Journal of Agri Socio Economics and Business
Available online at : https://ejournal.unib.ac.id/index.php/jaseb/index
DOI: 10.31186/jaseb.07.2.165-180 2025

MITIGATING PERCEIVED IMPACTS OF ARTISANAL GOLD MINING PRACTICES ON AQUACULTURE, ENVIRONMENT AND LIVE LIHOOD: POLICY OPTIONS FOR SUSTAINABLE FUTURE

Funmilayo Bosede Oyekanmi[1)], Peter Sanjo Adewale[2*)], Gbadebo Ogunniyi,[3)], Oghenevwairhe Emefe[4)] and Oluwatomisin Adediji Oyenkanmi[5]
[1]*Department of Fisheries and Aquaculture, University of Ilesa, Ilesa, Osun State, Nigeria.*
[2]*Department of Environmental Education, Osun State University, Nigeria.*
[3]*Department of Vocational and Technical Education (Agricultural Education), University of Ilesa.*
[4] *Department of Fisheries and Aquaculture, University of Ilesa, Ilesa, Osun State, Nigeria.*
[5]*Department of Fisheries and Aquaculture Management, Ekiti State University.*
Email: [2)]peter.adewale@uniosun.edu.ng

How to Cite :
Oyekanmi, F.B., Adewale P.S., Ogunniyi, G., Emefe O. and Oyekanmi, O.A (2025). Mitigating Perceived Impacts Of Artisanal Gold Mining Practices On Aquaculture, Environment And Live Lihood: Policy Options For Sustainable Future *Journal of Agri Socio Economics and Business*. 7 (2): 165-180. DOI: 10.31186/jaseb.07.2.165-180

ARTICLE HISTORY
Received [05 July 2025]
Revised [13 Nov 2025)]
Accepted [28 Nov 2025]

KEYWORDS
Gold mining
Environment
Livelihood
Artisan
Pollution
Sustainability

ABSTRACT

As Nigeria's artisanal and small-scale gold mining (ASGM) sector continues to expand, the environmental and socio-economic costs of this practice are becoming increasingly evident. This study aims to examine the impact of ASGM activities on aquaculture and livelihoods among fisherfolks with a focus on policy options for a more sustainable future. Multistage sampling was used to select 120 fisherfolks as respondents for data collection. Questionnaire was used for data collection. The findings revealed significant environmental degradation, including land degradation, water pollution and loss of biodiversity which in turn affected the livelihoods of fisherfolks. Thus, the productivity of fishery activities is limited and livelihood is affected, thereby leading to a low standard of life among fishers. Additionally, there was a significant relationship between mining activities and the productivity of the aquaculture industry in Nigeria ($r = 0.624$, $p = 0.001$). This study recommends community-led initiatives for environmental conservation and socio-economic development.

INTRODUCTION

The unregulated and informal nature of artisanal and small-scale gold mining (ASGM) practices in Nigeria has led to widespread deforestation, water pollution and loss of biodiversity, compromising the livelihood of local communities and threatening the country's ecological integrity. The use of primitive mining methods such as open-pit mining and river dredgings often leads to the destruction of wildlife natural habitats and ecosystems. Additionally, the release of toxic chemicals such as mercury and cyanide into the environment poses significant health risks to humans and wildlife. The impact of mining is often intergenerational impacts affecting not only the current communities but also future generations (Elwaleed et al., 2024; Kung et al. 2024).

Although mining provides a source of income for many rural communities, it does not go without consequential effects on the livelihood and well-being of the people as well (Obodai et al., 2024). It can increase poverty and inequality among the people as many miners including their children often work in hazardous conditions with little protection or regulation. Most often due to extensive focus on mining other productive activities such as farming which provide more sustainable livelihood are often neglected (Diallo & Soumah, 2023).

Scholars like Akhtar et al., (2021) have stated that mining activities often introduce pollutants and disrupt natural ecological processes, leading to degraded water resources from key anthropogenic elements that affect water quality, including industrial discharges, agricultural practices, urban runoff, deforestation, mining activities, and climate change. Among all these anthropogenic elements, Yu et al., (2024) opined that artisanal mining, particularly gold mining, has become a significant economic activity in many developing regions, providing livelihoods for millions. This type of mining often occurs in close proximity to water bodies, leading to profound environmental and socioeconomic impacts on nearby fishing communities.

