



From Fields to Pits: Artisanal Mining as a Climate Adaptation Pathway for Women Farmers in Drought-Prone Malole, Zimbabwe

Mbongeni Nhliziyo ^{1*}, Vuyisile Precious Moyo ², Philani Moyo ³,
Douglas Nyathi ⁴, and Wayne Malinga ⁵

^{1,3} University of Fort Hare, Fort Hare Institute for Social And Economic Research, East London, South Africa.

² University of Cape Town, African Climate and Development Initiative, South Africa.

⁴ University of Johannesburg, School of Public Management, Governance and Public Policy, Gauteng, South Africa.

⁵ Lupane State University (Main Campus), Faculty of Humanities and Social Sciences, Department of Development Studies, Lupane, Zimbabwe.

224055406@ufh.ac.za, vuyisile.moyo@uct.ac.za, pmoyo@ufh.ac.za, dnyathi@uj.ac.za,
wmalinga@lsu.ac.zw

Received: 10 April 2025

Accepted: 14 June 2026

Published: 10 September 2026

Abstract:

Rural communities in Zimbabwe's drought-prone regions grapple with severe livelihood insecurity due to the combined effects of climate change, economic instability, and limited access to formal employment. In Malole Village, Insiza District, women smallholder farmers have increasingly turned to artisanal mining as a response to chronic crop failures and acute deagrarianisation. This paper explores the viability of artisanal mining as a climate adaptation strategy for women small-farm holders, aiming to understand its contributions and limitations in enhancing household resilience. Guided by the Sustainable Livelihoods Framework, the research employed a qualitative case study design, incorporating in-depth interviews, focus group discussions, and field observations to capture lived experiences and socio-economic dynamics. Findings reveal that artisanal mining provides an immediate and substantial source of income, enabling women to purchase food, pay school fees, and diversify their livelihoods amid agricultural decline. It also offers a degree of financial autonomy in a context where alternative income-generating opportunities are scarce. However, the study identified significant challenges undermining this adaptation pathway. The criminalization of artisanal mining exposes women to exploitation by sponsors and mine barons, while the lack of legal protection fosters insecurity and vulnerability. Environmental degradation, including deforestation, soil erosion, and abandoned open pits, threatens both ecosystems and long-term agricultural productivity. We argue that while artisanal mining can serve as a short-term coping mechanism, it is not a sustainable adaptation strategy. The study suggests policy changes to formalize and regulate artisanal mining, gender-sensitive capacity-building programs, and integrated rural development initiatives that combine climate-resilient agriculture with safer, environmentally responsible livelihood diversification options.

Keywords: Artisanal mining, Climate adaptation, Sustainable livelihoods, Women, Zimbabwe.

1. Introduction

Climate change represents one of the most pressing contemporary developmental challenges, disproportionately affecting the poor and vulnerable in developing nations. This is acutely true in sub-Saharan Africa, where the frequency and intensity of extreme weather events, such as the ongoing El Niño-induced drought in Southern Africa, are intensifying poverty and undermining livelihoods (Dube et al., 2016; Moyo, 2023; Cai et al., 2025). Within this vulnerable context, women, who constitute the majority of the population and a large share of small-farm holders in countries like Zimbabwe, face a compounded burden. Their livelihoods are predominantly dependent on climate-sensitive, rain-fed agriculture, making them exceptionally susceptible to climatic shocks (Chidakwa et al., 2020; Dibakoane, Siyongwana, & Shabalala, 2022). This vulnerability is further entrenched by socio-cultural norms that often deny women critical assets, including land inheritance and property rights, thereby limiting their adaptive capacity (Nosheen, Iqbal, & Ahmad, 2023; Nyathi et al., 2024). In response to the escalating failure of traditional agriculture, women in drought-prone rural communities are increasingly turning to artisanal and small-scale mining (ASM) as an alternative livelihood strategy. This raises a critical question on how viable artisanal mining is as a climate resilience strategy for women smallholder farmers in poor, drought-prone Zimbabwean communities. This study seeks to answer this question by investigating Malole Village in the Insiza District. It moves beyond a simplistic economic analysis to explore the complex interplay of gender, environment, and institutional structures that shape this adaptation pathway.

The significance of this research lies in its specific focus on women as active participants in ASM, a perspective often overlooked in existing literature. Prior studies, such as Shaba (2024) and Ngwenya et al. (2024), have focused on the negative externalities of mining, including violence against non-mining women. Others, like Moyo et al. (2022) and Moyo (2024), have explored the broader paradoxes of mining and its impact on rural livelihoods. However, a dedicated examination of the unique challenges and opportunities for women small-farm holders who are directly engaged in artisanal mining as an explicit climate adaptation strategy remains

a critical gap. This research aims to fill that void by providing policymakers and academics with a nuanced understanding of how gender norms and government policies facilitate or hinder this endeavor. Globally, women constitute approximately 30% of the ASM workforce, with participation rates in Sub-Saharan Africa ranging from 40% to 50%, and even higher in specific sites (Kumah et al., 2022). In Zimbabwe, where women form roughly 70% of the agricultural labor force (Dube et al., 2021; Phiri et al., 2021), their engagement in mining is a logical, if fraught, response to climate-induced agricultural failure. Their roles are diverse, ranging from labor-intensive extraction and mineral processing, often involving hazardous substances like mercury, to providing essential goods and services as cooks, traders, and shopkeepers within mining communities (Hilson, 2003; Orleans-Boham et al., 2020). This income diversification can offer a vital, immediate financial lifeline, enabling women to meet household needs, pay school fees, and reinvest in farming (Moyo, 2024).

However, this apparent resilience is built on an unstable foundation. The ASM sector in Zimbabwe is characterized by informality, criminalization, and violence (Matanzima, 2025; Shaba, 2024; Matambo et al., 2023; Moyo, Ncube, & Ndlovu, 2022). This environment exacerbates risks for women, exposing them to exploitation by sponsors and middlemen, physical and sexual violence, and societal stigma that can jeopardize marital relationships (Shaba, 2024; Ngwenya et al., 2024). Furthermore, a profound contradiction lies at the heart of this strategy: artisanal mining itself is a significant driver of environmental degradation, including land degradation from open-pit mining and water pollution (Moyo, 2024). This undermines the very natural resource base, healthy land, and water essential for long-term agricultural sustainability and community resilience, potentially creating a maladaptive cycle where short-term gains are achieved at the expense of long-term security. This article is premised on four specific objectives: to assess the gendered climate change vulnerabilities experienced by small-farm holders in Malole Village; to evaluate the effectiveness of artisanal mining as an adaptation strategy for these women; to investigate its socio-economic impacts on their lives; and to identify the key roles of government and development stakeholders in supporting safe and sustainable engagement.

