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Socio-Economic and Environmental Dimensions of Artisanal Mining: Implications for Selected Sustainable Development Goals in Plateau State, Nigeria

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ABSTRACT

Artisanal and small-scale mining, ASM, is a pretty big livelihood thing in mineral rich developing places, Plateau State Nigeria included. It helps people with work and earnings, but at the same time it is linked with land degradation, forest clearing, and problems in soils and water like contamination, agricultural setbacks, plus real health risks. This systematic review put together peer reviewed findings released from 2019 to 2026, looking at the socio economic and environmental ripple effects of artisanal mining. The focus stays on Plateau State and also on selected Sustainable Development Goals, SDGs. The whole review followed the Preferred Reporting Items for Systematic Reviews and Meta Analyses, PRISMA 2020 framework, so yes it was guided. Because study designs, the populations involved, how exposure was measured, and the outcomes reported differed a lot, we synthesized the evidence in a narrative way rather than pooling numbers. What emerges is a dual link between ASM and sustainable development. On one hand, mining sustains livelihoods and generates income, which aligns with SDGs 1 and 8, but on the other hand the environmental burden and health impacts may slow progress towards SDGs 3, 6, and 15. Plateau specific work points to higher levels of lead and arsenic in mine tailings, it also signals potentially poisonous elements in soils from abandoned sites. Reports also mention contaminated fruits, and community level deforestation, pollution, land degradation, food production losses, and social disruption that can spread. For ASM to remain sustainable, there is need for inclusive formalisation, routine environmental monitoring, site rehabilitation, stronger occupational health protection, alternative income sources, and meaningful participation from the community.

1. Introduction

Artisanal and small-scale mining is a labour intensive way of extracting minerals that's usually marked by lower mechanization levels and a lot of involvement by people, families, cooperatives, and informal groups. The sector matters economically in many developing countries, since it offers livelihood chances to those who have limited access to formal work and other streams of income Baffour-Kyei et al. (2021). Still, the same traits that make ASM reachable for economically vulnerable communities can also make it more troublesome to supervise and to environmentally manage (Macháček et al., 2022; Huntington & Marple-Cantrell, 2022).

The literature is, increasingly recognizing the contradictory character of ASM. Schwartz et al. (2021) describe artisanal and small scale mining as a crucial livelihood activity among some of the world's poorest populations, while also noting occupational accidents like overheating, overexertion, dust exposure, and exposure to toxic chemicals and gases as major health concerns.

The connection between mining and agriculture is pretty multifaceted too, Ofosu et al. (2020) found that ASM can bring in revenues and livelihood openings, but it can also undermine agricultural systems through land degradation, farm invasion, water and mercury contamination, and the shift of labor from farming into mining. Because of that, their review frames ASM plus agriculture as maybe complementary livelihood arrangements but also potentially competing ones.

These contradictions are really relevant to Plateau State. The state has a long record of mineral extraction, specially tin mining, and a number of Local Government Areas around the Jos Plateau have seen both old and present mining work. So today, current artisanal mining is happening in landscapes that may already show abandoned pits, tailings and, changed drainage paths and weakened farmland, all together, not just in theory but on the ground.

The Sustainable Development Goals gives a helpful frame for looking at these competing effects. ASM can help SDG 1 No Poverty and SDG 8 Decent Work and Economic Growth, through employment, and through income generation, in practice. On the other hand, environmental contamination along with occupational exposure may weaken SDG 3 Good Health and Well-being, and SDG 6 Clean Water and Sanitation. Meanwhile land degradation plus vegetation loss can threaten SDG 15 Life on Land. The link to SDG 13 Climate Action seems less direct, yet it still matters via land use change, vegetation loss, ecosystem degradation and rehabilitation.

Importantly, the SDGs do not automatically provide the solution to the problems linked with ASM. Hirons (2020) argues that SDG implementation can end up re-creating mining biases at large scale and formalization pathways that marginalize poorer artisanal miners. In other words the author points out that ASM stays connected to the SDGs through both synergies and antagonisms, and that governance arrangements matter a lot for whether these connections end up generating positive or negative outcomes, in practice.