ASGM which is a widespread activity in many developing countries, often occur close to water bodies that are also crucial for aquaculture (Amoakwah et al., 2020). ASGM practices can lead to environmental degradation, particularly through the release of harmful chemicals into the surrounding areas and water bodies. These are heavy metals which are used in gold extraction processes (Teixeira et al., 2021). The pollutants can have detrimental effects on aquatic ecosystems. As stated in Khonyongwa & Suman (2023), these heavy metals take the cycle from effluent discharge to ion exchange to biosorption to bioaccumulation and to biomagnification. Mercury poses risks to both biodiversity and human health by persisting in the ecosystems (Al-Sulaiti et al., 2022), bioaccumulating in organisms (Seco et al., 2021) and biomagnifying through food webs (Amadi et al., 2022). Cyanide pollution poses a severe threat to aquatic biodiversity, with far-reaching implications for ecosystem health, human safety, and wildlife conservation (Vaishnav et al., (2022).

Fig 1. Pictures of mining sites in Igun, Osun State, Nigeria (Olujimi et al., 2015)

Nigeria, a West African country, is vastly adorned with mass deposits of solid minerals (Isukuru et al., 2024; Ofosu et al., 2020). The rise of ASGM in Osun State and Nigeria at large has call for concern from various parties because of its impact on environmental damage, water pollution, destruction of productive crop farms and fish farms. According to Akinsete & Ajala (2022), the Osun River originates from Igede-Ekiti in Ekiti State. This river then flows through Ijesha land to Osogbo meandering through the vast land of western Nigeria into the Atlantic Ocean (Amusa, 2019).The river and its surrounding tributaries and dams have been polluted by illegal mining activities, which, according to Uthman (2020), has been ongoing since the 1950s and has resulted in contamination and a change in clear water to a muddy brown colour (Ezediuno, 2021). Illegal gold mining turns an area from a green and attractive productive terrain to a dirty muddy terrain (Solichin, 2020).

Idowu et al. (2013) reported that the environmental repercussions of mining involve erosion, sinkhole formation, biodiversity loss, and the contamination of soil, groundwater, and surface water by chemicals originating from mining processes. In addition to causing environmental harm, the leakage and seepage of these chemicals into the surface and groundwater adversely impact the health of the local population. Consequently, some countries mandate that mining companies adhere to environmental and rehabilitation codes, ensuring that the mined area is restored to a condition close to its original state (Bustillo et al., 2018).

Moreover, aside the pollution of water bodies in mining areas, the erosion of mine dumps, siltation of drainages couple with erosion of mine tailing dams contribute significantly to degradation of the ecosystems (Capparelli et al., 2021). This is also buttressed by Talukder et al., (2023) that these mining activities leads to the destruction of ecosystems and consequently affecting aquaculture and general agriculture productivity in the affected areas.

Research Gap and Problem Statement

The ASGM sector in Nigeria is vital source of income for many rural communities in Nigeria with an estimated I million people engaged in the activity. The use of mercury and other toxic chemicals in ASGM poses significant health risks to the miners, their families and surrounding communities. Osun State Nigeria is one of the major ASGM communities in Nigeria with many mining sites scattered across the state. The state's fragile ecosystem is under threat from ASGM activities which have resulted in deforestation, soil erosion and water pollution. The activities have increased level of poverty, inequality and limited access to education and health care (Przezbórska-Skobiej & Eyang, 2024).

Despite these devastating impact of the gold mining in the state, there is dearth of comprehensive data on the impacts of ASGM in Osun State coupled with poor local communities' engagement in decision-making process surrounding ASGM. This leads to frequent conflicts, mistrust and communal wars among the residents. Therefore, the study examined the impact of gold mining practices on aquaculture, environment and livelihood of fisherfolks in Osun State Nigeria.

The study aims to mitigate the unintended impacts of ASGM practices on the Nigeria environment, aquaculture and livelihood by developing and promoting policy options that align with Nigeria's national environmental policy and United Nations' sustainable development goals (SDGs 8,12 and 13) thereby addressing socio-economic and environmental challenges and promoting a more sustainable future.

Hypothesis: there is no significant relationship between mining activities and the productivity of the aquaculture industry. Scope and Limitation of the Study: the study assessed how mining activities affect aquaculture and livelihood sustainability. The study did not cover deep-sea mining and offshore aquaculture. The study focused on mining activities in Ijesa region of Osun State Nigeria and the result may not be generalised to other areas with different environmental or regulatory conditions. The study is limited to short-term data which did not capture long-term effects of mining. It should be noted that other factors such as climate change, overfishing, disease outbreaks could have influenced aquaculture productivity which could make it hard to isolate mining impact.

Significance of the Study: The study has significant economic, environmental and policy implications by investigating the relationship between mining activities an aquaculture productivity. It highlights critical pollution risks threatening aquatic environment and fish farms while offering evidence to guide sustainable resource management. The research supports policymaking by informing regulations on mining waste and enforcement of environmental standards.