2. Theoretical framework

The Sustainable Livelihoods Framework (SLF) is a conceptual tool developed by the UK Department for International Development (DFID, 1999) to understand the complex and dynamic factors that influence people's ability to secure and sustain their livelihoods. It examines how different forms of capital, that is, human, social, natural, physical, and financial, interact within a given vulnerability context to shape livelihood strategies and outcomes (See Fig 1). The sustainable livelihoods approach focuses on the adaptive capacity of households and communities. It consists of access to assets (physical, social, human, natural, and financial), transformative structures and processes (governance, laws, policies, institutions), and diverse livelihood strategies (Frankenberger et al., 2012; Lan et al., 2021; and Tambe, 2022). Households and communities are more capable of dealing with shocks and stresses when they have i) more than one way of earning a living

(livelihood diversification strategies), ii) access to sufficient livelihood assets (financial, markets, good education, social networks, roads, water, and land), and iii) access to both official and unofficial governing bodies that support resource management, along with supportive policies, laws, and social customs. These elements enable them to adapt effectively by providing essential services, security, and safety nets (Frankenberger et al., 2012; Liu et al., 2020; Mohamed & Mbataru, 2021; Tambe, 2022). In the context of this study, the SLF is particularly relevant for examining artisanal mining as a viable adaptation strategy among women smallholder farmers affected by climate change in Malole Village, Insiza District. Different capitals will be examined to assess how they enhance artisanal mining as a practical alternative strategy for women farmers. The community operates in a context of vulnerability characterized by chronic drought, erratic rainfall, and limited access to formal employment.

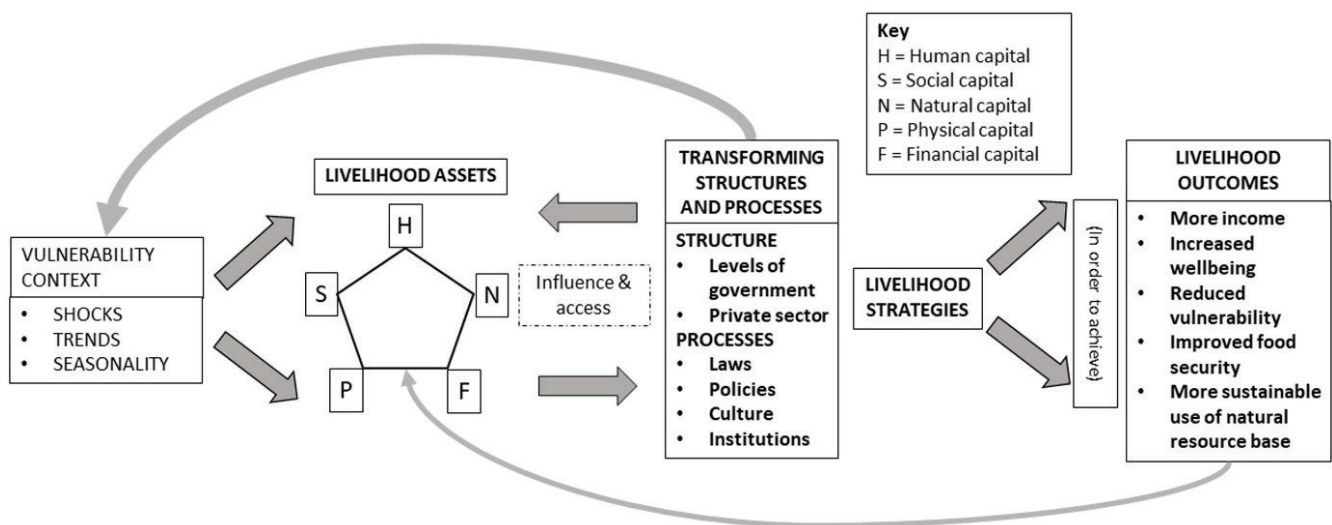


Figure 1: The DFID Sustainable Livelihoods Framework (SLF) (Source: DFID 1999 (cited from Natarajan et al., 2022))

The idea of assets is central to the SLF. Rather than understanding vulnerability and poverty as simply a lack of income, SLF considers the assets poor people need to sustain their families and communities. This article focuses on four types of assets, natural capital (land, water, trees, biodiversity), human capital (skills, knowledge, ability to work), social capital (any assets such as rights or claims that are derived from membership

of a group e.g. ability to call on friends or kin in times of need and support from farmer's organisations), and physical capital (infrastructure like roads, transport and communication systems, shelter, water and sanitation systems, and energy) (Moyo, 2024). A focus on assets or capital helps establish which resources are available and accessible to support flexibility, learning, social organization, and agency in adaptation. With these

assets, women smallholder farmers can pursue a range of livelihood strategies, activities, and choices that ultimately determine their livelihood outcomes.

Moyo (2024) notes that climate change gradually erodes the natural capital (e.g., agricultural land, water resources) on which smallholder farming depends, prompting women farmers to pursue alternative income-generating activities, such as artisanal mining. The SLF enables the study to assess how access to different capitals influences women farmers' ability to enter and benefit from artisanal mining, while also revealing the constraints that limit its sustainability.

Furthermore, the SLF's focus on transforming structures and processes provides an analytical lens for understanding how governance frameworks, policy environments, and power relations, such as the criminalization of artisanal mining and the influence of mine sponsors or barons, shape the risks and opportunities associated with this livelihood strategy. It also facilitates the integration of environmental considerations by highlighting how livelihood activities, such as unregulated mining, can degrade natural capital, thus undermining long-term resilience. Using the SLF allows this study to go beyond a narrow economic evaluation of artisanal mining and instead situate it within the broader socio-economic, environmental, and institutional context. This holistic approach is essential for designing interventions that not only address immediate livelihood needs but also support sustainable adaptation pathways that protect both ecosystems and community resilience in the face of climate change (Chambers & Conway, 1992; Scoones, 2009).

3. Methods

This study employed a qualitative case study research approach to ensure both depth and breadth of understanding. According to Johnson et al. (2007), qualitative research aims to explore participants' experiences of a phenomenon of interest. This study used purposive sampling. Campbell et al. (2020) state that purposeful sampling strategies move away from any random form of sampling and are strategies to ensure that specific types of cases that could be included

are part of the final sample in the research study. Furthermore, Kelly (2010) observes that purposive sampling is used to select respondents most likely to provide appropriate and useful information. Guided by the above assessments, women involved in the ASM sector in Malole were purposively selected to share their experiences of moving from subsistence farming to artisanal mining. Thematic analysis was applied in this study owing to its ability to evaluate participants' experiences, meanings, and realities, and its appropriateness for analyzing the nuances of meaning in textual data (Bryman, 2016).

