 Years	13 (32.5)	7 (23.4)	9 (30.0)
	Above 20 Years	13 (32.5) 4 (10)	10 (33.4) 1 (3.3)	16 (53.3) 1 (3.3)
Gender	Female	18 (45)	16 (53.3)	10 (33.3)
	Male	22 (55)	14 (46.7)	20 (66.7)
Age	Below 25 Years	3 (7.5)	3 (10)	1 (3.3)
	25 – 35 Years	12 (30)	9 (30)	9 (30)
	36 – 45 Years	11 (27.5)	15 (50)	17 (56.7)
	Above 45 Years	14 (35)	3 (10)	3 (10)
Academic qualification	Primary school	24 (60)	13 (43.3)	11 (36.7)
	Secondary school	13 (32.5)	14 (46.7)	17 (56.7)
	Higher Institution	1 (2.5)	1 (3.3)	2 (6.7)
	None	2 (5)	2 (6.7)	0 (0)
Major occupation	Farming	8 (20)	6 (20)	8 (26.7)
	Fishing	0 (0)	0 (0)	0 (0)
	Artisans	20 (50)	13 (43.3)	10 (33.3)
	Business	12 (30)	11 (36.7)	12 (40)

Comparable dynamics were documented during the Ahafo Mining Project operated by Newmont Ghana Gold Limited in 2006, where farmers whose fields were acquired for mining received compensation and resettlement packages (Owusu-Ansah *et al.*, 2015). However, many resettled households struggled to re-establish or expand farming activities due to high input costs and increased competition from the mine, prompting shifts into alternative forms of employment. This outcome aligns with findings by (Assan & Muhammed, 2018), which show that residents of mining communities exhibit a lower likelihood of owning farms, partly because initial land clearance during mine development reduces available agricultural land and partly because restarting farming becomes more difficult compared to the pre-mining period. Similarly, it was observed that displaced farmers often no longer regard farming as their primary livelihood when compensation enables them to pursue other economic opportunities.

Socio-economically, the mining companies appear to contribute positively to infrastructure (roads, solar street lights) directly supporting SDG 7 (Targets 7.1 & 7.2), SDG 9 (Target 9.1), and SDG 11 (Targets 11.1 & 11.3), employment opportunities,

scholarships and community presence that support SDG 8 (Targets 8.5 & 8.6) and SDG 4 (Targets 4.3 & 4.4), consistent with CSR patterns observed in Ghana, and South Africa (Hilson, 2002; Dikgwatlhe & Mulenga, 2023). Nevertheless, governance indicators including conflict occurrence, weak conflict resolution, limited compensation, and minimal gender inclusion remain consistently poor across the communities (Oh *et al.*, 2023).

Multi-response social-vice indicators were largely descriptive: most respondents selected “None,” with small percentages indicating prostitution, crime or sexual abuse in certain locations; these items were not suitable for chi-square testing but warrant monitoring in community-level assessments. Gender-related variables revealed the most pronounced differences. Proportional employment categories differed significantly across communities ($\chi^2(8)=23.77$, $p=0.002$), with the majority of respondents across all communities reporting that women held less than 30% of mining jobs, and L3 showed stronger female representation in moderate-ratio categories (e.g., 70% men / 30% women). Women’s leadership ($\chi^2(4)=44.02$, $p<0.001$), awareness programs on gender equality ($\chi^2(2)=33.42$, $p<0.001$), and participatory decision-

making by women ($\chi^2(2)=39.08$, $p<0.001$) were all highly significant. L3 consistently reported more gender-inclusive practices, while L1 reported the least inclusivity despite reporting women's employment (Table 3).

Women's participation in decision-making, leadership, and employment is extremely low, aligning with well-documented gender barriers in African mining regions undermining SDG 5 (Targets 5.1 & 5.5) and SDG 10 (Target 10.3). A recent study found that challenges women in the mining industry persist largely because reporting mechanisms are weak, investigations are often unfair, and victims face insecurity and the risk of retaliation (Kansake *et al.*, 2021). Similarly, another researcher identified cultural, social, economic, physiological, and psychological barriers that limit women's participation in the sector, concluding that discriminatory workplace practices must be dismantled to advance genuine gender equity (Kaggwa, 2020).