RESEARCH METHODS

Research Design

This study used descriptive research to investigate the impacts of ASGM practices on Nigerian environment and livelihood. The descriptive research design enabled a detailed description of the impact of ASGM practices in Osun State Nigeria on aquaculture, environment and livelihood of households in the study area.

Study Area

This study was carried out in Osun State, Nigeria fishing communities. The state has 3 senatorial districts with 10 local government areas each making a total of 30. Main cities in the state include Osogbo being the state capital, Ife, Ede and Ilesa as shown in the Figure 1

Osun State is one of the rural states in Nigeria. It is mostly populated by the low-income earners who largely depend on farming and trading. In the past decades after the discovery of gold in Osun State especially in Ilesha environment, most artisanal have gone into mining of gold to make quick income. Most of these artisanal did not receive any formal training on gold mining. They actively engage in mining of gold without protections leading to exposure to hazardous chemicals. The households in Osun State Nigeria constituted the population of this study.

Sampling and Data collection

A multistage sampling procedure was used to select the respondents for the study in line with Singh et al., (1996). The first stage involved purposive selection of the Osun East Senatorial district, which is the area with the highest gold deposit in the state. Second, 5 local government areas, Atakunmosa East, Atakunmosa West, Ilesa East, Ilesa West and Obokun, were purposively selected because they are concentrated with high levels of mining activities. Additionally, 10 different mining sites close to fishing areas where fish production activities are carried out were randomly selected, and 20% of the fisher folks in each area were selected, for a sample size of 120 respondents. Weighted mean was obtained by calculating the mean weight filled by the respondents, which gave a clear picture of the effects the mining activities have on the cultured fish population.

Research instrument

Observation and structured questionnaire were used for data collection. The researchers visited the site of mining and observe activities. In addition, structured questionnaire was also administered to the respondents. The questionnaire was a Likert type with 4 options (Strongly agree, Agree, Disagree and Strongly disagree). The questionnaire was divided into three sections, A, B and C. Section A will seek demographic data, section B was on impact of ASGM activities on fishery activities and environment. Section C asked questions on effect of ASGM activities on livelihood capital.

Validity of the instrument

The instrument was validated by the experts in aquaculture, environmental studies and social sciences. The research instrument was rigorously validated for content and relevance through a formal assessment by a panel of six independent specialists, comprising two experts each from the fields of aquaculture, environmental science, and development studies. These experts meticulously evaluated each item in the questionnaire for its clarity, relevance, accuracy, and comprehensiveness in measuring the impacts of artisanal mining on fishery-based livelihoods. Their feedback led to critical refinements in the wording, structure, and scope of the survey.

Reliability of the instrument:

The instrument was subjected to test-retest method to determine an appropriate and effective instrument. To ensure the reliability and temporal stability of the data collection instrument, a test-retest method was employed, whereby the same survey was administered to a select group of fifteen fish farmers on two separate occasions, spaced two weeks apart. The responses from both rounds were quantitatively analyzed using the Intraclass Correlation Coefficient (ICC), which yielded a high reliability coefficient of 0.85, thereby statistically confirming the instrument's consistency and effectiveness in producing stable and dependable measurements over time.

Procedures for data collection

The questionnaire was administered to the respondents directly and retrieved by the researchers immediately they were completed. The researchers also participated in direct observation of the activities of the gold miners in the communities.

Data Analysis

Researches observations were recorded and thematically analysed. The data analysis was conducted using a combination of statistical packages, including IBM SPSS Statistics (Version 28) and Microsoft Excel, following a multi-stage analytical process. Demographic data (age, sex, education, marital status) were summarized using descriptive statistics. Frequencies (n) and percentages (%) were calculated for all categorical variables to profile the respondent population. Qualitative data from open-ended observations and field notes were transcribed and analyzed using a thematic analysis framework. Respondents' perceptions of the effects of Artisanal and Gold Mining (ASGM) activities were measured on a 4-point ordinal scale: *Very severe (4), Severe (3), Not severe (2), No effects (1)*.

For each indicator, a Weighted Mean Score (WMS) was calculated using the formula:

$$\text{Weighted Mean} = \frac{\Sigma(fi \cdot wi)}{N}$$

where:

fi = frequency of responses for each scale point
wi = weight assigned to the scale point (4, 3, 2, 1)
N = total number of respondents (120)

A predetermined benchmark means of 1.5 was established as the cutoff for significance. A WMS > 1.5 was interpreted as a negative effect or severe impact, with a higher score indicating a more severe perception of the impact. This analysis is presented in Tables 2 and 3.

To objectively test the hypothesis of a relationship between mining activities and aquaculture productivity, a bivariate correlation analysis was performed.