3.1. Study area

Data for this study were collected in Malole Village, Insiza District, Zimbabwe. Malole Village (ward 10) is located in the Insiza District (see Fig. 2) on the eastern side of Matabeleland, South Province. The village capital is Filabusi, situated 100 km south of Bulawayo, 5 km off the Mbalabala/Zvishavane Road. The land of the village is pronounced as gentle and undulating with scattered granite outcrops. The land has dense bush on red clay soils, whereas light loamy sandy soils have sparse bush or savanna grasslands. Underground rocks contain large reserves of minerals such as gold, asbestos, nickel, and limestone. Small-scale mining includes alluvial gold panning, dump processing, and reef mining. All medium- to large-scale mines were either shut down or maintained. Major rivers found in the village include Malole and Mwele, falling under the Save Basin (Umzingwane catchment). All these rivers have alluvial gold deposits. No major dams were found within the village, and only small farm dams were silted up. The village falls within the Insiza South Constituency and is in agro-ecological zones IV and V. The region is characterized by low, erratic rainfall patterns of less than 650mm per year, droughts, and recurrent heatwaves (Moyo et al., 2019; Dube and Phiri, 2016). The incidence of drought is very high, and the ecologically dry season is the longest. Cattle ranching and other livestock farming, especially goats, have remained the dominant forms of livestock farming. Moyo (2024) notes that rural farmers in this region have long suffered from changes in climatic conditions. What is interesting is that, despite the region being too dry for crop production, communal households continue to grow crops such as maize, millet, and rapoko, *inter alia*.

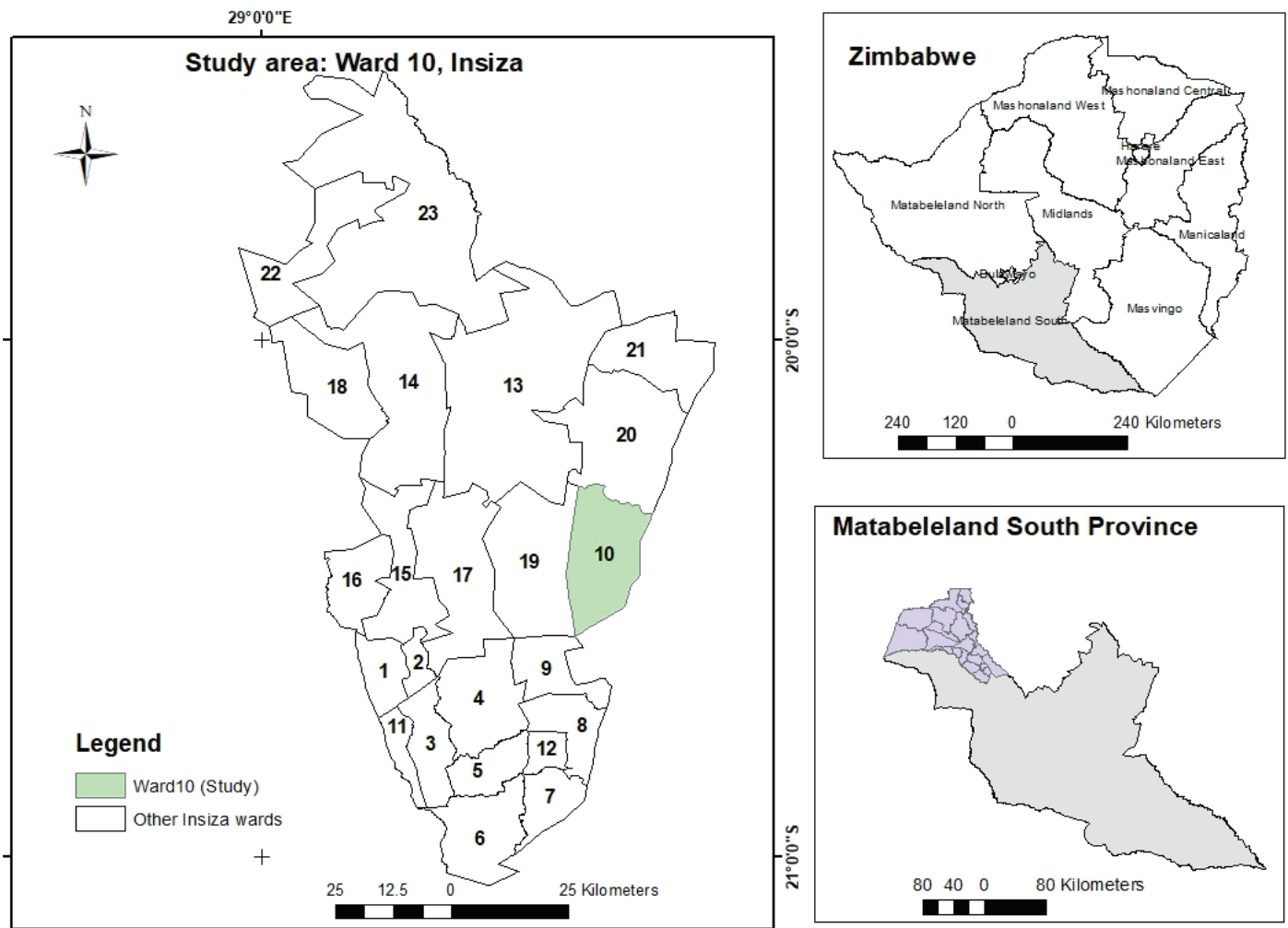


Figure 2: Insiza District map

3.2. Data collection and study analysis

Data collection integrated 10 in-depth interviews with smallholder women farmers, 2 focus group discussions with 6 women each, and field observations to capture a rich, nuanced representation of women smallholder farmers in Malole Village, Insiza District, Zimbabwe. Qualitative tools offered deeper insights into lived experiences and adaptive strategies. In addition, data were gathered from 8 key informants, including 4 representatives of organizations that work with women farmers, 2 local government officials from the Insiza Rural District Council, and 2 Agritex officers. The study also analyzed government policy documents, NGO reports on climate adaptation, artisanal mining, and rural livelihoods. This methodological combination enabled triangulation, enhancing the validity and reliability of the findings while situating local experiences within broader institutional and policy contexts. Thematic analysis was applied in this study owing

to its ability to evaluate participants' experiences, meanings, and realities, and its appropriateness for analyzing the nuances of meaning in textual data (Bryman, 2016).

To bridge the gap between human narratives and measurable resilience indicators, we systematically quantified qualitative data from the in-depth interviews, focus group discussions, and key informant sessions using NVivo software. Following the iterative coding framework established by the Sustainable Livelihoods Framework (SLF), we categorised the data into the SLF's five core capital asset domains.