This systematic review looks at the following questions:

- What socio-economic benefits, and also what costs, are tied to artisanal mining?
- What environmental effects and health impacts are associated with artisanal mining?
- What empirical evidence is available regarding these effects in Plateau State?
- What are the implications of these effects for selected SDGs?
- Which policy and research gaps still remain?

2. Methods

2.1 Review design

The review ended up being structured according to the PRISMA 2020 reporting framework, honestly it felt like the most reasonable choice. PRISMA 2020 presents a 27-item reporting framework, it is meant to enhance transparency, completeness and also reproducibility in systematic reviews (Page et al., 2021). Since the available studies vary a lot in research design, study populations, mining commodities, geographic context, exposure measurements and outcome indicators, a conventional statistical meta-analysis seemed not very appropriate. A narrative synthesis was used instead, because it better fits those differences.

2.2 Eligibility criteria

Studies were treated as eligible when they: were published between 2019 and 2026, were published in peer reviewed academic journals, looked at artisanal or small-scale mining, or activities that are closely related, documented socio-economic, environmental, health, or livelihood outcomes, took place in Nigeria, in sub-Saharan Africa, or internationally, but with findings that were directly relevant to the review question, or looked at the link between ASM and sustainable development, in a broader way. Studies were left out when they were newspaper reports, websites, conference abstracts, unpublished dissertations, non peer reviewed reports or publications with not enough bibliographic info for verification

2.3 Information sources and search strategy

The search approach was put together from combinations of these ideas “artisanal mining” OR “artisanal and small-scale mining” OR ASM AND “Nigeria” OR “Plateau State” OR “Jos Plateau” OR “Barkin Ladi” OR “Bokkos” AND “socio-economic” OR livelihoods OR agriculture OR environment OR pollution OR heavy metals OR health OR “Sustainable Development Goals” OR SDGs. The review also applied backward and forward citation checking on key peer reviewed papers, and special attention was paid to Plateau specific studies because the review is geographically minded focused

3. Findings

3.1 Characteristics of the evidence

The evidence consisted of international and African reviews along with empirical studies from Plateau State, and yes, it all sort of adds up when you put it together. The international literature lays out the wider livelihood, agricultural, environmental and health dimensions of ASM, while the Plateau specific studies give direct pointers on contamination, livelihood outcomes and environmental deterioration. Bwede et al. (2021) looked at heavy metals in tin mine tailings in Zabot and Tafan districts, within the Barkin Ladi Local Government Area , and honestly the journal label makes it pretty clear it’s an original research article. Mafulul et al. (2023) went over potentially toxic elements in soils and fruits close to abandoned mining ponds in Kuba, Bokkos Local Government Area.

Owolabi et al. (2024) looked at the socioeconomic and environmental conditions in the mining areas of Jos and Barkin Ladi, using both questionnaire and interviews, even though the setting is pretty specific. In their work, they talked with and reached out to 450 households, and then they went into occupational questions, socioeconomic details, environmental concerns, plus health related issues, more or less in one sweep.

Table 1. Selected empirical evidence on the socio-economic and environmental effects of mining in Plateau State

Study	Location/design	Sample/material	Major empirical findings	Main implication
Bwede et al. (2021)	Zabot and Tafan districts, Barkin Ladi LGA	Tin-mine tailings; EDX-XRF and SEM	Pb: 270–300 mg/kg; As: 40–70 mg/kg. Cr, Ni, Cd, Cu and Zn were within stated permissible limits, while Pb and As exceeded limits. Hazard quotient and hazard index values were >1. Children had greater exposure risk than adults.	Potentially serious human-health implications; relevant to SDG 3 and SDG 15.
Mafulul et al. (2023)	Kuba, Bokkos LGA	Abandoned-mine soils and mango, guava, avocado and banana fruits; ICP-MS	All eight assessed potentially toxic elements in abandoned-mine soils were significantly higher ($p < .05$) than corresponding control-soil values.	Evidence of persistent contamination and possible food-chain exposure; relevant to SDGs 3, 6 and 15.
Owolabi et al. (2024)	Jos and Barkin mining communities	450 households; questionnaire and interviews	Occupational distribution included farmers (8.3%), artisans (26.7%), traders (8.3%), civil servants (13.3%) and artisanal miners (26.7%). 30% of 80 interviewed artisanal miners were women.	Mining is a significant livelihood activity but has important social and environmental consequences.
Owolabi et al. (2024)	Jos and Barkin mining communities	Household perceptions	89% identified deforestation and 80% identified land degradation as major negative environmental effects. Other reported effects included air, water and noise pollution.	Strong perceived environmental degradation; relevant to SDGs 13 and 15.