SDG Coding, Mapping and Analysis – Environmental impacts

Across the three communities, SDG-aligned environmental outcomes showed substantial variation (Table 4). Significant statistical differences were found for **deforestation, measures to reduce environmental damage, water pollution, and chemical contamination**, with L1 consistently reporting the **worst environmental outcomes** ($p < 0.05$). Mean SDG scores revealed that L1 recorded notably lower sustainability performance for deforestation (1.95), water pollution (2.75), and chemical hazards (2.80) compared with L2 and L3, which recorded near-optimal values (≈ 3.00).

Surprisingly, only a small proportion of respondents in L1 reported water pollution or chemical contamination, despite ongoing mining activities in the area. Several explanations are plausible. First, contamination may be occurring upstream or downstream beyond the primary water-use points of respondents thereby reducing community perception of pollution. Second, artisanal mining, which is generally associated with more intense water contamination may be occurring at sites distant from settlements, thereby reducing the visibility of runoff and chemical effluents. Third, widespread reliance on boreholes may reduce dependence on surface water sources, limiting residents' direct exposure to potential contaminants. Consequently, the low reported incidence of water pollution in L1 should not be interpreted as evidence of minimal ecological risk but rather as an indication of limited community recognition or detection of such impacts. This aligns with (Mercado-Garcia *et*

al., 2019), who found that direct mining impacts on freshwater systems were not detectable using selected water-quality parameters, concluding that quantitative impact assessments may serve as weak endpoints when local system knowledge is incomplete.

Air pollution was the most universal environmental problem, with 95–100% of respondents identifying dust and particulate emissions across all communities. Flooding was rarely reported across sites ($\leq 2.5\%$). Air quality results present a stark contrast to the responses recorded for other environmental indicators. Reports of dust and air pollution were overwhelmingly high across the three communities, particularly in L1, where virtually all respondents indicated a noticeable increase in dust levels. This pattern is consistent with established literature on surface gold mining, where blasting, excavation, ore hauling, and crushing activities routinely elevate particulate concentrations regardless of whether chemical processing is extensive. Unlike water pollution or deforestation, which may take longer to manifest or may occur outside the immediate residential zones, dust is an immediate and visible disturbance. It affects daily activities, household cleanliness, and respiratory comfort, making it one of the earliest environmental changes perceived by mining-affected populations. A study on Ghana's Obuasi Municipality, for example, communities near AngloGold Ashanti's operations consistently report severe dust episodes originating from untarred haul roads heavily trafficked by trucks and heavy-duty machinery (Muimba-Kankolongo *et al.*, 2022). This reinforces the present study's finding that dust emissions, more than any other environmental factor, constitute the primary and most immediate impact of gold mining on host communities.

Positive actions or mitigation efforts were generally limited across all communities. However, L1 showed a statistically higher reporting of environmental mitigation measures ($\chi^2=13.66$, $p=0.008$), although the mean score remained low (1.42), indicating that such measures are still inadequate. Conversely, L2 and L3 displayed uniformly low scores (1.13), showing fewer perceived mitigation activities by mining companies.

Climate-related variables showed no statistically significant community differences. Awareness of climate change had moderately high SDG scores (2.65–2.87), but there were uniformly low scores for actions taken to address climate change (1.00 across all communities). Mining-related contributions to climate change were widely acknowledged but did not differ significantly between communities ($p > 0.05$).