Using NVivo's coding query and matrix coding features, we translated qualitative indicators into numerical scores on a standardised 1-to-5 Likert-type scale (1 = Very Low/Weak, 2 = Low, 3 = Moderate, 4 = High, and 5 = Very/ High/Strong). This scoring rubric evaluated the intersection of each asset's perceived importance to households against its

actual functional effectiveness under climate stress. We then calculated frequency counts and percentage distributions for reported livelihood strategies and outcomes. Finally, we exported these numerical scores and frequency shares to generate visual outputs that enable a robust quantitative evaluation of women smallholder farmers' adaptive capacities in Malole Village.

4. Findings

Artisanal small-scale mining has emerged as a controversial yet significant alternative livelihood strategy in response to declining agricultural productivity caused by climate change. While illegal and unregulated mining activities contribute to environmental degradation, including the destruction of land and water sources relied upon by women farmers, the sector also provides employment opportunities and financial support for vulnerable rural households. Using the Sustainable Livelihoods Framework as the analytical lens, this study examines how households mobilize human, natural, physical, and social capital to sustain livelihoods within a context of climate vulnerability. The framework also highlights the influence of institutions, policies, and external shocks on livelihood outcomes. In this context, the study specifically explores how artisanal small-scale mining functions as a climate adaptation strategy for women smallholder farmers in Malole Village, balancing both opportunities and socio-environmental challenges.

4.1. Context, conditions, trends

This component explores the broad external environment that shapes livelihoods, including policies and politics. In this case, government regulations, legal frameworks, and power dynamics affect mining operations and access to resources. We note that artisanal mining is not regularized in Zimbabwe; it is, in fact, criminalized. This has a (dis)empowering effect, especially on women small farm holders, who in many cases fear arrest and lose their property to "mine barons/marshals" as protection fees and even law enforcement agents during raids. The lack of recognition also means there is no institutional or financial support that female artisanal miners may receive from the government. This hinders miners from selling their gold at competitive market prices and usually relies on middle buyers who buy it at low prices. In this case, smallholder farmers are experiencing losses

because they often borrow food and other mining equipment, such as shovels, picks, and dishes, for processing, with prices marked up and paid after gold sales. The study also noted that, in most cases, the owners and suppliers of the equipment and food, who are referred to as sponsors, are also buyers of gold, albeit at unfavorable prices. This creates an environment of exploitation and perpetuates inequalities in the village.

The collapsing economy is prompting women to seek alternative livelihood opportunities. The study's findings noted that most smallholder women entered artisanal mining in response to a failing economy and limited employment opportunities in their communities. The rural livelihood context is also affected by droughts, extreme heat, and floods, which negatively impact agricultural activities. This is a microcosm of Malole Village, which faces recurrent droughts. One farmer stated,

In Malole Village, climate change has caused prolonged drought over the past decade, leading to depleted pastures, degraded rangelands, and drying water sources. Both humans and livestock face severe water shortages, while underground water has become increasingly inaccessible. Failed borehole drilling attempts worsen the crisis, forcing families to sell cattle to finance drilling, only to find no water.

4.2. Livelihood resources (Capital assets)

These are the assets or capital that people have access to and can draw upon to pursue their livelihoods. Regarding natural capital, Malole Village has known gold deposits and is surrounded by two rivers, Malole and Mwele, further opening opportunities for alluvial mining, which is rampant. These rivers are also sources of water for agricultural and domestic use. Because these rivers are not privately owned, everyone has access to them for water, fishing, farming (small gardens next to water sources), and mining. The study noted that, while there is limited economic/financial capital for artisanal miners, particularly access to credit, tools, equipment, and infrastructure for transporting minerals, artisanal miners have been able to save and are now able to engage in village savings groups/associations, which they have tapped from in times of drought. Other privileged people have been able to buy their

own equipment and build water infrastructure, such as boreholes. Borehole drilling has not only been a result of artisanal mining; other small-farm women have also sold their livestock to drill boreholes and buy processing plants. Although unregistered, these businesses have been lucrative for smallholder farmers in Malole village. They have not only been a viable livelihood strategy but also a source of employment for young men

who operate stump mills and mechanics during breakdowns. Additionally, small businesses, such as grocery stores and clothing shops, have sprouted around the village. Unfortunately, some concerns have been the emergence of shebeens/taverns selling illicit beer and drugs, which will potentially make the village a hotspot for associated sexually transmitted diseases and HIV/AIDS.

Table 1. Summary of the livelihood assets and observed impacts in Malole

Capital Type	Key Assets	Positive Impacts	Negative Impacts	Overall Condition
Natural	Land, Water, Biodiversity	Food, Grazing, Wild products, minerals	Land degradation, water scarcity, and deforestation	Severely degraded
Physical	Roads, Buildings, Irrigation, and mining equipment	Mining-funded infrastructure	Destroyed roads, theft, and poor maintenance	Declining and not available for poor women
Human	Labour, health, education	Indigenous knowledge, Mining skills training	Migration, illness, and school dropouts	Eroding
Social	Networks, NGOS, Institutions	Remittances, community support	Corruption, breakdown of trust, GBV	Weakening
Financial	Income, savings, livestock	Mining income, ISALs	Unstable Income, Inflation, Livestock Loss	Highly variable

The table above (**Table 1**) shows that natural capital is the most critical, as it is the basis for all mining activities, yet it is the most degraded, creating systemic vulnerability across all livelihood systems. It provides a qualitative summary of the five core assets within the SLF as experienced by women in Malole Village. By categorizing these assets, the table illustrates the Capital Base upon which households attempt to build resilience. The data reveal that while natural capital available at the study site, including land, water, and biodiversity, serves as the primary foundation for local livelihoods, it is currently severely degraded due to the convergence of climate-induced drought and unregulated mining activities. The table highlights a systemic vulnerability in which the depletion of natural and physical capital directly forces reliance on unstable financial avenues, creating a feedback loop of socio-economic insecurity.

For a comprehensive understanding of the relative weight and efficacy of these assets, **Table 2** below adopts a quantitative scoring system (1–5 scale) based on thematic analysis of interview transcripts. Following the process of quantifying qualitative evidence, each score reflects the intersection of perceived importance to the household against the actual functional effectiveness of that capital in the face of climate shocks. For instance, although Social Capital is rated as Very High (5) in importance due to its role in community support networks, its functional effectiveness is rated as High (4) rather than 5, reflecting the breakdown of trust and the rise of conflict observed in the field. This scoring matrix allows for a clearer visualization of where policy interventions are most urgently needed to bridge the gap between asset importance and performance.

