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## **MINERS ADAPTATION STRATEGIES ON IMPACT OF ARTISANAL MINING ACTIVITIES AMONG RURAL COMMUNITIES IN KADUNA STATE, NIGERIA**

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### **Abstract**

*Mining serves as a major source of livelihood for many rural communities around the world. However, it often exposes miners to various risks, including workplace accidents, consumption of contaminated food and water, and the spread of diseases. This study explores how miners in the rural areas of Kaduna State, Nigeria, adapt to the challenges associated with artisanal mining. Data were gathered using focus group discussions, in-depth interviews, and direct observations in the field. The findings, analysed using descriptive statistics with NVivo Version 11.0, reveal a variety of coping strategies employed by miners. These include avoiding polluted water sources, treating water through boiling, filtration, or chemical methods, relying on family, unions, and friends for medical support, and adopting safety measures like wearing protective gear and ensuring safe mining practices. Other strategies include consuming treated or packaged water, promoting awareness about mining hazards, and improving personal nutrition. Based on these findings, the study recommends that miners actively engage with their unions and build strong relationships with peers and community members to ensure support during times of need. Secondly, miners should ensure safe mining practices by avoiding underground mining and mishandling of mining equipment.*

**Keywords:** Artisanal Mining, Miners, Adaptation Strategies, Livelihood and Rural Communities

### **Introduction**

Artisanal mining remains a pervasive livelihood source across many developing regions. Income generation is the main reason responsible for involvement in artisanal mining (Traore *et al.*, 2024). The sector presents both opportunities and challenges providing income while exposing communities to environmental degradation, health risks, and social instability (Mutagwaba *et al.*, 2018; Oruonye *et al.*, 2024; Fagariba *et al.*, 2024; Donkor *et al.*, 2024). Despite these challenges, miners have developed diverse adaptation strategies to mitigate adverse effects of mining. Globally, adaptation strategies by artisanal mining communities include resilient responses such as land reclamation, alternative potable water sources, and protective health measures like mosquito nets and covering mining pits demonstrating a pattern of coping, despite hazardous conditions (Mabe *et al.*, 2021). In Sub-Saharan Africa, artisanal mining contributes to household livelihood by providing employment and income. For instance, it constitutes a critical livelihood in Uganda, engaging an estimated 200,000 miners and supplying about 30 % of the country's gold exports (Intergovernmental Forum-IGF, 2021). Miners lack basic safety equipment and using hazardous processes like mercury amalgamation during mining processes (Awori & Afedraru, 2024). This informality exacerbates environmental degradation, occupational risks, and public health threats (Twinobusingye, 2021)

In Ghana, displaced artisanal miners responded to the sector bans by turning to alternative livelihoods such as farming, trading, and labour work, with farming emerging as the most common coping strategies (Mabe *et al.*, 2021). On a broader scale, innovations replacing harmful practices such as mercury use are gaining traction. In Ethiopia, for example, gravity separation technology and mobile on-site processing units have started replacing toxic extraction methods, reducing environmental pollution and enhancing extraction safety (Teku, 2025). Miners and communities



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demonstrate resilience by engaging in livelihood diversification such as, small trade or alternative income sources especially in response to shocks (Mukooli, 2022). Common responses on injuries sustained during mining include self-medication, involving the use of traditional remedies, such as applying locally made balms for physical injuries (Wireko-Gyebi *et al.*, 2022).

In Nigeria, although regulations like the Nigerian Minerals and Mining Act (2007) and environmental enforcement by NESREA exist, artisanal mining communities often lack awareness about these frameworks and appropriate safety or environmental practices. This regulatory gap hinders effective adaptation among miners (Oruonye *et al.*, 2024). For instance, in Ebonyi State there was low safety awareness among miners, with most failing to comply with environmental and safety regulations (Oruonye *et al.*, 2016). Kaduna State possesses a rich abundance of commercially valuable mineral resources, such as tin, tantalite, sapphire, zircon, gold, and nickel that attract mining. The environmental impacts of artisanal mining in Kaduna are significant. The mostly unregulated practice of artisanal mining has resulted in environmental degradation, land displacement, and the disruption of traditional livelihoods like farming and livestock rearing. These effects are especially troubling for rural communities that depend heavily on natural resources for daily sustenance and economic stability (Kareem & Owao, 2000; Adekoya, 2003; Yunana & Banta, 2014; Gadzama, 2015). for example, a 2025 study revealed severe degradation of vegetation, farmlands, biodiversity, grazing lands, and domestic water sources, undermining local resource sustainability (Zankan *et al.*, 2025).