The Pearson Product-Moment Correlation Coefficient (r) was calculated using the formula:

$$r = \frac{n(\Sigma xy)-(\Sigma x)(\Sigma y)}{\sqrt{n\,\Sigma x^2-(\Sigma x)^2[n\Sigma y^2-(\Sigma y)^2}}$$ (Schober et al., 2018).

where:
Xi and Yi are the individual scores for the variables 'ASGM activities' and 'aquaculture production,' respectively.
X¯$\bar{X}$ and Y¯$\bar{Y}$ are the mean scores for each variable.

Ethical consideration

The consent of the respondents was obtained before the commencement of the research. The detail of the research was explained to the participants. They were given ample opportunity to ask questions about the study and their participation. The respondents were allowed to opt out of the study at any time they wish to do so. The ethical principle guiding research involving human being as stated by University of Ilesa were carefully followed in conducting this research.

Limitation of the study

The study examined only the impact of ASGM activities on aquaculture, livelihood and environment of fisherfolks in Osun State Nigeria. The impact of other activities in the area apart from ASGM were not examined.

RESULTS AND DISCUSSION

The demographic characteristics of the respondents examined were age, sex, level of education and marital status. Twenty-eight percent of the respondents were aged 25-30 years, 37.5% were aged 31-40 years, and only 7.5% were aged 61 years or older. This implies that the majority (i.e. more than 70%) are still in their active productive years, which will be highly significant to their fishery business. A total of 63.3% of the respondents were male, while only 36.7% were female. This implies that the majority of people in the fishery sector in the study were male, which may be the result of the laborious nature of activities in the fishery business, which women's folk funds are difficult to cope with (Table 1).

Only 17.5% of the respondents had no formal education, while the rest had a considerable level of education, ranging from primary (26.7%) to secondary (40.8%) and tertiary education (15.0%). Only 27.5% were single, while 40.0% were married, 21.7% were divorced/separated, and 10.8% were widowed/widowered, which implies that the majority of the respondents were married and thereby had dependants in the form of spouses and children whose decisions/conditions affected management decisions in the respondent businesses (Table 1).

Table 1. Demographic Characteristics of the Respondents

Items	Freq.	Percentage %
Age (Years)		
25 – 30	25	20.8
31 – 40	45	37.5
41 – 50	24	20.0
51 – 60	17	14.2
61 years and above	9	7.5
Sex		
Male	76	63.3
Female	44	36.7
Level of Education		
No primary education	21	17.5
Primary education	32	26.7
Secondary education	49	40.8
Tertiary education	18	15.0
Marital Status		
Single	33	27.5
Married	48	40.0
Divorced/Separated	26	21.7
Widow/Widower	13	10.8

Source: Field survey 2022**.**

Considering the benchmark of 1.5, mining activities have a negative influence on fishery activities (Table 2). It leads to destruction of fish ponds (2.18) dams (1.98), disturbance of rivers, streams and lake (2.17), destruction of fish habitat (2.07), pollution of water qualities (1.82), destruction of available land (2.13), reduced labour supply (1.98), increased cost of production (1.9) increased mortality (1.75), poor fish multiplication (1.78), low fish productivity (2.0), exposure of fish facilities to theft and poaching (1.8) reduced fish supply (2.17) and processing quality (1.88) (Table 2).

Table 2. Effect of ASGM Activities on Fishery Activities

Effects	Very severe	Severe	Not severe	No effects	Weighted mean
Destruction of fish pond	64	26	18	12	2.18
Destruction of dams	46	38	24	12	1.98
Disturbance of rivers, streams and lakes	64	24	20	12	2.17
Destruction of fish habitat	50	36	26	8	2.07
Pollution of water source	46	42	22	10	2.03
Contamination of waters	52	40	22	6	2.15
Reduction of water qualities	42	32	28	18	1.82
Destruction of available lands	52	38	24	6	2.13
Reduced labour supply	46	38	24	12	1.98
Increased cost of production	42	40	22	16	1.9
Increased mortality	32	44	26	18	1.75
Poor fish multiplication	44	32	18	26	1.78
Low fish productivity	46	38	26	10	2.0
Exposure of fish facilities to theft and poaching	32	46	28	14	1.8
Reduced fish supply	52	42	20	6	2.17
Reduced processing quality	44	38	18	20	1.88

Source: Field survey 2022.

Table 3 reveals the effect of ASGM activities on the livelihood improvement of fishers. This shows that with a cut-off of 1.5, mining activities have a negative effect on financial capital, which results in reduced income (1.98), savings (1.88) and credit (1.87) (Table 3). Additionally, climate change has a negative effect on natural capital, as it leads to reduced soil fertility/productivity (2.18), reduced land availability (1.93), and poor water resources (2.1). Physical capital is negatively affected by reduced household assets (1.98) and fishing practices (1.82), and human capital is negatively affected by reduced labour availability (2.13) and poor health status (1.73) (Table 3).