Table 2: Scoring of assets in Malole

Capital Type	Importance (1–5)	Effectiveness (1–5)	Justification
Natural	5	2	Core livelihood base but heavily degraded
Physical	3	2	Important, but the infrastructure is dwindling
Social	5	4	Networks and good relations are key in the mining sector
Human	4	3	Most women do not have the skills in mining

Scale – 1=Very Low; 2= Low; 3=Moderate; 4= High; 5=Very High

4.3. Livelihood strategies

This entails how people combine their livelihood resources to achieve their desired outcomes. In Malole Village, artisanal mining has emerged as a viable livelihood strategy. Women Artisanal miners upscaled their mining through alluvial mining and picking up stones from the big mines that they took to the stump mills. One artisanal miner reported that this has been profitable for a few women.

Last year, amid the drought, I ventured into mining after my neighbor introduced me to the opportunity and assured me it could provide a livelihood. We collected stones from the mines, some dropped by trucks, and others left unused when the mines first opened. This endeavor has become our means of living. I remember forming a syndicate of three, and nearly every week, we earn between US\$100 and US\$130. This income has enabled me to pay my grandchildren's school fees, buy food, and even purchase seeds for the farming season.

4.4. Outcomes

Artisanal mining undertaken by female smallholders has yielded mixed results, as detailed in **Table 3** below. It categorizes the Livelihood Outcomes component of the SLF, contrasting the immediate benefits against the long-term costs of artisanal mining as an adaptation strategy. By organizing findings into positive and negative contributions of artisanal mining, the table highlights the trade-offs inherent in this adaptation pathway. The data reveal that while mining provides critical financial capital to meet immediate needs like school fees and food, it generates significant negative externalities for natural and human capital, such as environmental degradation and health risks. Aggregating these qualitative impacts provides a visual assessment of whether artisanal mining acts as a sustainable adaptation pathway or merely a short-term survival mechanism, supporting the argument that current mining practices are essentially a maladaptive cycle.

Table 3. The perceived impact of artisanal mining on women smallholders

Capital Asset	Positive Impacts (Benefits)	Negative Impacts (Costs)
Financial Capital	- Provides a crucial source of cash. - Enables buying food and meeting basic household needs. - Offers an alternative income when agriculture fails or employment is lost.	Income may be unstable and unpredictable.
Human Capital	- Income is used to send children to school and improve human capital. - Improves ability to cope with economic and climate-related shocks.	Mining has promoted school dropouts and a rise in illicit activities.
Natural Capital	Provides an alternative livelihood when agricultural yields are low. People may also rely on wild food in times of drought	- Land is degraded and mining promotes open pits that are left unrehabilitated. - Animals die after falling into mining pits (e.g., at Malole River). - Pits become contaminated and unsafe water sources.
Social Capital	Income helps sustain households from ISALs, and these help the community during crises.	Potential for conflict over resource use and environmental damage.

The results of the study show the connection between climate change-induced shocks and artisanal mining. As Mkodzongi and Spiegel (2019) found, climate-change-driven agricultural poverty

has driven rural people to seek refuge in artisanal mining. In Malole, one finds both licensed and unlicensed operators. Licensed operators are those with mine claims who are registered with

the Ministry of Mines and Mining Development and Insiza Rural District. Most registered operators are men; they employ local people, pay fees to the council, and have some form of corporate social responsibility. One of the female miners reported that artisanal small-scale mining has played a pivotal role in the lives of women farmers in their ward, and she said that:

Legal small-scale mining operators in the ward have positively transformed livelihoods by employing over 150 women in the past three years. The income earned has improved household welfare, enabling families to buy food and pay school fees. Additionally, miners drilled three boreholes, reducing the long distances traveled for water. Their operations demonstrate how responsible mining can support community development.

However, the positive accounts of artisanal small-scale mining came from a few women who seem to benefit directly from the mining because of their political affiliation, rather than from most of the communal farmers. Ordinary women farmers largely condemned artisanal small-scale mining as bringing more harm than good to their already dwindling livelihoods. As indicated, despite the economic gains, artisanal small-scale mining has led to environmental issues, including land degradation, water pollution, and biodiversity loss. Security and safety issues were also reported as being rampant in the area.

One observes that artisanal small-scale mining is on a collision course with the livelihoods of communal farmers. Instead of bringing development, artisanal mining has become a resource curse in Insiza. It has also created a “Dutch disease” as espoused by Moyo *et al.* (2020). Mining areas are now among the most expensive places in Zimbabwe because businesspeople think people there have money from gold. This puts poor rural farmers at more risk as they can hardly afford to pay for basic services or buy foodstuffs. Respondents in the focus group discussions described themselves as unlucky locals who have suffered from artisanal small-scale mining activities. They believe that instead of viewing artisanal small-scale mining as a transformative livelihood strategy, it has greatly destroyed the lives of women farmers. Women were reported

as double victims of artisanal small-scale mining. Besides having their land degraded and rendered unsuitable for agricultural activities, they are not fully accepted into the artisanal mining sector, and those who manage to be part of the sector face challenges of sexual harassment and are looked down on. The interviews and focus groups also highlighted how artisanal mining was connected to corruption.

Desirable outcomes related to sustainability and resilience include increased income, poverty reduction, and enhanced livelihood adaptation. Indeed, the findings indicate that smallholder farmers’ ability to cope with and recover from shocks and stresses, particularly those associated with climate change, has been enhanced. As noted, income from artisanal mining has enabled these women to trade, buy food, and send their children to school during times of need. Notably, these activities are usually funded by agricultural surplus, which is no longer available. Additionally, the unemployment rate means that many breadwinners have lost their jobs and are unable to meet household needs.

Unfortunately, the sustainability of natural resources is unsatisfactory, with significant degradation and open pits left behind. This has affected animals that get trapped while trying to drink water.

I’ve lost animals to the open pits left by miners along the Malole River. These pits pose a significant threat, especially during droughts, as they also serve as a vital water source.

4.5. Institutional processes and organizational structures

This component focuses on formal and informal rules, norms, and organizations that influence access to resources and the pursuit of livelihood strategies. These factors can significantly impact climate resilience in artisanal mining. As noted above, there are challenges in recognizing artisanal mining as a viable enterprise for poor people. Expensive licensing fees and corruption force miners to mine illegally, and alluvial mining has been banned in Zimbabwe (Moyo, 2024). While the respondents acknowledged they were aware of the procedures for obtaining a license, they lacked the capital to do so.