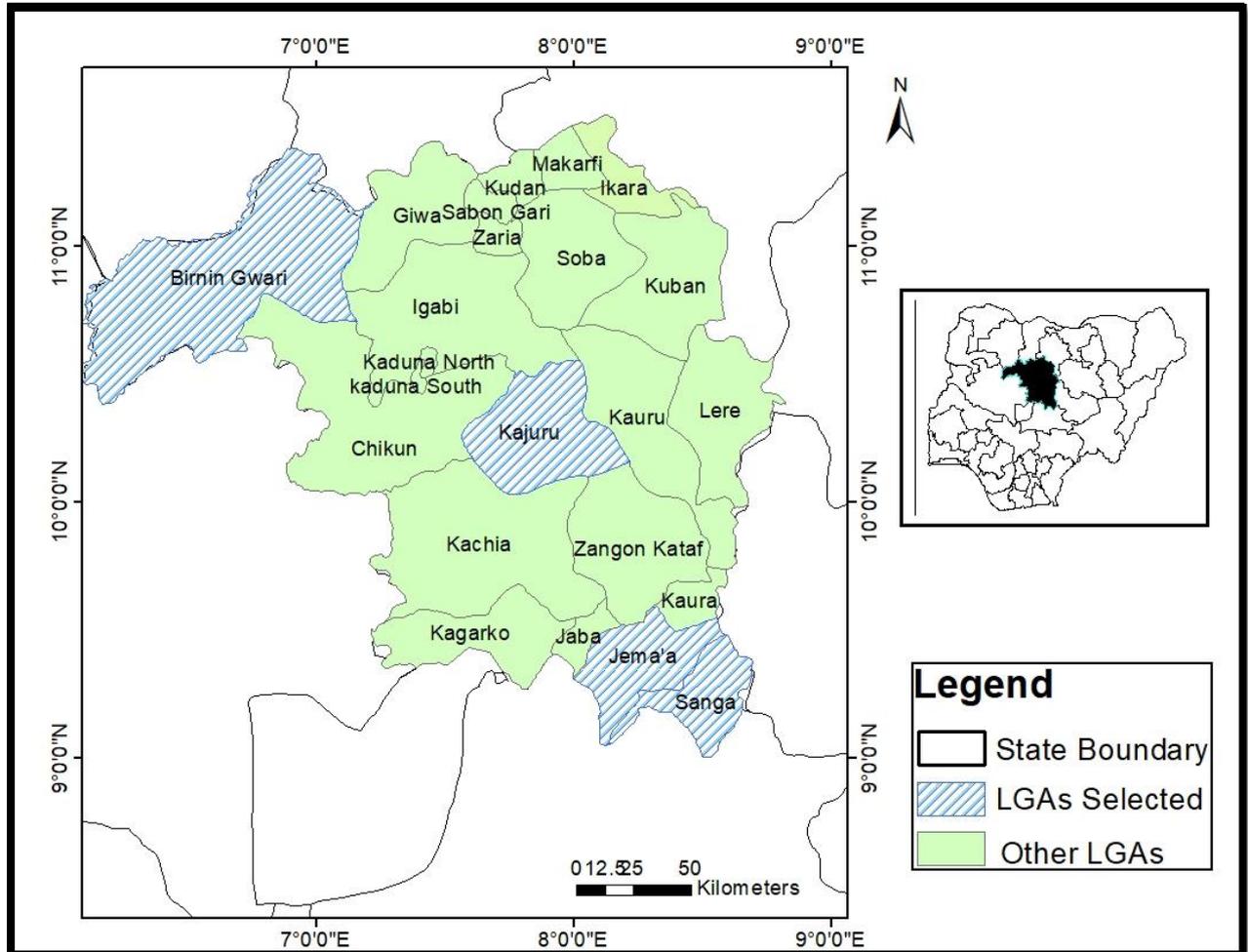
Within mining communities, participation in artisanal mining often spans entire households and generations, with children routinely integrated into mining labour from a young age, reshaping familial norms and livelihoods away from farming (Gadzama, 2020). In many instances, mining has reduced access to arable land, contaminated water sources, and led to injuries and fatalities among miners. In light of these escalating challenges, it is crucial to assess miners' adaptation strategies for coping with the impacts of artisanal mining in Kaduna State, Nigeria. Such research is vital for shaping informed policies that safeguard rural livelihoods while supporting sustainable resource management and fostering economic development.