Sources: Bwede et al. (2021) Mafulul et al. (2023); Owolabi et al. (2024). These figures here are basically pulled straight out of what the studies said, so you know it, there’s no real extra processing or interpretation, just direct reporting

4. Socio- economic impacts of artisanal mining

4.1 Employment and household income

ASM is usually talked about as a genuinely economic activity, and in the literature it shows up as one of the more consistent patterns. It offers an accessible way of earning for people who have a limited education, limited start-up capital, or simply limited entry to jobs in the formal sector. Schwartz et al. (2021) point out that artisanal and small-scale mining supports economically vulnerable groups, but they also note, that these benefits sit side by side with serious health and community related risks.

The evidence from Plateau State supports this view. In the work by Owolabi et al. (2024) it was described that artisanal mining was one of the key work activities in the communities that were examined. For the respondents that were surveyed, artisanal miners accounted for 26.7%, while farmers were 8.3%, artisans also 26.7%, traders 8.3%, and civil servants 13.3%.

The same work also highlighted a noticeable divergence in the monthly earnings of the miners. Specifically, 52.7% earned under ₦20,000, 45.3% earned between ₦21,000 and ₦80,000, then 1.7% earned above ₦81,000 during the time span covered by the field study. Taken together these numbers show that mining can indeed generate income but it also exposes a fairly high level of economic fragility among miners.

More recent signals from Plateau State underscore why artisanal and small-scale mining is still one major livelihood activity. A 2025 study with 119 respondents in Jos, Plateau State found that a large share of them had been active in artisanal mining for 11–15 years. This suggests that the practice is somewhat stable, not simply a short-term income pathway. That same study also suggested that miners typically made around ₦1,000–₦5,000 daily, but the money flow was really more about how much mineral material they managed to extract in the day.

The mining income was mainly put toward day to day household requirements, including sustenance, healthcare, and education, and the modest savings level reported by respondents implied that most earnings were being consumed for immediate survival rather than any longer term economic buildup. In other words, this points to ASM as a meaningful source of income and livelihood in Plateau State, yet it also brings attention to the economic fragility of miners, because their earnings hinge on mineral yields and on the uneven ,informal character of mining activities (Azi et al., 2025).

The consequences for SDG 1 and SDG 8 are not one sided. Mining may deliver cash that would not easily be reached otherwise, but when earnings are low and unstable, when work remains informal, and when social protection is thin, employment does not automatically translate into decent employment.

4.2 Artisanal mining and agriculture

The way mining and agriculture interact is especially significant in Plateau State. Ofosu et al. (2020) pointed out three main ways that ASM can mess with farming: land degradation, farm invasion and then water and mercury pollution, plus the movement of labour from agriculture into mining.

Owolabi et al. (2024) also noted that mining in the Jos and Barkin communities seems to have a competitive, not complementary relation with agriculture, honestly not a helpful match at all.

They said mining was tied to deforestation, soil or land degradation and pollution, and then they went on to conclude, that these outcomes endanger the everyday agricultural livelihoods. This result matters in other places too, beyond SDG 8. When cropland is taken over by mining activities, communities may end up relying more on mining income while also losing a key source of food and work. In that situation, short-term poverty reduction could end up generating longer-term livelihood vulnerability.

4.3 Gender and social consequences

The Plateau available evidence shows a meaningful participation by women. Owolabi et al. (2024) for example reported that 30% of the 80 artisanal miners interviewed, were women. In their account women were especially engaged in hauling tin ore from the mining pits towards the processing areas, and it was noted too that some women received lower grade tin ore as payment rather than cash. Overall, the outcomes suggest that when ASM delivers economic gains, those benefits travel through gendered labour arrangements. It therefore mean that any review of mining and sustainable development should not only ask how many people are employed, but also who benefits in practice, how pay is structured, and which risks different groups end up carrying.