While women have always faced challenges in seeking approval from their husbands, interviewed respondents stated that they did much of the mining with their husbands. In contrast, others received their husbands' approval. It was noted that, due to the challenges and gendered burdens women face, non-governmental organizations were providing women with projects such as goat and poultry keeping, which were seen as sustainable livelihood pathways. However, the return on capital cannot be matched with gold mining. One farmer actually stated that for a goat to reach the gestation period, get pregnant, give birth, and for the offspring to grow, "we are talking about a year, and you sell it for \$50, which you can get in one week from mining." Additionally, these animals require feed that farmers lack access to.

5. Discussion of findings

The study underscores the significant and often detrimental influence of climate and agro-ecology on shaping livelihood trajectories, a factor categorized within the vulnerability context by the Sustainable Livelihoods Framework (SLF). As highlighted in Table 1, the degraded status of natural capital in Malole Village acts as a key driver of vulnerability. This confirms findings by IPCC (2022) that recurrent droughts have severely compromised traditional natural capital, specifically agricultural land and water resources, rendering exclusive dependence on farming unsustainable. Consequently, climate change has acted as a catalyst for community impoverishment, necessitating a shift towards alternative livelihoods. Paradoxically, this environmental transformation has simultaneously unveiled a different form of natural capital: gold deposits and rivers suitable for alluvial mining. This exemplifies the dynamic and substitutable nature of livelihood assets, a central tenet of the SLF (Bebbington, 1999).

Individuals utilize several forms of capital to construct their livelihoods (DFID, 1999). The findings reveal a complex interplay among these capitals. In the absence of formal financial capital, women have developed innovative, informal economic institutions, such as village savings groups, to accumulate resources. Income from mining is subsequently reinvested to build physical capital, such as drilling boreholes that serve both productive and domestic needs, demonstrating a tangible link between different capital assets.

Furthermore, the formation of mining syndicates is a direct response to adversity. It represents the active creation of social capital—networks of trust and reciprocity that facilitate collective action and help navigate a challenging operational environment (Putnam, 2000). The emergence of stump mills and ancillary small businesses illustrates the positive multiplier effects of these strategies, generating new employment opportunities and fostering local economic diversification beyond the immediate mining activities.

Artisanal mining is identified as the core livelihood strategy, often pursued alongside diversification into activities such as petty trading and grass cutting. This diversification is a rational response to the inherent risks of mining and reflects a core principle of the sustainable livelihoods approach: spreading risk to reduce vulnerability to a single shock (Ellis, 2000). The application of mining income to pay school fees, purchase food, and buy seeds signifies a fundamental shift in livelihood pathways. Where households once depended on agricultural surpluses, they now utilize mineral resources to sustain their agricultural potential, illustrating a profound adaptation to a changed environmental and economic context.

The SLF assesses outcomes through the lenses of livelihood enhancement and sustainability (Scoones, 1998). This study reveals profoundly mixed outcomes as summarized in Table 3, while artisanal and small-scale mining (ASM) has generated significant positive livelihood outcomes, including increased income, poverty reduction, and enhanced resilience to climate-related shocks, enabling women to meet essential needs and thereby achieving a key goal of the framework. On the other hand, these gains come at a severe cost to environmental sustainability. The documented environmental degradation, such as deforestation and open pits, poses dangers to livestock and wildlife. The gravity of these costs is confirmed by one participant who stated, "*I've lost animals to the open pits left by miners along the Malole River.*" This validates Hislon's (2002) maladaptive thesis. This tension underscores a fundamental challenge within sustainable development: short-term livelihood gains can directly undermine the natural resource base upon which long-term sustainability depends.

The study strongly supports the significant influence of both formal and informal institutions in determining access to resources and shaping strategies. Formal institutions, such as government policies and laws, often create obstacles, whereas informal institutions, like syndicates and kinship networks, are utilised by women to overcome these challenges. The introduction of alternative livelihood projects by NGOs constitutes an intervention by an external institutional entity. However, a participant's direct feedback offers a critical perspective, highlighting the gap between the slow, small-scale benefits of typical NGO initiatives (such as poultry farming) and the community's urgent, substantial economic needs. This highlights that the perceived logic of a livelihood strategy is highly context-dependent and that external interventions must address local economic conditions and priorities to be successful (Cleaver, 2005).

Gendered nature of the impacts of artisanal small-scale mining

The findings show that artisanal small-scale mining has adversely affected rural women in Malole more than it has affected their male counterparts. Previous empirical studies by scholars such as Moyo (2024), Shaba (2024), and Mawowa (2013) show that artisanal mining-related shocks affect women and men differently because of their expected gender roles in society. In most cases, it is due to their productive and reproductive roles. In Malole, artisanal small-scale mining has worsened the situation of women already affected by climate change. A response from a district official stated that the social and normative constraints on women's roles in choosing artisanal mining as a livelihood strategy are compounded by strong social norms governing their home and childcare responsibilities, which limit their access to knowledge and networks. Responses from focus group discussions and interviews also show a clear difference in roles between males and females. Women's work is often piecemeal, individual, and done in ways that hardly allow them to balance mining with other household obligations. The preceding sentence concurs with Matanzima (2025) and Moyo (2024), who claim that women in artisanal mining are subordinated to domestic households and, hence, cannot be part of a male-dominated artisanal mining sector. Thus, these conditions consign women to both environmental degradation and systemic exclusion challenges.

This is reflected in the low effectiveness scores for human and physical capital in Table 2. Gender inequality was clearly evidenced in Malole. Findings from the study show that women's oppression emerges from specific forms of social organization and subjectivity. Patriarchal norms, beliefs, and values prevent women's full participation in artisanal small-scale mining activities (*woman from a key informant interview*). The lower contribution of women to the artisanal mining sector is often obscured by the dominant male profile in mining, hindering women's meaningful participation (Moyo, 2024).

6. Conclusion

This study's investigation into artisanal mining as a climate adaptation strategy for women smallholder farmers in Malole Village reveals a complex and paradoxical reality. The findings demonstrate that while artisanal mining has emerged as a crucial and effective short-term coping mechanism, its long-term sustainability is severely compromised by a confluence of institutional, social, and environmental constraints. Artisanal mining provides a vital pathway for enhancing livelihood adaptation and resilience. It offers a direct and significant source of income that mitigates the shocks of persistent drought and a failing agricultural economy. For women smallholder farmers in Malole, this activity has become a financial lifeline, enabling them to meet immediate household needs, such as purchasing food, paying school fees, and reinvesting in agricultural inputs. The economic returns from mining are demonstrably superior and more immediate than those from other non-mining strategies, such as small-scale livestock keeping, thereby making it an economically rational choice in the context of deepening climate vulnerability. However, a critical analysis using the sustainable rural livelihoods framework reveals that this resilience rests on an unsustainable foundation. The criminalization of artisanal mining by government authorities creates an environment of exploitation and insecurity. This forces women to operate informally, reliant on exploitative relationships with sponsors and middle buyers who capture a disproportionate share of the profits. This lack of formal recognition and institutional support severely limits their capacity to accumulate secure financial capital or achieve long-term economic stability.