Table 3. Effect of ASGM Activities on Livelihood Capital

Livelihood Capital	Very severe	Severe	Not severe	No effects	Weighted mean
Financial Capital					
Reduced income	46	38	24	12	1.98
Reduced savings	42	40	20	18	1.88
Reduced credit	51	30	10	29	1.86
Natural Capital					
Disturbed soil fertility/productivity	64	26	18	12	2.18
Poor water resources	52	36	24	8	2.1
Reduced land availability	46	34	26	4	1.93
Physical Capital					
Reduced household assets	46	38	24	12	1.98
Reduced fishing implement/tool	42	32	28	18	1.82
Human Capital					
Reduced labour availability	52	38	24	6	2.15
Poor health status	32	42	28	18	1.73

Source: Field survey 2022.

Table 4. Bivariate analysis of the relationship between mining activities and aquaculture production

ASGM activities* aquaculture production	r	p	N	Decision
	0.624**	0.001	120	significant

**. Correlations are significant at the 0.01 level (2-tailed).

The above table reveals the analysis of the relationship between mining activities and the productivity of the aquaculture industry. This shows that there is a significant relationship between mining activities and the productivity of the aquaculture industry ($r = 0.624$, $p = 0.001$); that is, the ASGM activities ongoing in the study area resulted in the low productivity of the aquaculture industry (Table 4).

Table 5. Regression analysis between mining activities and aquaculture production

PredictorVariables				
Intercept	1.656	0.007	236.57	<0.001
Very severe	0.008	0.001	16.40	<0.001
Severe	0.005	0.001	10.00	<0.001
Not severe	0.002	0.001	2.43	0.047

- $R^2 = 0.997$; Adjusted $R^2 = 0.995$; F-statistic = 834.6; Model p-value = 4.42e-09

Moreover, the regression model as shown in Table 5 demonstrates a near-perfect fit ($R^2 = 0.997$), indicating that the weighted mean is a direct linear function of the severity counts of mining activities on aquaculture production. All severity categories are statistically significant positive predictors ($p < 0.05$), confirming a consistent and quantifiable impact gradient (Table 5).

Discussion of findings

Artisanal activities impact the livelihood of community members in various ways. It impacts various aspect of livelihood capitals including human, financial, social and natural capitals. This result agrees with the finding of Adewale et al. (2023), who identified human, financial, social and natural capitals as essential aspect of livelihood capital in their study. Majority of the respondents perceived the effects of ASGM activities on fishery activities and the environment as severe. Specifically, the mining activities lead to destruction of fish ponds and habitat. It disturbs rivers, streams and lakes and cause pollution of water sources leading to spread of diseases. Moreover, it leads to destruction of available arable land, it causes reduced labour supply, further increasing cost of production and mortality rate. In addition to result in poor fish multiplication, low fish productivity, exposure of fish facilities to theft and poaching, reduced fish supply and processing quality. Similar findings of Talukder et al. (2023) and Wyatt et al. (2017) also shows that poor fishing and low fish productivity are some of the impact of artisanal mining. The adverse effects of mining activities in Osun State are pronounced in terms of environmental degradation which in turn affects local economies and health of human.

The activities lead to severe pollution of water bodies with heavy metals like mercury and cadmium contaminating aquatic ecosystems as evidenced in studies conducted by Adusei et al., (2024) and (Gomez et al., 2024) who equally argued that artisanal mining is a source of water pollution. Moreover, the destruction of fish habitats and water sources results in reduced fish populations which are crucial for local diets and economies as also idenitfied by Adetiloye et al. (2024) and Donkor et al. (2024). Although artisanal mining can provide some form of economic opportunities, it often leads to overdependence on mining can provide economic opportunities however, it can lead to overdependence on mining, hindering diversification of livelihoods and increased household poverty. Adetiloye et al., (2024) and Fagariba et al. (2024) have equally decried the impact of artisanal mining on livelihood sustainability. In addition, mining activities could increase living costs and social issues such as frequent conflicts over land use, gender-based violence (Donkor et al., 2024).

ASGM activities in Nigeria have significant negative impacts on fishery activities and livelihood capitals. The gold mining activities impact financial capital severely as idenified by Moyo et al. (2022). Similarly, Izerimana & Godwin (2024) also decried and attributed the reduces the income of the respondents in their study to poor mining around water bodies. The strain on financial capital is often increased by the lack of formal support from government and regulations by relevant agencies. This limits the artisanal gold miner's ability to save and invest in sustainable practices.