The study also pointed to population influx, loss of cultural heritage communal conflicts, a rise in crime, farmland loss, and inflation as social and economic consequences linked with mining in the communities studied.

5. Environmental impacts

5.1 Deforestation and land degradation

Land degradation is among the most visible consequences of mining in Plateau State. Excavation, vegetation removal, dumping of tailings and then the abandonment of pits permanently change the landscape, in a way that can last for years.

Owolabi et al. (2024) reported that 89 % of respondents pointed toward deforestation, and 80 % mentioned land degradation as major negative effects on the environment. In the very same study, air, water, and noise contamination were also described as key issues. These results line up with the wider international literature. Ofosu et al. (2020) describes land degradation as a central pathway through which ASM weakens agriculture and rural livelihoods. Hirons (2020) similarly highlights deforestation, land degradation and river siltation as the enduring environmental problems tied to ASM. Such implications matter especially for SDG 15, since land degradation can remain in place long after active mining has stopped

5.2 Heavy metal contamination

The most compelling environmental-health evidence from Plateau State talks about heavy metals and maybe other potentially hazardous elements. Bwede et al. (2021) looked at seven heavy metals in tin-mine tailings from Zabot and Tafan districts in Barkin Ladi. Chromium, nickel, cadmium, copper and zinc were reported within the allowable limits, while lead and arsenic came out higher than expected.

Lead levels were 270 to 300 mg/kg, and arsenic was 40 to 70 mg/kg. Their hazard quotient and hazard index figures landed above one, showing the chance of serious health impacts. Also, the children were flagged as having higher exposure risk than adults. This matters because it links environmental deterioration with a tangible human-health signal rather than depending only on ideas about pollution.

5.3 Contamination of agricultural products

Mafulul et al. (2023) extended what was found in contaminated mining settings into possible exposure along the food-chain. The investigators measured arsenic, cadmium, chromium, copper, manganese, nickel, lead and zinc in abandoned-mine soils and in fruits near mining ponds in Kuba, Bokkos LGA. For each assessed potentially toxic element, the concentrations in abandoned-mine soils were much higher than in the control soils, $p < .05$, though they still kept the comparisons tight. They also looked at mango, guava, avocado and banana. Taken together, this evidence matters for SDG 3, SDG 6 and SDG 15, because contamination can go past the original mine site into crop-growing environments, and from there into wider food systems.

6. Health implications

Health risks tied to ASM usually show up via several paths. Schwartz et al. (2021) highlight accidents, physical overexertion heat exposure, dust inhalation, and also contact with toxic chemicals and gases as the main occupational dangers.

What stands out in the Plateau evidence is that environmental exposure might be more than just "there in the background". The Pb and As results from Barkin Ladi suggest possible chemical exposure, and then the study by Mafulul et al. (2023) implies contamination of soils and fruits around abandoned mining sites.

Bwede et al. (2021) reported that children face higher exposure risks than adults. It implies that a sustainable mining policy should put child focused environmental-health supports at the center , including limits on children's access to mining locations, environmental education, and regular biological or environmental monitoring where it is justified.

Table 2. Mapping empirical mining impacts to selected SDGs

Selected SDG	Relevant mining-related outcome	Evidence from reviewed studies	Direction of effect	Key sustainability concern
SDG 1 – No Poverty	Employment and income	ASM provides livelihoods; 52.7% of surveyed miners in the Owolabi et al. (2024) study earned <₦20,000/month during the study period.	Mixed	Short-term income may coexist with long-term livelihood vulnerability.
SDG 3 – Good Health and Well-being	Toxic-element exposure and occupational risks	Pb 270–300 mg/kg and As 40–70 mg/kg in Barkin Ladi tailings; HQ and HI >1; children more exposed.	Predominantly negative	Environmental and occupational exposure.
SDG 6 – Clean Water and Sanitation	Mining-related pollution and contamination risks	Mining communities reported water pollution; potentially toxic elements were elevated in abandoned-mine soils.	Negative/uncertain	Need for systematic water-quality surveillance.
SDG 8 – Decent Work and Economic Growth	Employment and local economic activity	Artisanal miners represented 26.7% of surveyed respondents; women constituted 30% of 80 miners interviewed.	Mixed/positive with risks	Informal work, low income, occupational hazards and weak social protection.
SDG 13 – Climate Action	Deforestation and land-use degradation	89% of respondents identified deforestation and 80% land degradation as major impacts.	Negative	Loss of vegetation and ecosystem resilience.
SDG 15 – Life on Land	Land degradation, contamination and ecosystem disruption	Deforestation, land degradation, mine tailings and persistent potentially toxic elements.	Predominantly negative	Mine rehabilitation and ecosystem restoration.