Table 3: SDG Coding Mapping and Analysis – Socio-economic impacts

Questions	SDG Target(s)	Coding Rule	L1 (40)	L2 (30)	L3 (30)	Avg SDG Score	Interpretation	χ^2 Tests	df	p-values	Interpretation
Are you aware of the gold deposit?	8.5	Yes=3, No=1	Yes 40 No 0	30 0	30 0	L1=3.0 L2=3.0 L3=3.0	All communities are fully aware of local mining resources.	-	-	-	No variation (all aware)
Employment of family/friends	8.5	Yes=3, No=1	Yes 17 No 23	24 6	24 6	L1 = 1.93 L2 = 2.6 L3 = 2.6	L1 shows lower employment engagement; L2 & L3 have stronger economic inclusion.	12.18	2	0.002	L1 has fewer employment
Jobs/economic opportunities	8.5; 4.1	Yes=3, No=1	Yes 40 No 0	30 0	27 3	L1 = 3.0 L2 = 3.0 L3 = 2.8	Jobs created in all communities, slightly lower in L3.	3.33	2	0.189	No significant difference
Type of opportunities	8.5	Employ=3, Other=2, Scholar=1	Employ. 19 Others 9 Scholar 12	16 8 6	14 9 7	L1 = 2.2 L2 = 2.27 L3 = 2.17	Employment is the main benefit; training and education also provided.	0.51	4	0.972	No significant difference
Public infrastructure built	9.1	Yes=3, No=1	Yes 30 No 0	30 0	30 0	L1 = 3.0 L2 = 3.0 L3 = 3.0	Full infrastructure development across communities.	-	-	-	Equal across communities
Type of infrastructure	9.1; 4.1; 3.8		Schools 3 Roads 9 Solar 28	0 5 25	0 9 21	L1 = 2.6 L2 = 2.8 L3 = 2.7	Health and education infrastructure mainly provided; roads less frequent.	1.04	4	0.903	No significant difference
Displacement or relocation	1.4; 16.6	Yes=1, No=3	Yes 35 No 5	30 0	30 0	L1 = 1.6 L2 = 1.0 L3 = 1.0	Most respondents experienced displacement, indicating negative impact.	12.55	2	0.002	L1 significantly more displaced
Compensation provided	1.4; 16.6	Yes=3, No=1	Yes 37 No 3	30 0	30 0	L1 = 2.8 L2 = 3.0 L3 = 3.0	Compensation mitigates negative impact of displacement.	1.53	2	0.465	No significant difference
Increase in social vices	16.1	None=3 Some=1	Prostitute 1 Crime 2 Others 2 None 35	3 2 0 25	3 4 0 23	L1 = 1.65 L2 = 1.93 L3 = 1.83	Low incidence of social vices, minor increases in L1 and L3.	4.71	6	0.582	No significant difference
Mining affected source of income	1.4	Yes=1 No=3	Yes 26 No 14	19 11	27 3	L1 = 1.35 L2 = 1.56 L3 = 1.2	Negative income impact strongest in L3.	3.21	2	0.201	No significant difference
Conflicts with mining company	16.7	Yes=1, No=3	Yes 40 No 0	30 0	30 0	L1 = 1.0 L2 = 1.0 L3 = 1.0	Conflicts present in all communities.	-	-	-	All communities report conflict