## **Materials and Methods**

### **Study Area**

Kaduna State is situated in North Central Nigeria and is one of the country's 36 states. It spans latitudes 9° 03'N to 11° 32'N and longitudes 6° 05'E to 8° 38'E, east of the Greenwich Meridian. Covering 46,053 km<sup>2</sup> about 5% of Nigeria's total land area it shares borders with Kano, Katsina, and Zamfara States to the north; Bauchi and Plateau States to the east; Niger State to the west; and the Federal Capital Territory and Nasarawa State to the south. Politically, Kaduna State is divided into 23 local government areas (see Figure 1).

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**Figure 1: Map of Kaduna State showing the local government Areas selected for the study**

**Source: GIS Lab, Department of Geography BUK**

Kaduna State has an AW climate type (Koppen classification) with two distinct seasons: dry and wet. The southern part, around Kafanchan and Kagoro, experiences a longer rainy season from April to October, while the northern areas like Zaria and Makarfi have a shorter rainy season from mid-May to September, similar to Kano (Abaje *et al.*, 2018). Rainfall peaks once annually, usually in August or September, influenced by tropical maritime and continental air masses. Annual rainfall decreases from about 1659 mm in the south (Kafanchan) to 1246 mm in the central area (Kaduna) and 1017 mm in the north (Zaria). The state's average annual rainfall and humidity are 1307 mm and 56.6%, respectively, with temperatures ranging from 15.1°C to 35.2°C. Orographic effects from the Jos Plateau and Kagoro hills positively influence the southern climate, affecting rainfall, temperature, and humidity (Ishaya and Abaje, 2008). The study area is located in Nigeria's Guinea Savanna region, which receives substantial rainfall and experiences limited bush burning (Buba, 2015). It is underlain by Pre-Cambrian basement complex rocks mainly granite, gneiss, migmatite, and quartzite favorable for mineral mining (NMMS, 2017). Key economic activities include farming, mining, commerce, animal rearing, and hunting. The population is culturally diverse, with the north largely inhabited by Hausa Muslims, while the south is home to various ethnic groups, predominantly Christians, each with distinct traditions, ethnic identities, and social norms.



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## Data Collection

Data for this study were gathered through Focus Group Discussions (FGDs), in-depth interviews, and direct field observation. Artisanal miners were purposively selected, as they are directly involved in mining and best positioned to share insights on the adaptation strategies they use. Only individuals aged 18 and above were included, as they are capable of independent decision-making. Four local government areas - Sanga, Jema'a, Kajuru, and Birnin Gwari were purposively chosen due to active artisanal mining activities. In each LGA, one FGD was conducted with a group of 6-10 miners, facilitated by a moderator and supported by a note-taker who also handled audio recordings. Participants were selected from the mining population in each area. Additionally, four individuals, including mining officials, were selected for in-depth interviews across the study locations. These interviews focused on key issues relevant to the research objectives. Direct field observations were also conducted to examine mining processes, identify minerals extracted, and document adaptation strategies used by miners.