The most significant contradiction, however, lies in the sector's direct undermining of the natural resource base, the very foundation of a sustainable rural livelihood. The study confirms that rampant, unregulated mining is causing significant environmental degradation, including the proliferation of dangerous open pits that directly threaten livestock and local ecosystems. This environmental cost, coupled with attendant social risks such as the emergence of illicit activities and health hazards, indicates that gains in immediate resilience are being achieved at the expense of future sustainability. Above all, artisanal mining in Malole Village represents a powerful, yet fragile, testament to the ingenuity of women adapting to profound systemic shocks. The study contends that for this practice to evolve from a mere coping mechanism into a genuinely sustainable livelihood strategy, it must be accompanied by supportive institutional and policy reforms. This necessitates the formalization and regulation of the sector to protect laborers from exploitation, provide secure tenure and access to fair markets, and mandate environmental rehabilitation. Without such targeted interventions, artisanal mining's viability as a pathway to genuine climate resilience will remain profoundly limited, perpetuating a cycle in which immediate survival is prioritized to the expense of long-term security and environmental integrity.

Disclosure Statement and Competing Interests: No potential conflict of interest was reported by the author(s)

Informed consent: Written consent was obtained from all participants.

Funding: The authors received no direct funding for this research.

Consent to publish: All participants provided consent for anonymized data to be used in scientific publications.

Data availability statement: The data for this study are available on request from the corresponding author.

ORCID

Mbongeni Nhliziyo: 0000-0001-5579-562X

Vuyisile Precious Moyo: 0000-0003-4305-5178

Philani Moyo: 0000-0002-9089-7565

Douglas Nyathi: 0000-0003-1310-627X

Wayne Malinga: 0000-0003-3446-3313

References:

- Ayanlade, A., Oluwaranti, A., Ayanlade, O. S., Borderon, M., Sterly, H., Sakdapolrak, P., Jegede, M. O., Weldemariam, L. F., & Ayinde, A. F. O. (2022). Extreme climate events in sub-Saharan Africa: A call for improving agricultural technology transfer to enhance adaptive capacity. *Climate Services*, 27(100311), 100311. <https://doi.org/10.1016/j.cliser.2022.100311>
- 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>
- Bebbington, A. (1999). Capitals and capabilities: A framework for analyzing peasant viability, rural livelihoods and poverty. *World Development*, 27(12), 2021-2044. [https://doi.org/10.1016/s0305-750x\(99\)00104-7](https://doi.org/10.1016/s0305-750x(99)00104-7)
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77-101. <https://doi.org/10.1191/1478088706qp0630a>
- Cai, W., Reason, C., Mohino, E., Rodríguez-Fonseca, B., Malherbe, J., Santoso, A., Li, X., Chikoore, H., Nnamchi, H., McPhaden, M. J., Keenlyside, N., Taschetto, A. S., Wu, L., Ng, B., Liu, Y., Geng, T., Yang, K., Wang, G., Jia, F., ... Mutemi, J. N. (2025). Climate impacts of the El Niño-Southern oscillation in Africa. *Nature Reviews Earth & Environment*, 6(8), 503-520. <https://doi.org/10.1038/s43017-025-00705-7>
- Campbell, S., Greenwood, M., Prior, S., Shearer, T., Walkem, K., Young, S., Bywaters, D., & Walker, K. (2020). Purposive sampling: Complex or simple? Research case examples. *Journal of Research in Nursing*, 25(8), 652-661. <https://doi.org/10.1177/1744987120927206>

- Carraro, C. (2016). Climate change: Scenarios, impacts, policy, and development opportunities. *Agricultural Economics*, 47(S1), 149–157. <https://doi.org/10.1111/agec.12306>
- Chidakwa, P., Mabhenha, C., Mucherera, B., Chikuni, J., & Mudavanhu, C. (2020). Women's vulnerability to Climate change: Gender-skewed implications on agro-based livelihoods in Rural zvishavane, zimbabwe. *Indian Journal of Gender Studies*, 27(2), 259–281. <https://doi.org/10.1177/0971521520910969>
- Cleaver, F. (2005). The inequality of social capital and the reproduction of chronic poverty. *World Development*, 33(6), 893–906. <https://doi.org/10.1016/j.worlddev.2004.09.015>
- Department for International Development DFID. (1999). *Sustainable livelihoods guidance sheets*.
- Dibakoane, S., Siyongwana, P., & Shabalala, A. N. (2022). Vulnerability, impact and adaptation strategies of female farmers to climate variability. *Jambá: Journal of Disaster Risk Studies*, 14(1). <https://doi.org/10.4102/jamba.v14i1.1302>
- Dube, T., Moyo, P., Ncube, M., & Nyathi, D. (2016). The impact of climate change on Agro-Ecological based livelihoods in Africa: A review. *Journal of Sustainable Development*, 9(1), 256. <https://doi.org/10.5539/jsd.v9n1p256>
- Dube, T., Ncube, C., Moyo, P., Phiri, K., & Moyo, N. (2021). Marginal communities and livelihoods: San communities' failed transition to a modern economy in Tsholotsho, zimbabwe. *Development Southern Africa*, 38(6), 1031–1045. <https://doi.org/10.1080/0376835x.2021.1955660>
- Ellis, F. (2000). *Rural livelihoods and diversity in developing countries*. 17.Oxford University Press.
- Gbegbelegbe, S., Serem, J., Stirling, C., Kyazze, F., Radeny, M., Misiko, M., Tongruksawattana, S., Nafula, L., Gakii, M., & Sonder, K. (2017). Smallholder farmers in eastern Africa and climate change: A review of risks and adaptation options with implications for future adaptation programmes. *Climate and Development*, 10(4), 289–306. <https://doi.org/10.1080/17565529.2017.1374236>
- Gizaw, M. S., & Gan, T. Y. (2016). Impact of climate change and el niño episodes on droughts in sub-Saharan Africa. *Climate Dynamics*, 49(1–2), 665–682. <https://doi.org/10.1007/s00382-016-3366-2>
- Hilson, G. (2002). The environmental impact of small-scale gold mining in Ghana: Identifying problems and possible solutions. *The Geographical Journal*, 168(1), 57–72. <https://doi.org/10.1111/1475-4959.00038>
- Hilson, G., Hilson, A., & McQuilken, J. (2016). Ethical minerals: Fairer trade for whom? *Resources Policy*, 49, 232–247. <https://doi.org/10.1016/j.resourpol.2016.05.002>
- Intergovernmental Panel on Climate Change. (IPCC). (2019). *Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems*. Ipcc.Ch; Special Report on Climate Change and Land. <https://www.ipcc.ch/srcccl/download/>
- IPCC. (2022). *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.
- Johnson, R. B., Onwuegbuzie, A. J., & Turner, L. A. (2007). Toward a definition of mixed methods research. *Journal of Mixed Methods Research*, 1(2), 112–133.
- Jordaan, S. M., Davidson, A., Nazari, J. A., & Herremans, I. M. (2019). The dynamics of advancing climate policy in federal political systems. *Environmental Policy and Governance*, 29(3), 220–234. <https://doi.org/10.1002/eet.1849>
- Kelly, B. C. (2010). Sampling and recruitment issues in qualitative drugs research: Reflections on the study of club drug users in metro New York. *Substance Use & Misuse*, 45(5), 671–683.
- Kumah, C., Hilson, G., & Quaicoe, I. (2020). Poverty, adaptation and vulnerability: An assessment of women's work in Ghana's artisanal gold mining sector. *Area*, 52(3), 617–625. <https://doi.org/10.1111/area.12639>