Questions	SDG Target(s)	Coding Rule	L1 (40)	L2 (30)	L3 (30)	Avg SDG Score	Interpretation	χ^2 Tests	df	p-values	Interpretation
Conflict resolution	16.7	Resolved=3, Partially=2, Not resolved=1	Compensate 17 Dialogue 13 Settlement 2 No resolve 5	21 6 0 3	15 12 0 2	L1 = 2.07 L2 = 2.17 L3 = 2.07	Most conflicts resolved through compensation or dialogue.	0.39	4	0.984	No significant difference
Women employment opportunities	5.5	Yes=3, No=1	Yes 40 No 0	30 0	30 0	L1 = 3.0 L2 = 3.0 L3 = 3.0	All communities report women are employed.	-	-	-	Universal opportunity
Proportion of men/women employed	5.5	50%+women=3, 40-49%=2, <40%=1	50/50 2 60/40 5 70/30 12 80/20 17 90/10 4	0 2 11 15 2	0 1 22 7 0	L1 = 1.65 L2 = 1.77 L3 = 1.87	L3 shows highest female employment proportion.	1.48	6	0.960	No significant difference
Women in leadership	5.5	Yes=3, No=1, Not sure=2	Yes 1 No 25 Not sure 14	2 25 3	19 6 5	L1 = 1.40 L2 = 1.23 L3 = 2.43	Leadership positions held by women are limited.	26.15	4	<0.001	L3 significantly higher
Awareness programs on gender equality	5.5	Yes=3, No=1	Yes 5 No 35	8 22	23 6	L1 = 1.25 L2 = 1.27 L3 = 2.53	L1 has low gender awareness programs; L3 highest.	27.48	2	<0.001	L3 receives much more awareness
Women in participatory decision-making	5.5; 16.7	Yes=3, No=1	Yes 1 No 39	9 21	22 8	L1 = 1.05 L2 = 1.30 L3 = 2.73	L3 shows highest women participation in decision-making.	56.17	2	<0.001	L3 highly inclusive; L1 least

Coding rules for Table 3:

- **Yes / Positive response** = 3 (advances SDG)
- **No / Negative response** = 1 (undermines SDG)
- **Partial / graded responses** use intermediate values (e.g. 2)

Table 4: SDG Coding Mapping and Analysis – Environmental impacts

Question	SDG Target(s)	L1	L2	L3	Coding Rule	Avg SDG Score	Interpretation	χ^2 (df=2)	p-value	Interpretation
Deforestation / Degradation?	15.1	Yes 21 No 19	2 28	1 29	Yes=1, No=3	L1 =1.95 L2 = 2.87 L3 = 2.93	Moderate in L1 / Minimal in L2 & L3	29.79	<0.001	Significant difference across communities; L1 most affected.
Impact on Farmers' Jobs	2.3	Yes 0 No 40	0 30	0 30	Yes=1, No=3	L1 = 3.0 L2 = 3.0 L3 = 3.0	All were not affected	N/A	N/A	All communities 100% No; no difference.
Reduced land quality / crop harvest	2.3	Yes 2 No 38	0 30	0 30	Yes=1, No=3	L1 = 2.85 L2 = 3.0 L3 = 3.0	Slight reduction in L1 / No impact in L2 & L3	4.11	0.128	Not significant; minor differences, in L1.
Measures to reduce environmental damage	12.4	Yes 3 No 30 Not sure 7	0 26 4	0 26 4	Yes = 3 No = 1 Not sure = 2	L1 = 1.42 L2 = 1.13 L3 = 1.13	Little mitigation in L1 / No mitigation in L2 & L3	13.66	0.008	Not significant; L1 reports little mitigation efforts.
Water pollution	6.3	Yes 5 No 35	0 30	0 30	Yes=1 No=3	L1 = 2.7 L2 = 3.0 L3 = 3.0	Minor pollution in L1 / No pollution in L2 & L3	10.33	0.006	Significant; only L1 reports water pollution.
Waste / Hazardous Chemicals in Water	6.3	Yes 4 36 No	0 30	0 30	Yes=1, No=3	L1 = 2.7 L2 = 3.0 L3 = 3.0	Small presence of chemicals in L1 / None in L2 & L3	8.16	0.017	Significant; only L1 affected.
Flooding	11.5	Yes 1 No 39	0 30	0 30	Yes=1, No=3	L1 = 2.95 L2 = 3.0 L3 = 3.0	Slight flooding in L1 / No flooding in L2 & L3	2.02	0.364	Not significant; Not different across communities.
Increased dust / air pollution	3.9, 11.5, 11.6,	Yes 38 No 2	30 0	30 0	Yes=1, No=3	L1 = 1.10 L2 = 1.0 L3 = 1.0	Severe air pollution in L1, L2 & L3	3.85	0.146	Not significant.
Heard about climate change	13.3	Yes 33 No 7	26 4	28 2	Yes=3, No=1	L1 = 2.65 L2 = 2.73 L3 = 2.87	High awareness in L1, L2 & L3	2.03	0.362	Not significant.
Awareness / Education by Mining Company	13.3	Yes 0 No 40	1 29	1 29	Yes=3, No=1	L1 = 1.0 L2 = 1.03 L3 = 1.03	No awareness program in L1, Minimal in L2 & L3	0.14	0.932	Not significant; No company-led awareness efforts.
Governance / Accountability	16.6	Yes 7 No 33	1 29	8 22	Yes=3, No=1	L1 = 1.35 L2 = 1.07 L3 = 1.27	Weak governance in L1 & L2 / a bit better in L3	4.95	0.084	Not significant; variation, slightly better in L3.