## Data Analysis

The data for this study were analyzed using descriptive statistics with the aid of NVivo Version 11.0, a software designed for qualitative and mixed-methods research. NVivo is capable of processing unstructured data such as text, audio, video, and images. It allows researchers to efficiently manage and condense large volumes of qualitative information from interviews, FGDs, in-depth interviews, and participatory rural appraisals into organized textual formats. The software supports transcription and coding, enabling the categorization of participants' opinions and perceptions into concise themes. The results were presented in tabular form for clarity.

## Presentation of Results and Discussion

### Miners Adaptation Strategies to cope with the effect of Artisanal Mining in the Study area

Table 1 presents the adaptation strategies employed by miners to cope with the impacts of artisanal mining in rural communities of Kaduna State, Nigeria. The findings reveal that miners adopt various coping mechanisms, including the use of protective gear such as nose masks, rain boots, and gloves; avoiding underground mining during the rainy season; relying on family support; and investing in asset acquisition for future security.

Table 1: **Miners Adaptation Strategies on impact of Artisanal Mining activities**

<b>Strategies to cope with injuries sustained during mining</b>	<b>Strategies to maintain good health during mining</b>	<b>Strategies to cope with the effect of rainy season on mining</b>
<ul style="list-style-type: none"><li>i. Support from union members and friends to treat the victims,</li><li>ii. Support from the victim's family and Acquisition of assets</li></ul>	<ul style="list-style-type: none"><li>i. Drinking of sachet/ treated water,</li><li>ii. Sensitisation campaign on the dangers of mining,</li><li>iii. Sleeping under mosquito net and utilisation of blanket,</li><li>iv. Utilisation of nose mask,</li><li>v. Utilisation of rain boot and gloves,</li><li>vi. Proper handling of mining equipment,</li><li>vii. Eating balance diet, and</li><li>viii. provision of pillars underground during mining</li></ul>	<ul style="list-style-type: none"><li>i. Avoiding underground Mining and</li><li>ii. Utilisation of water pumping machine</li></ul>



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### **Strategies to Cope with Injuries Sustained during Mining activities in Kaduna State**

Miners often suffer various injuries during mineral extraction, either due to ground subsidence or from the use of mining tools and equipment. To cope with such injuries, they adopt several strategies, including receiving assistance from union members and friends for medical treatment, relying on family support, and investing in asset acquisition as a form of financial security.

#### **Support from Union and Friends to Treat the Victims**

Some participants noted that union members who sustain injuries during mining activities receive financial support for medical treatment provided they have fulfilled their required contributions to the union. Those who fail to pay their dues are not recognised as union members and, therefore, are not eligible for such support. Another key responsibility of the union is to assist in rescuing individuals trapped underground due to subsidence. However, financial aid is not extended to non-contributing individuals, regardless of the severity of their injuries, as their lack of participation reflects a lack of unity. For union members who die as a result of mining accidents or illness, the union prioritises funeral arrangements, including grave digging and providing a casket. Additionally, friends of the affected individuals often contribute funds to support their treatment. This collective support system is one of the reasons miners tend to work in groups when extracting minerals. This perception was well illustrated by a discussant:

“We support injured members, rescue the trapped, and bury the dead but non-contributors receive no help, regardless of injury”.

#### **Support from the Victim's Family**

Some participants noted that victims' families play a crucial role in supporting injured relatives, often covering hospital bills themselves. In many cases, this financial burden forces them to sell personal assets like land and livestock. Families, especially immediate relatives, go to great lengths to ensure the recovery of their loved ones. This finding aligns with Arthur-Holmes et al. (2016), who observed that families of artisanal mining victims often sacrifice their resources for treatment. A notable example is the case of a miner from Bayya Gidan Waya who suffered a spinal cord injury due to subsidence. His family reportedly spent over ₦800,000 on his treatment, with both nuclear and extended members contributing. To raise the funds, they were compelled to sell valuable assets, reflecting the severe economic strain such injuries place on families involved in artisanal mining.