Considering the impact on the natural capital mining operations degrade the environment leading to low agricultural productivity and reduced soil fertility (Mamodu et al., 2018). It also has severe impact on water resources and reduced land availability. This result is similar to the finding of Bartrem et al. (2022), who argued that contamination of water resources affect both aquatic life and the quality of water available for irrigation and domestic use. In addition, the mining activity reduced respondents' household assets leading to poor productivity. Moreover, the decline in natural resources often leads to reduced household assets as families struggle to maintain productivity in agriculture and fishing (Perez et al., 2015). This loss of assets further increase poverty, making it difficult for families to recover or adapt to changing economic conditions was also idenitified by Izerimana & Godwin (2024) in their study.

Moreover, the activities of the artisanal gold miner have impact on the human capital of the respondents. It also reduces the human capital of the respondents in term of labour availability and poor health status. Human capital was mostly impacted. This implies that mining activities in the study area have negative effects on livelihood capitals. This result corroborates the findings of Baffour-Kyei et al. (2021).

CONCLUSIONS AND POLICY IMPLICATIONS

Conclusions

ASGM activities have constituted a great nuisance to the fishery industries in the gold mining district of Osun State which is a microcosm of Nigeria as it relates to ASGM. This has negatively impacted the sector by destroying the fish habitat, polluting perennial water sources and disturbing water quality; thereby decreasing the productivity of fish production and thus reducing the livelihood capitals/assets of fish farmers. Additionally, exposure of fish facilities to theft/poaching is another problem constituted by gold mining, which has led many fishers to lose sight of fish production.

Suggestion

To promote sustainable aquaculture and enhance the well-being of fishermen, it is essential to embrace mitigation strategies. One example is the utilization of acid mine drainage, where polluted water is directed to a treatment facility for the neutralization of contaminants before being released into waterways. Enforcing key technologies for monitoring and controlling water flow at mining sites, including diversion systems, containment ponds, groundwater pumping systems, subsurface drainage systems, and subsurface barriers, is crucial. Additionally, governmental authorities should establish committees to conduct daily oversight of mining activities and provide training to artisans in sustainable mining practices, fostering a conducive environment for sustainable aquaculture production.

REFERENCES

Adetiloye, A., Ot, F., & Ca, O. (2024). Evaluating Socio-Economic and Environmental (SEE) Impact of Artisanal and Small-Scale Mining (ASM) of gemstones on livelihood in the Ijero-Ekiti community, Nigeria. Deleted Journal, 4(5), 939–944. https://doi.org/10.62225/2583049x.2024.4.5.3348

Adewale, P. S., Makinde, S. C. O., & Kusemiju, V. O. (2023). Urban and Peri-Urban Vegetable Production Effects on Farmers' Livelihoods in Lagos State, Nigeria. Journal of Environment and Sustainable Development, 2(1), 41–48. https://doi.org/10.55921/vget1906

Adusei, S., Gikunoo, E., Arthur, E. K., Amponsah, W., Agyemang, F. O., & Ohemeng-Boahen, G. (2024). Heavy Metal Pollution from Illegal Mining 'Galamsey' Activities on the Viability of Clarias Gariepinus in the Oda River, Ghana. Research Square (Research Square). https://doi.org/10.21203/rs.3.rs-5661424/v1

Akhtar, N., Syakir Ishak, M. I., Bhawani, S. A., & Umar, K. (2021). Various natural and anthropogenic factors responsible for water quality degradation: A review. Water, 13(19), 2660.

Akinsete, M. O., & Ajala, A. S. (2022). Traditional Beliefs and Healing Potential of the Osun River: Quest for Indigenous Water Management Approaches in Osogbo, Southwestern Nigeria. In From Traditional to Modern African Water Management: Lessons for the Future (pp. 161-178). Cham: Springer International Publishing.

Al-Sulaiti, M. M., Soubra, L., & Al-Ghouti, M. A. (2022). The causes and effects of mercury and methylmercury contamination in the marine environment: A review. Current Pollution Reports, 8(3), 249-272.

Amadi, C. N., Frazzoli, C., & Orisakwe, O. E. (2022). Sentinel species for biomonitoring and biosurveillance of environmental heavy metals in Nigeria. Journal of Environmental Science and Health, Part C, 38(1), 21-60.

Amoakwah, E., Ahsan, S., Rahman, M. A., Asamoah, E., Essumang, D. K., Ali, M., & Islam, K. R. (2020). Assessment of heavy metal pollution of soil-water-vegetative ecosystems associated with artisanal and small-scale gold mining . Soil and Sediment Contamination: An International Journal, 29(7), 788-803.

Amusa, S. B. (2019). Tradition and Modernity. African Sacred Spaces: Culture, History, and Change, 165.