Sources: Bwede et al. (2021); Mafulul et al. (2023); Owolabi et al. (2024); Ofosu et al. (2020); Schwartz et al. (2021); Hirons (2020).

7. Artisanal Mining and the Sustainable Development Goals

From the synthesis it appears that ASM must be framed as a sustainable-development trade-off, not as an activity that is automatically good or bad.

The brighter part of the trade-off comes through employment, income creation, and livelihood diversification, which also links to SDGs 1 and 8. In settings where formal jobs are few, removing ASM without setting up replacement options could worsen hardship, and in practice push communities deeper into poverty.

The darker part shows up as land degradation and deforestation, plus pollution, toxic- element exposure, and a range of work-related dangers. These outcomes endanger SDGs 3, 6, and 15. They can also indirectly erode SDG 1, since farming yields and ecological resources may decline when the environment gets damaged.

This duality is consistent with Hirons (2020), who says that ASM can both back and weaken the SDGs at the same time. The author also warns that SDG oriented policy may, in turn, create unintended consequences if it privileges big-scale, state centred and technology driven ways to handle mining governance.

Thus, the key policy question for Plateau State is not merely "Should artisanal mining be stopped?" but rather, under what institutional, environmental, and technological conditions can artisanal mining provide livelihoods without damaging the natural and social resources that sustainable development depends on?

8. Discussion

The evidence shows that artisanal mining in Plateau State produces a multidimensional sustainability dilemma

First the sector has undeniable livelihood significance, the occupational data that Owolabi et al. (2024) reported shows substantial engagement in mining and related activities. A blanket prohibition seems, in practice, a bit problematic, because mining income may serve as an important survival mechanism for households

Second, the environmental costs are substantial too. The high proportions of respondents who identify deforestation and land degradation indicates environmental degradation is not just a theoretical concern. It is experienced directly by communities

Third, environmental contamination creates a pathway for mining to impact health. The Barkin Ladi heavy metal study gives quantitative evidence of potentially hazardous Pb and As concentrations, and it also highlights children as especially vulnerable.

Fourth, the contamination of soils and fruits near abandoned mining ponds shows that mining impacts can remain, even after the actual extraction stops. Mafulul et al. (2023) thus underline an important distinction between what happens during active mining, and what lingers afterward as post mining environmental legacies.

Fifth, mining can produce a livelihood paradox. On one hand, the immediate income from mining may lower household poverty. On the other hand, soil degradation, plus water disruption can diminish alternative income sources. This lines up with Ofosu et al. (2020), who say mining and agriculture could work together in certain situations, but at the same time ASM might also bring fragilities within agrarian economies.

9. Policy Implications

Overall, the results back an integrated policy framework anchored on six priorities.

9.1 Inclusive formalization

Formalization should help miners get licensing at a fair price and provide technical help, access to finance, and entry to legal markets, instead of depending mostly on punishments and enforcement. Hirons (2020) warns that formalization that is poorly shaped can push the poorest miners to the side, and leave them with fewer options.

9.2 Environmental monitoring

Mining communities should be involved in regular monitoring of soil, surface water, groundwater, and agricultural products. Priority parameters should cover Pb, As, Cd, Cr, Ni and other contaminants that matter for the local mineral geology.

9.3 Mine-site rehabilitation

Abandoned pits and tailings should be mapped, placed into categories, and then rehabilitated. The rehabilitation work should aim to bring back agricultural output, vegetation cover, and safer water systems rather than only filling pits.

9.4 Occupational-health protection

Miners need suitable personal protective equipment, dust-control steps, safer processing approaches, first-aid facilities, and occupational-health education.