#### **Acquisition of Assets/Investment**

Participants noted that they invest earnings from artisanal mining in assets as a strategy to cope with potential injuries or death. Some purchase houses to rent out, while others buy motorcycles or vehicles for commercial use. These assets serve as alternative income sources, especially when miners are injured, lose body parts, or grow too old to work. By using their income wisely, they create financial security for themselves and their families in case of accidents or future incapacity caused by the physically demanding and risky nature of artisanal mining. Some miners invest in small businesses, such as provision stores, while others save part of their income in banks for emergencies or future needs. These strategies help them cope with injuries, disability, or even death, as families can rely on the assets left behind. This aligns with Wireko-Gyebi et al. (2022), who reported that miners use savings and investments to manage mining-related risks. Similarly, UNDP. (2009) and Bargarioria et al. (2020) found that miners turn to alternative livelihoods like commercial transport, woodfuel collection, and charcoal production when mining activities stop or become unsustainable.

### **Strategies to Maintain Good Health during Mining in Kaduna State**

Miners in rural Kaduna State adopt various strategies to protect their health during mineral extraction. These include drinking treated or sachet water, attending sensitization campaigns on mining hazards, using mosquito nets and blankets, wearing nose masks, rain boots, and gloves,



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handling equipment properly, eating balanced diets, and providing support pillars underground for safety. These coping measures help reduce health risks and improve resilience in hazardous mining environments.

**Drinking of Sachet or Treated Water**

Most participants reported using sachet water during mineral extraction to maintain good health and avoid polluted river water. However, they acknowledged that some sachet water is illegally produced and may not be safe. Due to high demand at mining sites, vendors often raise prices. This aligns with Makwerere et al. (2018), who noted that households buy water during extreme situations. In remote or rocky mining areas, limited access to food and water vendors forces miners to drink contaminated water, increasing the risk of diseases like typhoid and cholera, which negatively affects their health and overall well-being. Some FGD participants said they drink treated water, often boiling it at home before bringing it to mining sites. This practice, mainly adopted by new miners, helps avoid relying on polluted river water. They usually heat the water at night to kill germs and let it cool for the next day's use. Occasionally, they add alum to purify it further. These efforts help them maintain good health during mining. However, when they earn money from mineral sales, they often switch to buying sachet water instead of using their treated water.

**Sensitisation Campaign on the Dangers of Mining**

Some participants noted that miners are regularly sensitised to the health risks of mineral extraction. Health personnel are invited to mining sites to educate miners and those indirectly involved like food and water vendors on the dangers of environmental pollution, poor hygiene, and exposure to harmful chemicals like mercury. They advise vendors to keep food covered to prevent contamination and encourage miners to avoid drinking polluted water, use mosquito nets, and wear protective gear such as rain boots, gloves, and nose masks. While some miners follow these health guidelines, others choose not to adopt the recommended safety practices. A leader from one of the mining sites in the study area shared the following insight: "As leaders, we ensure members stay healthy so they can work effectively, earn income, and pay union dues. We regularly invite health personnel to advise miners on health issues during mining activities"

The findings of this study contrast with those of Charles et al. (2013), who reported that despite the rise in artisanal mining in Tanzania, there is a significant lack of community-based and occupational health education programs addressing the hazards of dangerous chemicals like mercury exposure.

**Sleeping under Mosquito Net and utilisation of Blanket**

Mining areas often have pits and ponds that serve as breeding grounds for mosquitoes and other disease vectors. Many participants said they sleep under mosquito nets to prevent malaria, developing this habit to reduce infection risk. Some also cover themselves with blankets to protect against cold and illnesses like pneumonia. The use of insecticide-treated nets and indoor spraying has helped reduce malaria cases in Sub-Saharan Africa (Tizifa et al., 2018). Those who contract malaria seek treatment to recover. However, many miners avoid using nets during the hot dry season because nets trap heat and limit airflow, making sleep uncomfortable. This reduces their consistent use of mosquito nets despite the health benefits. This was clearly illustrated by one of the participants, who shared: "I sleep under a mosquito net and use a blanket to avoid malaria and cold-related illnesses. However, some miners avoid nets due to heat, increasing their risk of malaria"

This aligns with findings by Gatune and Besada (2020) and Adum et al. (2023), who reported that gold miners account for most malaria infections due to their failure to follow recommended prevention measures.