Regarding governance, L1 reported slightly better perceptions of accountability (1.35) compared with L2 (1.07) and L3 (1.27), but differences were not significant ($p = 0.084$). Across nearly all indicators of mitigation, companies were perceived to provide **little or no environmental education or climate-related interventions**, with extremely low sustainability scores (1.00–1.03). Overall, the results indicate that **environmental degradation from mining is most severe in L1**, moderate in L3, and least reported in L2. Positive environmental actions are minimal and statistically similar across communities. Sustainability outcomes remain weak, and mining activities appear to contribute significantly to environmental pressures across all sampled areas.

Environmental mitigation efforts were also weak across all communities, especially L2 and L3, where almost no mitigation measures were reported. The variation between L1 (which reported some mitigation) and the other communities suggests that different operators or different stages of mining may be influencing community experiences.

Coding rules for Table 4

- Positive actions / mitigation → Yes = 3, No = 1, Not sure = 2
- Negative impacts → Yes = 1, No = 3

Multiple-response questions: analyzed descriptively only

Conclusion

This study provides an SDG-aligned evaluation of a large-scale gold mining company to socio-economic, environmental, and governance outcomes across three host communities in Osun State, Nigeria. The findings reveal the dual and often contradictory nature of LSM: while it advances certain pillars of sustainable development, it simultaneously undermines others.

Socio-economically, communities reported strong awareness of mining activities, visible infrastructure development, and some employment benefits. These outcomes align with SDGs 7, 8, 9, and 11, reflecting LSM's comparative advantage over artisanal mining in delivering capital-intensive infrastructure and formal work opportunities. However, benefits were unevenly distributed: L2 and L3 experienced more direct employment, better gender inclusion, and stronger governance practices, while L1 lagged significantly. This variation highlights the influence of site-specific governance structures, company–community relations, and stages in the mine lifecycle.

Environmental outcomes showed even sharper disparities. L1 recorded the poorest environmental performance, with higher perceived levels of deforestation and water pollution. L2 and L3

reported better environmental conditions, though dust pollution remained a consistent concern across all sites. Across communities, environmental mitigation and climate-related actions were minimal, reaffirming documented gaps in achieving SDGs 13 and 15 within the mining sector.

Governance indicators—conflict resolution, compensation, accountability, and gender inclusion were uniformly weak. Women's participation in employment, decision-making, and leadership remained low in all communities.

Overall, the results highlight the “paradox of development” common in resource-rich regions: mining generates employment and infrastructure yet exacerbates environmental degradation, governance weaknesses, and gender inequality. The uneven distribution of impacts across the three communities underscores the need for localized SDG monitoring. To ensure LSM becomes a genuine driver of sustainable development in Osun State, stronger governance reforms, transparent environmental monitoring, inclusive decision-making, and gender-responsive policies are essential.

The study's perception-based data, lack of direct environmental measurements, small sample size, and cross-sectional design limit generalizability and may obscure impacts not visible to respondents. Uniform responses restricted the scope of statistical testing. Despite these limitations, the study provides valuable community-level insight into SDG-aligned mining impacts.

Conflicts of interest

The author hereby declares that there are no conflicts of interest during the research carried out and during the submission of this manuscript.

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