9.5 Alternative livelihood development

When environmental restoration asks for reduction or moving mining activity elsewhere, it would help to build alternative livelihoods before restrictions actually start, or at least while they are being rolled out. Things like agriculture and agro-processing, livestock production, small scale manufacturing, and skills-based enterprises could lower the heavy dependence on mining.

9.6 Community participation

People living in mining communities should be involved in decisions tied to mineral rights, environmental monitoring, rehabilitation, and how benefits are shared. Sustainable development cannot be achieved through top-down regulation alone, there is also need for participation that is real not only on paper.

10. Research Gaps

The review points to a handful of research gaps that matter.

First, many of the Plateau studies we have now are cross sectional. Long term, or longitudinal, research is needed to see if environmental contamination and livelihood impacts grow stronger, fade away, or continue to persist over time.

Second, socio-economic and environmental outcomes are rarely brought together in one analytical model. Future studies should look at how mining income, agricultural productivity, food security, environmental contamination and health link up, even if the relationships feel messy.

Third, it is still hard to measure progress directly for specific SDG indicators at the mining community level. Future research should take selected SDGs and make them operational, like turning them into community-level indicators you can actually measure.

Fourth, the gender disaggregated evidence stays limited. The women participation that Owolabi et al. (2024) points at suggests there is still a clear need for more research on gender specific economic benefits, exposure pathways and also who actually ends up deciding.

Fifth, children need more focused attention, because the evidence from Barkin Ladi suggests higher exposure risks than adults (Bwede et al., 2021).

At the same time, there is not enough evidence about how effective rehabilitation strategies are in Plateau State. Future research should line up rehabilitated places with unreclaimed sites, looking at soil quality, vegetation, water quality, agricultural output and also household livelihood indicators.

11. Limitations of the Review

This review has multiple limitations. First, the academic work that directly studies artisanal mining in Plateau State across 2019–2026 is still fairly small. Because of this, some international and sub-Saharan African findings were used to give context to what is happening specifically in Plateau.

Second, the included studies vary a lot. The studies use different designs, sampling methods, environmental measures, and outcome indicators, so a quantitative meta analysis is not appropriate.

Third, even though the review was laid out based on PRISMA 2020 principles, the earlier draft didn't really include a prospectively recorded multi-database search history. So the exact identification and exclusion tallies at each database level have not been invented. In other words, a final journal submission will need to re-run the search in the named databases, and then present the exact PRISMA flow numbers.

12. Conclusion

Overall, the evidence indicates that artisanal mining in Plateau State brings both developmental advantages and major socio-environmental drawbacks. It supports jobs, household earnings , and livelihood diversification, and in doing so it backs elements tied to SDGs 1 and 8. At the same time, the same body of evidence also shows deforestation, soil and land degradation, pollution, agricultural losses, and likely dangerous contamination in mining locations. Taken together, these impacts undermine progress toward SDGs 3, 6, 13 and 15.

The quantitative evidence matters a lot, in a very direct way. In Barkin Ladi, Pb concentrations around 270 to 300 mg/kg and As levels of roughly 40 to 70 mg/kg were reported in tin mine tailings, with hazard quotient plus hazard index figures that went beyond one. Children were also shown to be more exposed than adults (Bwede et al., 2021). In Kuba, Bokkos, potentially toxic elements were significantly higher in soils from abandoned mines when compared with the control soils, and then fruits growing close to the abandoned mining ponds were examined too, as possible exposure routes (Mafulul et al., 2023). In Jos and Barkin, 89% of the people said deforestation was a major environmental problem, and 80% pointed to land degradation as well (Owolabi et al., 2024).

These findings indicate that the main challenge isnt just whether artisanal mining exists, but more about the situation, in which it happens. A sustainable path for Plateau State, really needs inclusive formalization, environmental monitoring, protection for workers health, mine rehabilitation, alternative livelihood development and participatory community governance.

In the end, artisanal mining ought to be brought into sustainable development planning, rather than being treated as an activity outside it. The aim should be capturing the income benefits and the livelihoods linked to mining while preventing the erosion of environmental resources, and also of human capabilities that long term development depends on.

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