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### **Utilisation of Nose Mask, Rain Boot and Gloves**

Participants noted that wearing nose masks is one strategy used to prevent respiratory diseases during mining. Masks help reduce inhalation of dust and limit the spread of illnesses like COVID-19 and Ebola, while also lowering the risk of asthma and pneumonia. Many miners see masks as effective protection and use them during mineral extraction. This aligns with Brooks and Butler (2021), who found that community mask use significantly reduces the transmission of respiratory diseases. However, some miners reject masks, believing they restrict oxygen intake especially during underground mining where air is limited. Others simply disregard health advice and refuse to wear masks, doubting their effectiveness. This attitude, rooted in disbelief or indifference, leads to poor adherence to preventive measures despite the known risks.

Some FGD participants noted that they use rain boots and gloves during mining to prevent injuries. These protective tools are especially common among miners working in rocky or hilly areas, where movement is difficult. Rain boots help them navigate rough terrain and carry materials to streams for washing, while gloves protect their hands when handling tools like diggers, shovels, hammers, and chisels. However, many miners still neglect these safety measures, believing boots do not guarantee protection, as injuries and even deaths have occurred despite using them. Those who avoid protective gear are often the ones who experience frequent and serious injuries during mineral extraction. This is what one of the participants has to say: "Rain boots and gloves are essential for mining, especially on rocky surfaces. Boots protect us from sharp rocks, while gloves help safely handle mining tools" This study aligns with the findings of Nakua et al. (2019) and Gatune and Besada (2020), who reported that a moderate number of miners choose to use protective measures such as rain boots and hand gloves while working.

### **Proper Handling of Mining Equipment**

Improper handling of mining equipment poses serious health risks to miners, often leading to injuries during mineral extraction. Some participants emphasized the importance of carefully using tools like diggers, shovels, hammers, and chisels to avoid accidents. However, not all miners follow this practice, resulting in varying degrees of injuries. Nakua et al. (2019) also observed that injuries often result from both equipment misuse and slippery terrain. Additionally, mining tools are sometimes used as weapons during conflicts between miners, leading to severe harm or even death. In response, some mining communities have introduced strict rules, including penalties or reporting offenders to security agencies. Miners found using tools to fight may be banned from mining in that area. These measures have helped reduce violence and injuries in several mining communities in Kaduna State, promoting safer mining practices among workers.

### **Eating of Balanced Diet**

Mining requires intense physical effort, prompting miners to consume energy-rich foods, especially carbohydrates, to maintain strength. Some participants noted that they eat balanced meals using their earnings from artisanal mining to stay healthy and energised. This supports Sarwar et al. (2015), who stated that choosing nutritious foods promotes a healthy body, improves mood, and reduces disease risk. However, despite awareness of healthy eating, some miners engage in harmful habits like consuming alcohol, hard drugs, and tobacco, which negatively affect their health and behavior in host communities. These habits also prevent them from saving money, pushing their families toward poverty. Many miners eat whatever food is readily available, regardless of its nutritional value, simply to feel full. This inconsistent diet, combined with substance abuse, contributes to poor long-term health and unstable financial situations for both the miners and their households. The lack of proper nutrition and financial planning reflects broader challenges faced by



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artisanal miners in maintaining sustainable livelihoods. Access to a better and more varied diet helps address issues related to macronutrient and micronutrient deficiencies, as well as malnutrition or hidden hunger. Singh (2023) emphasizes that the human body requires safe, sustainable, and balanced diets to bridge the gap between nutrient needs and actual intake, thereby correcting undernutrition, overnutrition, and micronutrient deficiencies.