Baffour-Kyei, V., Mensah, A., Owusu, V., & Horlu, G. S. (2021). Artisanal small-scale mining and livelihood assets in rural southern Ghana. Resources Policy, 71, 101988. https://doi.org/10.1016/j.resourpol.2021.101988

Bartrem, C., Von Lindern, I., Von Braun, M., & Tirima, S. (2022). Climate change, conflict, and resource extraction: Analyses of Nigerian artisanal mining communities and ominous global trends. Annals of Global Health, 88(1). https://doi.org/10.5334/aogh.3547

Bustillo Revuelta, M., & Bustillo Revuelta, M. (2018). Environment and Sustainability. Mineral Resources: From Exploration to Sustainability Assessment, 531-614.

Capparelli, V. M., Cabrera, M., Rico, A., Lucas-Solis, O., Alvear-S, D., Vasco, S., Galarza, E., Shiguango, L., Pinos-Velez, V., Pérez-González, A. and Espinosa, R., (2021). An integrative approach to assess the environmental impacts of gold mining contamination in the Amazon. Toxics, 9(7), 149.

Diallo, B. S., & Soumah, M. S. (2023). From agricultural practices to mining activities: The consequences of this paradigm shift for the food security in Guinea. *Przegląd Prawa Rolnego, 2(33)*, 171–190. https://doi.org/10.14746/ppr.2023.33.2.10

Donkor, P., Siabi, E. K., Frimpong, K., Frimpong, P. T., Mensah, S. K., Vuu, C., Siabi, E. S., Nyantakyi, E. K., Agariga, F., Atta-Darkwa, T., & Mensah, J. K. (2024). Impacts of illegal Artisanal and small-scale gold mining on livelihoods in cocoa farming communities: A case of Amansie West District, Ghana. Resources Policy, 91, 104879. https://doi.org/10.1016/j.resourpol.2024.104879

Elwaleed, A., Jeong, H., Abdelbagi, A. H., Quynh, N. T., Nugraha, W. C., Agusa, T., Ishibashi, Y., & Arizono, K. (2024). Assessment of Mercury Contamination in Water and Soil from Informal Artisanal Gold Mining: Implications for Environmental and Human Health in Darmali Area, Sudan. Sustainability, 16(10), 3931. https://doi.org/10.3390/su16103931

Ezediuno, F. (2021). Residents raise alarm as Osun river changes colour. Daily Post Nigeria. Retrieved March 25, 2023, from https://dailypost.ng/2021/04/01/residents-raise-alarm-as-osun-river-changes-colour/

Fagariba, C. J., Sumani, J. B. B., & Mohammed, A. S. (2024). Artisanal and Small-Scale Gold Mining Impact on Soil and Agriculture: Evidence from Upper Denkyira East Municipality, Ghana. European Journal of Environment and Earth Sciences, 5(3), 12-20.

Gomez, F. H., Pelegri, N., Lopez, J. G., Torres, K. C., & Vaccari, M. (2024). Impact of Artisanal Gold Mining in Community Conserved Areas with High Biodiversity Using a Multi-Criteria Approach: A Case Study in Colombia. Pollutants, 4(2), 276–290. https://doi.org/10.3390/pollutants4020018

Idowu O. S., Adelakun K. M., Osaguona P. & Ajayi J., (2013). Mercury contamination in artisanal gold mining area of Manyera river, niger state

Nigeria. Journal of Environmental Research and Management,4(9) : 0326-0333.

Isukuru, E. J., Opha, J. O., Isaiah, O. W., Orovwighose, B., & Emmanuel, S. S. (2024). Nigeria's water crisis: abundant water, polluted reality. Cleaner Water, 2 100026. https://doi.org/10.1016/j.clwat.2024.100026

Izerimana, J., & Godwin, L. S. (2024). Opportunity and side effects of Artisanal and Small-Scale mining in Nigeria. Modern Economy, 15(03), 233–250. https://doi.org/10.4236/me.2024.153012

Khonyongwa, O., & Suman. (2023). Life Cycle Assessment of Heavy Metal Toxicity in the Environment. In Heavy Metal Toxicity: Environmental Concerns, Remediation and Opportunities (pp. 209-223). Singapore: Springer Nature Singapore.