- Lunduka, R. W., Mateva, K. I., Magorokosho, C., & Manjeru, P. (2017). Impact of adoption of drought-tolerant maize varieties on total maize production in south eastern zimbabwe. *Climate and Development*, 11(1), 35–46. <https://doi.org/10.1080/17565529.2017.1372269>
- Matambo, M., Moyo, G., Mukonza, R. M., & Zendera, D. (2023). Machete-wielding Gangs in Zimbabwe's Mining Sector: Implications for Peace and Equitable Resource Extraction at Local Level. *African Journal of Peace and Conflict Studies*, 12(1), 47–66.
- Matanzima, J. (2024). "Disempowered by the transition": Manipulated and coerced agency in displacements induced by accelerated extraction of energy transition minerals in Zimbabwe. *Energy Research & Social Science*, 117, 103727. <https://doi.org/10.1016/j.erss.2024.103727>
- Mawowa, S. (2013). The political economy of Artisanal and Small-Scale gold mining in Central zimbabwe. *Journal of Southern African Studies*, 39(4), 921–936. <https://doi.org/10.1080/03057070.2013.858540>
- Moyo, F., Mthuthukisi Ncube, & Thabo Ndlovu. (2022). *The competing Nature-Based Livelihood-Strategies: Artisanal Small-Scale mining (ASM) perspectives in Agricultural-Communities in Umzingwane district, zimbabwe thabo ndlovu*. 1(2), 171–199. <https://doi.org/10.31920/2753-3182/2022/v1n2a7>
- Moyo, P. (2023). *Climate action in Southern Africa : Implications for Climate Justice and Just Transition*. Taylor & Francis.
- Moyo, V. P. (1980). *Rural farmers' adaptive and transformative capacity in response to climate change and small-scale artisanal mining in Gwanda, Zimbabwe* [Doctoral dissertation].
- Mugiyo, H., Magadzire, T., Choruma, D. J., Petrova, G., Manzou, R., Obert Jiri, & Tafadzwanashe Mabhaudhi. (2023). El niño's effects on southern african agriculture in 2023/24 and anticipatory action strategies to reduce the impacts in Zimbabwe. *Atmosphere*, 14(11), 1692–1692. <https://doi.org/10.3390/atmos14111692>
- Natarajan, N., Newsham, A., Rigg, J., & Suhardiman, D. (2022). A sustainable livelihoods framework for the 21st century. *World Development*, 155, 105898.
- Nosheen, M., Iqbal, J., & Ahmad, S. (2023). Economic empowerment of women through climate change mitigation. *Journal of Cleaner Production*, 421, 138480. <https://doi.org/10.1016/j.jclepro.2023.138480>
- Nyahunda, L., Calvin, M. J., Mabvurira, V., & Frans Koketso, M. (2020). Vulnerabilities and inequalities experienced by Women in the climate change discourse in South africa's rural communities: Implications for Social work. *The British Journal of Social Work*, 51(7), 2536–2553. <https://doi.org/10.1093/bjsw/bcaa118>
- Nyahunda, L., & Tirivangasi, H. M. (2022). Adaptation strategies employed by rural women in the face of climate change impacts in Vhembe district, limpopo province, south Africa. *Management of Environmental Quality: An International Journal*, 33(4). <https://doi.org/10.1108/meq-09-2021-0207>
- Nyasimi, M., & Huyer, S. (2017, June 6). *Closing the gender gap in agriculture under climate change*. Handle.Net. <https://hdl.handle.net/10568/81376>
- Nyathi, D., Joram Ndlovu, Mare, A., Dzvimbo, M. A., & Mduduzi Ndlovu. (2024). Women's vulnerability and adaptive capacity to Climate change in Agrarian settings of Zimbabwe. *Climate Change Management*, 541–559. https://doi.org/10.1007/978-3-031-58261-5_23
- Orleans-Boham, H., Sakyi-Addo, G. B., Tahiru, A., & Amankwah, R. K. (2020). Women in artisanal mining: Reflections on the impacts of a ban on operations in Ghana. *The Extractive Industries and Society*, 7(2), 583–586. <https://doi.org/10.1016/j.exis.2020.03.004>
- Phiri, K. (2014). Climate change impacts on rural based women: Emerging evidence on coping and adaptation strategies in Tsholotsho, zimbabwe. *Mediterranean Journal of Social Sciences*, 5(23). <https://doi.org/10.5901/mjss.2014.v5n23p2545>

- Phiri, K., Nhliziyo, M., Madzivire, S. I., Sithole, M., & Nyathi, D. (2021). Understanding climate smart agriculture and the resilience of smallholder farmers in Umguza district, zimbabwe. *Cogent Social Sciences*, 7(1). <https://doi.org/10.1080/23311886.2021.1970425>
- Putnam, R. D. (2000). *Bowling alone: The collapse and revival of American community*. Simon & Schuster.
- Scoones, I. (1998). *Sustainable rural livelihoods. A framework for Analysis. IDS working paper 72*.
- Shaba, J. (2024). *Women in Mining Worlds: a socio-environmental history of women in artisanal gold mining in Zimbabwe, with specific reference to Mazowe district, c. 1932 to 2021* [Doctoral dissertation].
- Spiegel, S. J. (2015). Shifting formalization policies and recentralizing power: The case of Zimbabwe's artisanal gold mining sector. *Society & Natural Resources*, 28(5), 543–558. <https://doi.org/10.1080/08941920.2015.1014606>