**Provision of underground pillars during mining**

Most of the participants noted that those who go for underground mining make sure they provide underground pillars to avoid subsidence. Pillars serve as standing walls that prevent the collapse of underground roofs. This enabled them to mine the minerals underground to generate income for their families. But there are some instances where miners do remove some of the pillars that hold the roofs as a result of presence of minerals in the standing walls. This has led to collapse of underground walls in different mining communities of Kaduna State. Example of this are the cases of subsidence that occurred at Ungwan Magaji (Mbututu), Godo Godo and Hayin Gada Gidan Waya all of Jema'a local government that led to burial of miners underground. This is what one of the participants has to say: "During underground mining, we make sure we provide pillars to hold the roof in order to prevent it from collapsing. But at times when miners discover that those standing walls/pillars have minerals, they chop them which always lead to collapse of roofs underground and as a result causing death to miners. Just look what happened at Ungwan Magaji, Godogodo and Hayin Gada Gidan Waya recently. People killed themselves just because of minerals. That is what I tried to avoid".

**Strategies to Cope with the Effect of Rainy Season on Mining in Kaduna State**

The study participants also noted that miners prevent underground mining and utilising pumping machine or submersible pump to cope with the effect of rainy season on mining activity.

**Avoiding Underground Mining**

Some participants explained that to cope with the rainy season's impact, miners often avoid underground mining known to cause subsidence and instead adopt surface mining. Rainfall softens and lubricates the soil, increasing the risk of roof collapse in underground pits. To reduce the danger, many miners steer clear of such practices during this period. This aligns with earlier findings (Abubakar, 2019) indicating that excess moisture weakens foundations. However, not all miners see it as a threat, and some continue underground mining despite the risks. For instance, in May 2022, several miners were buried in a collapsed underground pit at Ungwar Magaji in Jema'a Local Government due to subsidence during the rains. Many miners in the study area adopt surface mining during the rainy season due to its lower risk of injury or death. Having abandoned agriculture, they rely on mining as a full-time livelihood. To cope with seasonal hazards, they avoid underground mining despite its richer mineral deposits to reduce the risk of subsidence and accidents caused by rain-softened soil. This shift to surface mining allows continued extraction while minimizing the dangers associated with underground operations during the rainy season.

**Utilisation of pumping Machine**

The study revealed that miners in some communities of Kaduna State utilise pumping machines and submersible pumps to remove water from mining pits and wells, particularly during the rainy season, in order to create space for mineral extraction. This water removal technique is a common adaptation strategy that enables continued mining operations despite heavy rainfall. However, in areas with high water saturation, pits tend to refill quickly even after water has been pumped out. This persistent water accumulation often forces miners to abandon such sites to avoid the risk of pit wall collapse, which can result in serious injuries or fatalities. The rainy season poses a significant challenge to mining activities, as the accumulation of water in pits hinders access to mineral



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deposits. One participant noted that: “We use pumping machines to remove water from pits, but in some areas, water quickly refills due to rising water tables, especially in rainy seasons, making mining impossible. We often abandon such sites to prevent accidents. However, with the help of pumping machine or submersible, water is removed from these pits allowing miners to allow the miners continue with their activities, though subsidence occurs especially when soils have absorbed too much water leading to killings and injuries of miners.

## Conclusion

Mining impacts households in various aspects of their lives, often compelling them to seek alternative means of livelihood. This activity poses significant risks, including the loss of agricultural land, depletion of domestic water sources, destruction of vegetation, and incidents leading to injury or death. It also contributes to social challenges such as school dropouts, unintended pregnancies, and early marriages. In response, households in affected communities have adopted a range of coping strategies to manage the adverse effects of artisanal mining. These include saving money and starting businesses as financial buffers, building homes for personal use or rental income. Additional strategies involve avoiding contaminated water sources, consuming treated or packaged water, and avoiding underground mining during the rainy season. Collectively, these adaptive measures have helped many households in Kaduna State’s mining communities endure the ongoing challenges posed by artisanal mining. Based on these, the study recommends that miners actively engage with their unions and build strong relationships with peers and community members to ensure support during times of need. Ssecondly, miners should ensure safe mining practices by avoiding underground mining and mishandling of mining equipment. Additionally, both households and the government should prioritise the reclamation of degraded surface and underground mining sites for agricultural purposes, as a sustainable strategy to address the growing risk of food insecurity.

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