Kung, H. C., Wu, C.-H., Huang, B., Chang-Chien, G.-P., Mutuku, J. K., & Lin, W.-C. (2024). Mercury abatement in the environment: Insights from industrial emissions and fates in the environment. Heliyon, 10. https://doi.org/10.1016/j.heliyon.2024.e28253

Mamodu, A., Ojonimi, I. T., Apollos, S. S., Jacinta, O.-C. N., Salome, W. H., & Enesi, A. A. (2018). Analyzing the environmental impacts and potential health challenges resulting from artisanal gold mining in Shango area of Minna, North-Central, Nigeria. Journal of Degraded and Mining Lands Management, 5(2), 1055–1063. https://doi.org/10.15243/jdmlm.2018.052.1055

Moyo, T., Chitaka, T. Y., Lotter, A., Schenck, C. J., & Petersen, J. (2022). Urban mining versus Artisanal and Small-Scale Mining (ASM): An interrogation of their contribution to sustainable livelihoods in sub-Saharan Africa. The Extractive Industries and Society, 12, 101173. https://doi.org/10.1016/j.exis.2022.101173

Obodai, J., Bhagwat, S., & Mohan, G. (2024). The interface of environment and human wellbeing: Exploring the impacts of gold mining on food security in Ghana. Resources Policy, 91, 104863. https://doi.org/10.1016/j.resourpol.2024.104863

Ofosu, G., Dittmann, A., Sarpong, D., & Botchie, D. (2020). Socioeconomic and environmental implications of Artisanal and Small-scale Mining (ASM) on agriculture and livelihoods. Environmental Science & Policy, 106, 210-220.

Olujimi, O. O., Oputu, O., Fatoki, O., Opatoyinbo, O. E., Aroyewun, O. A., & Baruani, J. (2015). Heavy metals speciation and human health risk assessment at an illegal gold mining site in Igun, Osun State, Nigeria. Journal of Health Pollution, 5(8), 19-32.

Perez, C., Jones, E., Kristjanson, P., Cramer, L., Thornton, P., Förch, W., & Barahona, C. (2015). How resilient are farming households and communities to a changing climate in Africa? A gender-based perspective. *Global Environmental Change*, *34*, 95–107. https://doi.org/10.1016/j.gloenvcha.2015.06.003

Przezbórska-Skobiej, L., & Eyang, G. (2024). Economic and Non-Economic Aspects of Agritourism Development: The Evidence from Nigeria. In *CABI eBooks* (pp. 1–20). https://doi.org/10.1079/9781800623705.0002

Schober, P., Boer, C., & Schwarte, L. A. (2018). Correlation Coefficients: appropriate use and interpretation. *Anesthesia & Analgesia*, *126*(5), 1763–1768. https://doi.org/10.1213/ane.0000000000002864

Seco, J., Aparício, S., Brierley, A.S., Bustamante, P., Ceia, F.R., Coelho, J.P., Philips, R.A., Saunders, R.A., Fielding, S., Gregory, S. and Matias, R., (2021). Mercury biomagnification in a Southern Ocean food web. Environmental Pollution, 275, 116620.

Singh, R., Mangat, N. S., Singh, R., & Mangat, N. S. (1996). Multistage Sampling. Elements of Survey Sampling, 283-313.

Solichin, E. (2020). Implications of Illegal Gold Mining on the Household Economy and the Environment. Saudi Journal of Business and Management Studies, 5(1), 70-73.

Talukder, P., Ray, R., Sarkar, M., Das, A., & Chakraborty, S. (2023). Adverse effects of mining pollutants on terrestrial and aquatic environment and its remediation. Environmental Quality Management, 33(4), 595–610. https://doi.org/10.1002/tqem.22121

Teixeira, R.A., da Silveira Pereira, W.V., de Souza, E.S., Ramos, S.J., Dias, Y.N., de Lima, M.W., de Souza Neto, H.F., de Oliveira, E.S. and Fernandes, A.R., (2021). Artisanal gold mining in the eastern Amazon: Environmental and human health risks of mercury from different mining methods. Chemosphere, 284, 131220.

Uthman, S. (2020). INVESTIGATION: How illegal mining fuels poverty, river pollution, sacred grove desecration in Osun. TheCable. Retrieved March 25, 2023, from https://www.thecable.ng/investigation-how-illegal-mining-fuels-poverty-river-pollution-sacred-grove-desecration-in-osun

Vaishnav, A., Kumar, R., Singh, H. B., & Sarma, B. K. (2022). Extending the benefits of PGPR to bioremediation of nitrile pollution in crop lands for enhancing crop productivity. Science of the Total Environment, 826, 154170.

Wyatt, L., Ortiz, E. J., Feingold, B., Berky, A., Diringer, S., Morales, A. M., Jurado, E.R., Hsu-Kim, H. & Pan, W. (2017). Spatial, temporal, and dietary variables associated with elevated mercury exposure in Peruvian riverine communities upstream and downstream of artisanal and small-scale gold mining. International Journal of Environmental Research and Public Health, 14(12), 1582

Yu, M., Wang, Y., & Umair, M. (2024). Minor mining, major influence: Economic implications and policy challenges of artisanal gold mining. Resources Policy, 91, 104886.